

Historical Tsunami Effects from the 2004 Indian Ocean Tsunami

The 2004 Indian Ocean tsunami was the deadliest tsunami in history. In total, 227,899 people were killed or went missing, and are presumed dead, in 15 countries across South Asia, East and Southern Africa and in the Indian Ocean. Approximately 1.7 million people were displaced by the earthquake and subsequent tsunami. Earthquake and tsunami death tolls could not be separated, as the tsunami waves followed within as few as 20 minutes.

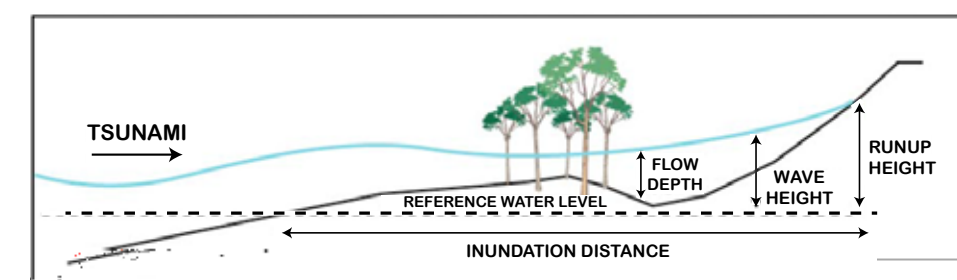
The earthquake of 26 December 2004 was the result of thrust faulting on the interface of the India and the Burma plates. The fault rupture propagated to the northwest from the epicenter for a total rupture length estimated at 1,200-1,300 km. The average displacement along the fault was likely 10–15 m, and in some locations possibly up to 20 m. The moment magnitude (M_w) attributed to the earthquake ranges between 9.1-9.3. Due to the earthquake, the sea floor was uplifted by several meters generating the destructive tsunami that impacted the Indian Ocean.

International Tsunami Survey Teams conducted post-tsunami science surveys in affected countries in the days and weeks after to collect runup and inundation data, building damage, eyewitness interviews, tsunami sediments, and marine and coastal ecosystem impacts. A total of 2,159 tsunami observations, with over 580 runup observations from Indonesia are available, with a maximum runup of 51 meters in Aceh Province, Northern Sumatra. At least 220 sea level gauges recorded the tsunami, with the majority of the instruments recording the tsunami located more than 1,000 km from the source in locations including the Atlantic, Pacific and Southern Oceans. In the Indian Ocean, sea level gauge observations of 1-2 m were reported from Sri Lanka, India, Seychelles, Oman, South Africa, Indonesia, Thailand and the Maldives, but none of these data were available in real-time for tsunami monitoring and to assist in tsunami warning.

