**IUGG Joint Tsunami Commission Working Group on Terminology**

**IOC/ITIC Tsunami Glossary Comments**

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# 1.Tsunami Classification

**Local tsunami**

A tsunami from a nearby source for which its destructive effects are confined to coasts less than 1 hour tsunami travel time, or typically within about 200 km from its source. A local tsunami is usually generated by an earthquake, but can also be caused by a landslide or a volcanic eruption (pyroclastic flow, debris flow, underwater explosions). Over history, 90% of tsunami casualties have been caused by local tsunamis

# 2. General tsunami terms

**Eddy**

***Comment by W. Power:*** *I find this definition a bit confusing, the analogy with a molecule is unclear, and “glob” is a vague term to me. See my suggested replacement below.*

~~By analogy with a molecule, a “glob” of fluid within the fluid mass that has a certain integrity and life history of its own; the activities of the bulk fluid being the net result of the motion of the eddies.~~

A persistent swirling motion in a body of water.

**Historical tsunami data**.

Data collected on past tsunamis that has been recorded in historical records.Historical data are available in many forms and at many locations. These forms include published and unpublished catalogs of tsunami occurrences, personal narratives, marigraphs, tsunami amplitude, runup and inundation zone measurements, field investigation reports, newspaper accounts, film, or video records.

**Seiche**

A seiche is a standing wave oscillation ~~A seiche may be initiated by a standing wave oscillating~~ in a partially or fully enclosed body of water. It may be initiated by long period seismic waves (an earthquake), wind and water waves, or a tsunami.

**Tsunami generation**

The process in which a tsunami is initially generated. Tsunamis are most frequently caused by earthquakes, but can also result from landslides, volcanic eruptions, and very infrequently by meteorites or other impacts upon the ocean surface. Tsunamis are generated primarily by tectonic dislocations under the sea which are caused by shallow focus earthquakes along areas of subduction. The upthrusted and downthrusted crustal blocks impart potential energy into the overlying water mass with drastic changes in the sea level over the affected region. The energy imparted into the water mass results in tsunami generation, i.e. energy radiating away from the source region in the form of long period waves.

<<Figure and caption below to be added to existing figures>>

*Source mechanisms of volcanic tsunamis (modified after Paris et al., 2014).*



Caption : In the case of a volcanic eruption, tsunamis might be generated by landslides (A and B), pyroclastic flows (C), caldera collapse (D), underwater explosions (E), blast (F) or volcano-tectonic earthquakes (G).

**Tsunami generation theory**

A theory to explain the generation of tsunamis by a particular physical mechanism. The theoretical problem of generation of the gravity wave (tsunami) in the layer of elastic liquid (an ocean) occurring on the surface of elastic solid half-space (the crust) in the gravity field can be studied with methods developed in the dynamic theory of elasticity. The source representing an earthquake focus is a discontinuity in the tangent component of the displacement on some element of area within the crust. For conditions representative of the Earth’s oceans, the solution of the problem differs very little from the joint solution of two more simple problems: The problem of generation of the displacement field by the given source in the solid elastic half-space with the free boundary (the bottom) considered quasi-static; and the problem of the propagation of gravity wave in the layer of heavy incompressible liquid generated by the known (from the solution of the previous problem) motion of the solid bottom. There is the theoretical dependence of the gravity wave parameters on the source parameters (depth and orientation). One can roughly estimate the quantity of energy transferred to the gravity wave by the source. In general, it corresponds to the estimates obtained with empirical data. Also, tsunamis can be generated by other mechanisms such as landslides (both subaerial and submarine), volcanic eruptions, asteroids, or nuclear explosions, thus implying different wave generation mechanisms.

<<Below is a suggestion for a simplified and shortened version of the above paragraph. It could optionally be merged with the entry for ‘Tsunami Generation’ as a second paragraph under that heading, in which case the first sentence below would be removed>>

A theory to explain the generation of tsunamis by a particular physical mechanism. For earthquakes the fault rupture is described as a dislocation in an elastic half-space, using the theory of elastic dislocations an estimate is made of the consequent displacement of the seabed (which is represented by the free surface of the half-space). The distribution of seabed displacement can then form the input to a tsunami model, or it can be used to estimate the potential energy of the tsunami according to the change in potential energy of the water displaced vertically by the seabed movement. On slopes with slopes, the vertical component of the horizontal component of displacement also occurs, which contributes to the generation of tsunami.As tsunamis can also be generated by other mechanisms such as landslides (both subaerial and submarine), volcanic eruptions, asteroids, or nuclear explosions, there are different wave generation mechanisms for these sources.