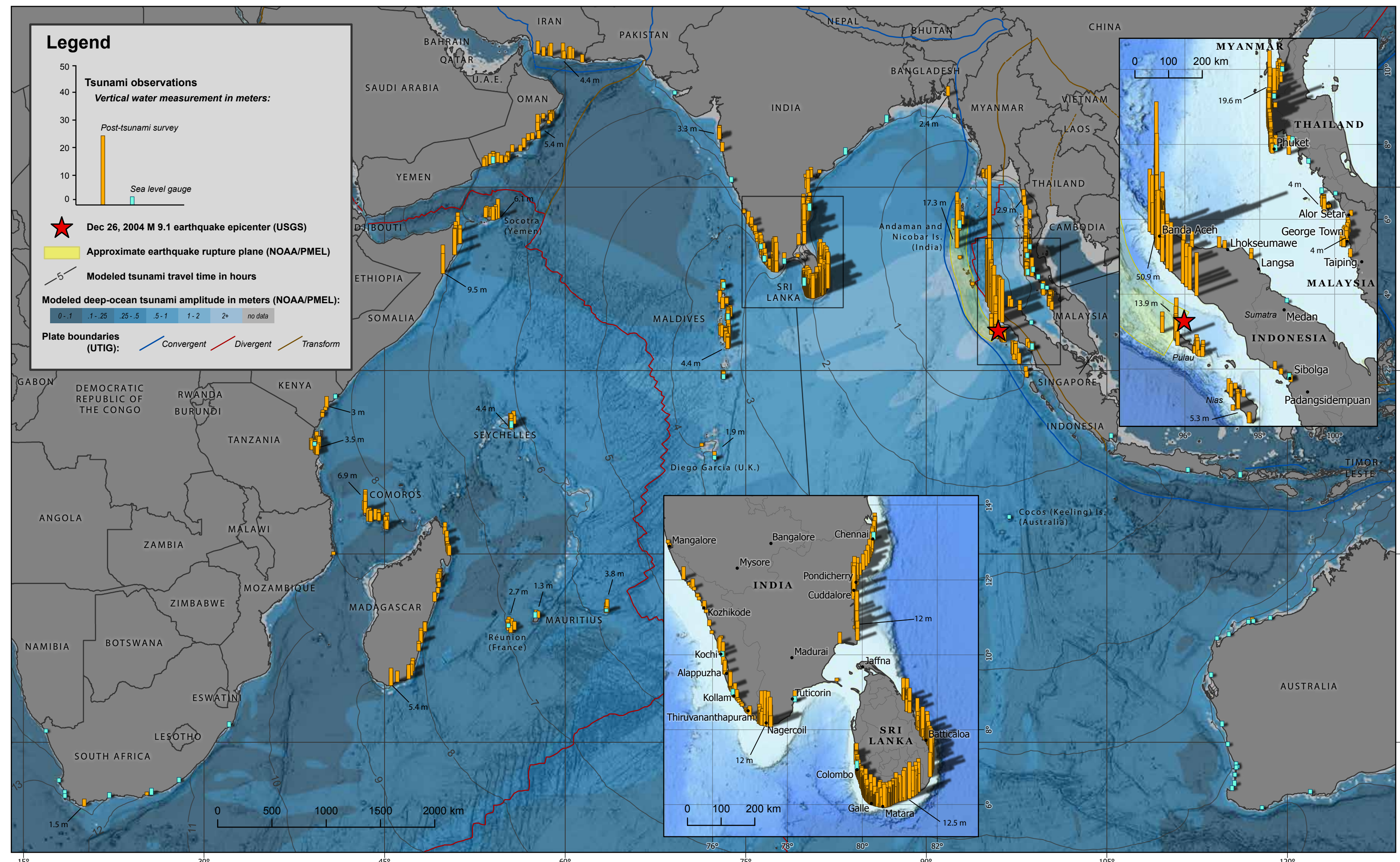
Additionally, approximately 600 post-tsunami survey images have been archived by NCEI, and more than 1,000 by the ITIC. Additionally, almost 150 peer-reviewed papers detailing deposits, sediments and other geological effects from the 2004 tsunami have been compiled by NCEI.

The total estimated material losses in the Indian Ocean region were over \$10 billion. The loss of lives and impacts led to the establishment of an interim warning system in the Indian Ocean in March 2005, and the formation of tsunami warning and mitigation systems for the Indian Ocean, Caribbean, and North-Eastern Atlantic and Mediterranean in June 2005 under the coordination of the UNESCO Intergovernmental Oceanographic Commission. These regional systems, together with the Pacific system established in 1965 after the M9.5 Chilean earthquake and tsunami, comprise the global tsunami warning system.

This poster summarizes the 2004 tsunami observations and images made available to the International Tsunami Information Centre (ITIC), a UNESCO-IOC / NOAA partnership, and NOAA's National Centers for Environmental Information (NCEI) and co-located World Data Service (WDS) for Geophysics. For a complete listing of references used in compiling the database, please visit: <https://www.ncei.noaa.gov/products/natural-hazards>