**Tsunami hazard assessment**

An assessment, typically in the form of a report, identifying and documenting the level of tsunami threat to which a population or set of assets is exposed. Documentation of tsunami hazards for a coastal community is needed to identify populations and assets at risk, and the level of that risk. This assessment requires knowledge of probable tsunami sources (such as earthquakes, landslides, and volcanic eruptions), their likelihood of occurrence, and the characteristics of tsunamis from those sources at different places along the coast. For those communities, data of earlier (historical and paleotsunamis) tsunamis may help quantify these factors. For most communities, however, only very limited or no past data exist. For these coasts, numerical models of tsunami inundation can provide estimates of areas that will be flooded in the event of a local or distant tsunamigenic earthquake or a local landslide.

**Tsunami impact**

The actual or potential consequences of a tsunami. Although infrequent, tsunamis are among the most terrifying and complex physical phenomena and have been responsible for great loss of life and extensive damage. Because of their destructiveness, tsunamis have important impacts on the human, social, and economic sectors of societies. Over the last 3600 years, there have been 252 fatal tsunamis and more than 540,000 deaths. The worst catastrophe in history was the 26 December 2004 Sumatra, Indonesia tsunami that killed 228,000 people in 14 Indian Ocean countries and caused $10 billion in damage. The Pacific Ocean, however, is where 70% of the world’s tsunamis occur. 99% of the deaths were caused by local tsunamis, which are those hit in less than 1 hour tsunami travel time. Since 81% of the tsunamis are Generated by shallow great earthquakes, shaking and damage from the earthquake is the 1st hazard to address before the tsunami arrives.

In Japan, which has one of the most populated coastal regions in the world and a long history of earthquake activity, tsunamis have destroyed entire coastal populations. There is also a history of severe tsunami destruction in Alaska, the Hawaiian Islands, Indonesia, and South 18 Tsunami Glossary 2019 America.The last major Pacific-wide tsunami was the 11 March 2011 Japan tsunami which killed more than 18,000 in Japan and 2 persons in the far field.

 **Tsunami numerical modelling**

Mathematical descriptions that seek to describe the observed tsunami and its effects.

Often the only way to determine the potential runups and inundation from a local or distant tsunami is to use numerical modelling since data from past tsunamis is usually insufficient. Models can be initialized with potential worst case scenarios for the tsunami sources or for the

waves just offshore to determine corresponding worst case scenarios for runup and inundation. Models can also be initialized with smaller sources to understand the severity of the hazard for the less extreme but more frequent events. This information is then the basis for creating tsunami evacuation maps and procedures. At present, such modelling has only been carried out for a small fraction of the coastal areas at risk. Sufficiently accurate modelling techniques have only been available in recent years, and these models require training to understand and use correctly, as well as input of detailed bathymetric and topographic data in the area being modelled.

Numerical models have been used in recent years to simulate tsunami propagation and interaction with land masses. Such models usually solve similar equations but often employ different numerical techniques and are applied to different segments of the total problem of

tsunami propagation from generation regions to distant areas of runup. For example, several numerical models have been used to simulate the interaction of tsunamis with islands. These models have used finite difference, finite element, and boundary integral methods to solve the linear long wave equations. These models solve these relatively simple equations and provide reasonable simulations of tsunamis for engineering purposes.

Tsunami warning centres use numerical models to forecast expected wave arrival times, directions of maximum tsunami energy, strength of near-shore water currents, and coastal wave height. This important information helps emergency response officials to plan and focus relief on where the impact is expected to be the greatest.

The choice of the model depends on the geometry and duration of the source, the quality of the available grid used for calculation, and the computing capacities. Sophisticated models such as dispersive, coupled flow/water models may have a very high computational cost. The modelling strategy is thus mostly guided by the objectives to be fulfilled: understanding the physics or evaluating hazards will not require the same approach.

Considering that landslide and volcanic tsunamis are usually characterized by intermediate to deep-water waves (shorter wave-lengths compared to tectonic tsunamis), it is highly recommended to use weakly dispersive, depth-averaged models (models based on the Boussinesq approximation) or fully dispersive three-dimensional models (e.g. Reynolds-averaged, Navier-Stokes models).