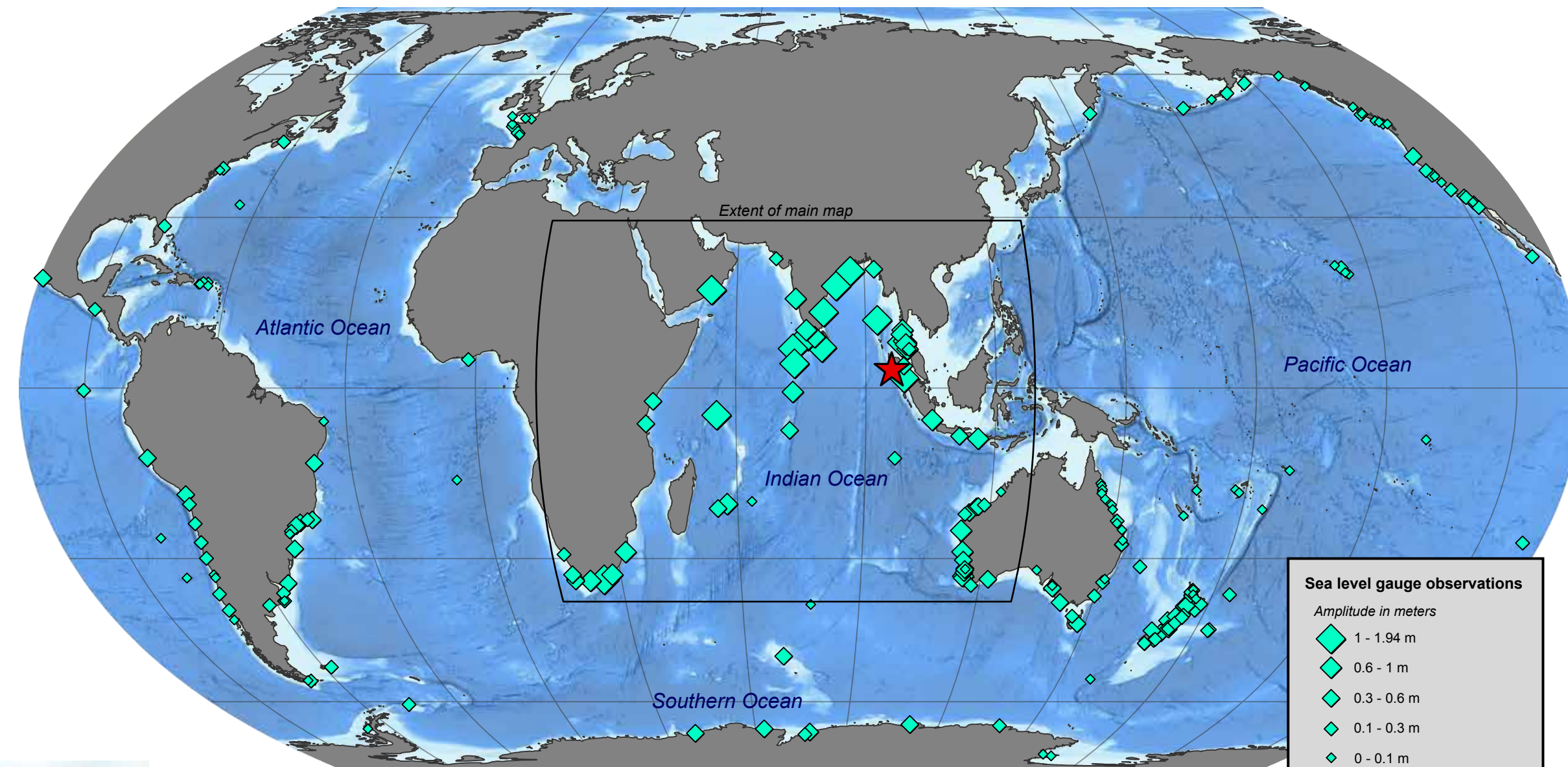


Tsunami hydrodynamic data terminology (after ITST Post-Tsunami Survey Field Guide, 2nd ed, IOC MG 37, UNESCO, 2014).



Country	Dead/Missing	Total Nbr of Runup Observations	Maximum Runup Height (m)	Damage (USD million)*
Indonesia	167,540	585	50.9	4452
Sri Lanka	35,322	408	12.5	1317
India	16,269	316	17.3	1023
Thailand	8,212	113	19.6	1000
Somalia	289	28	9.5	100
Maldives	108	169	4.4	470
Malaysia	75	60	4	500
Myanmar	61	24	2.9	500
Tanzania	13	20	3.5	
Yemen	2	20	6.1	
Seychelles	2	21	4.4	31
Bangladesh	2	2	2.4	500
South Africa	2	10	1.5	
Kenya	1	6	3	100
Madagascar	1	55	5.4	
Total	227,899	1,837	-	9993

*The dollar value listed is the value at the time of the event, if known.



Waves crushed structures, jammed boats into bridges, and filled rivers with debris. Banda Aceh, Indonesia. Credit: Badan Arsip Daerah Aceh



Waves derailed and overturned 8-car train, killing ~1700. Peraliya, Sri Lanka. Credit: Sena Vidanagama



Air Force building, Car Nicobar Island, India. Credit: Disaster Management, Andaman & Nicobar Islands



Khao Lak, Thailand. Credit: Khao Lak Ausflüge



Malé, Maldives. Credit: Sofwathulla Mohamed



Tsunami runup and inundation, Banda Aceh, Indonesia October 2024. Credit: Yuichi Nishimura

	Total Number of Observations		Local*		Distant**	
	Number of Observations	Maximum Height (Location)	Number of Observations	Maximum Height (Location)	Number of Observations	Maximum Height (Location)
Sea Level Gauge†	220	1.9 m (Colombo, Sri Lanka)	10	1.8 m (Port Blair, Andaman and Nicobar Isl.)	210	1.9 m (Colombo, Sri Lanka)
Post-tsunami survey††	1,939	50.9 m (Aceh, Indonesia)	784	50.9 m (Aceh, Indonesia)	1,155	12.5 m (Yala, Sri Lanka)

*Observation <1000 km from the source epicenter
 **Observation >1000 km from the source epicenter
 †Half of the maximum height (minus the normal tide) of a tsunami wave recorded at the coast by a sea level gauge. Also called the amplitude. ††Runup