**Tsunami propagation**

The spreading and travel of a tsunami from its source.Tsunamis travel outward in all directions from the generating area, with the direction of the main energy propagation generally being orthogonal to the direction of the earthquake fracture zone. Their speed depends on the depth of water, so that the waves undergo accelerations and decelerations in passing over an ocean bottom of varying depth. In the deep and open ocean, they travel at speeds of 500 to 1,000 km per hour (300 to 600 miles per hour). The distance between successive crests can be as much as 500 to 650 km (300 to 400 miles). However, in the open ocean, the height of the waves is generally less than a meter (3 feet) even for the most destructive teletsunamis, and the waves pass unnoticed. Variations in tsunami propagation result when the propagation impulse is stronger in one direction than in others because of the orientation or dimensions of the generating area and where regional bathymetric and topographic features modify both the waveform and rate of advance. Specifically, tsunami waves undergo a process of wave refraction and reflection throughout their travel. Tsunamis are unique in that the energy extends through the entire water column from sea surface to the ocean bottom. It is this characteristic that accounts for the great amount of energy propagated by a tsunami.

# 3. Surveys and Measurements

**Initial rise time *Comment by W. Power:*** *Changed the name of the definition..*

~~Time of the first minimum of the tsunami waves~~.

Time of the first rise in water level relative to the background tidal level.

**Inundation**

***Comment by W. Power:*** *Have separated 'Inundation' from 'Inundation distance'. However, I think 'Inundation' probably belongs better in the 'General Tsunami Terms' section.*

The process of overland flooding caused by a tsunami.

**Inundation-distance**

The horizontal distance inland that a tsunami penetrates, generally measured perpendicularly to the shoreline.

**Modified Sieberg sea-wave intensity scale**

***Comment by W. Power:*** *There are other intensity scales, why is the focus on this particular one?*

**Post-tsunami survey**

A field survey to collect data in the immediate aftermath of a tsunami. Tsunamis are relatively rare events and most of their evidence is perishable. Therefore, it is very important that reconnaissance surveys be organized and carried out quickly and thoroughly after each tsunami occurs, to collect detailed data valuable for hazard assessment, model validation, and other aspects of tsunami mitigation. Since the early 1990s, post-tsunami reconnaissance surveys have been organized following each major destructive tsunami to make measurements of runups and inundation limits, to collect associated data from eyewitnesses such as the number of waves, arrival time of waves, and which wave was the largest, and to assess human response to tsunami danger. The surveys have been organized on an ad-hoc basis, facilitated and coordinated by the IOC and ITIC working with the affected country, and conducted by international academic tsunami researchers (International Tsunami Survey Team, ITST). The IOC-ITST Post-tsunami Survey Field Guide (Manuals and Guides 37, 1998, 2nd Edition 2014, IOC/2014/MG/37) provides a flexible framework for undertaking surveys, their guiding principles and protocols data types, and observations to be taken to standardize data collection.

**Wave trough *Comment by W. Power:*** *Should this definition have a second component like that of ‘Wave crest’?*

1. The lowest part of a wave.

2. That part of the wave below still water level.

# 4. Tide, Mareograph, Sea Level

**Refraction diagrams**

Models using water depths, direction of wave, separation angle, and ray separation between two adjacent rays as input, to produce the path of wave orthogonals, refraction coefficients, wave heights, and travel times.

**Sea surface height**

Height of the Sea Surface relative to a reference level.Satellite altimeters monitor Sea Surface Height (SSH), and can record a snapshot of the propagating tsunami if the satellite orbit is located above the tsunami. During the 2004 Indian Ocean tsunami and 2011 Tohoku tsunami, several satellites captured the tsunami as it propagated across the Indian and Pacific Ocean, respectively.

# 6. Bibliography

<<Add the following reference under the ‘Technical’ category>>

Paris, R., Switzer, A.D., Belousova, M., Belousov, A., Ontowirjo, B., Whelley, P.L., Ulvrová, M., 2014. Volcanic tsunami: a review of source mechanisms, past events and hazards in Southeast Asia (Indonesia, Philippines, Papua New Guinea). Natural Hazards 70 (1), 447-470.