

CEDIM Forensic Disaster Analysis Group (FDA)

Volcano & Tsunami Hunga Tonga

Information as of 18th January 2022 – Report No. 1

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SUMMARY

Official Disaster Name	Date	Arrival UTC	Local
2022 Tonga Volcanic Eruption & Tsunami	15-01	4:15 UTC	+13

Location Information:

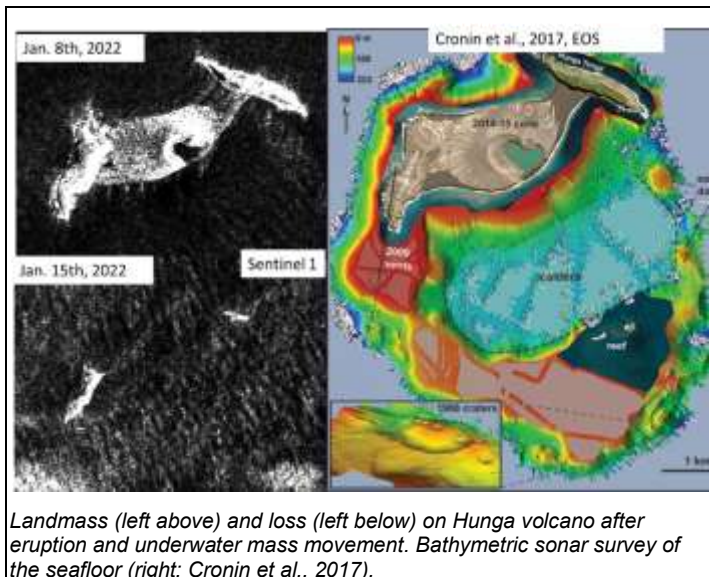
Country	ISO	Dev. Region	Most Impact	Building PF	HDI (2019)	GDP (2021)	Pop. (2021)
Tonga	TON	Tongatapu	Nuku'alofa, Hihifo	Medium	0.725	\$530 mn.	100,209

Volcano Description:

Hunga Tonga is a large undersea volcano about 70 km North-West from Tongatapu in the South-Western Pacific. The volcano is formed by 2 small islands, Hunga Tonga and Hunga Ha'apai which have been connected by recent eruptions in 1988, 2009 and 2014-2015. However, most of the volcano is submerged and lies at around 150 to 200 m below sea level and has a diameter of about 10 km.

Cronin et al. (2017) report that the volcanic system already had very violent and explosive eruptions in the past, indicating a major event about 1000 years ago. Such an eruption is often associated with a large underwater mass movement which can trigger major tsunamis.

Hazard Information

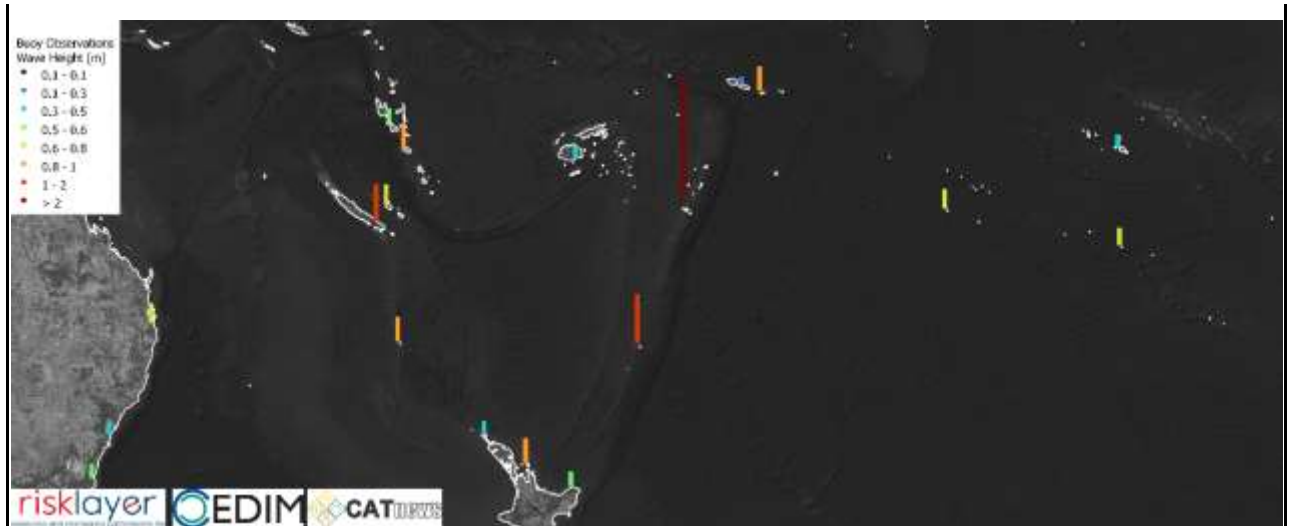
 <p>Landmass (left above) and loss (left below) on Hunga volcano after eruption and underwater mass movement. Bathymetric sonar survey of the seafloor (right; Cronin et al., 2017).</p>	<p>The eruption sequence started on Dec. 20th, 2021 with a single eruption. It was followed by a larger event on Jan. 14th and the main eruption starting on Jan. 15th around 17:15 local time (04:15 UTC). All eruptions were associated with a loud sonic boom. The explosion of the main eruption was heard over thousands of kilometers.</p> <p>The main eruption triggered a major mass movement, which is the anticipated source for the tsunami afterwards. The tsunami was observed on Tongatapu within 15min and disrupted energy supplies. The tsunami was observed all around the Pacific and Coral & Tasman sea with run-ups of up to 3m. Run-Up on Tonga was probably much higher.</p>
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Preferred Damage Information:

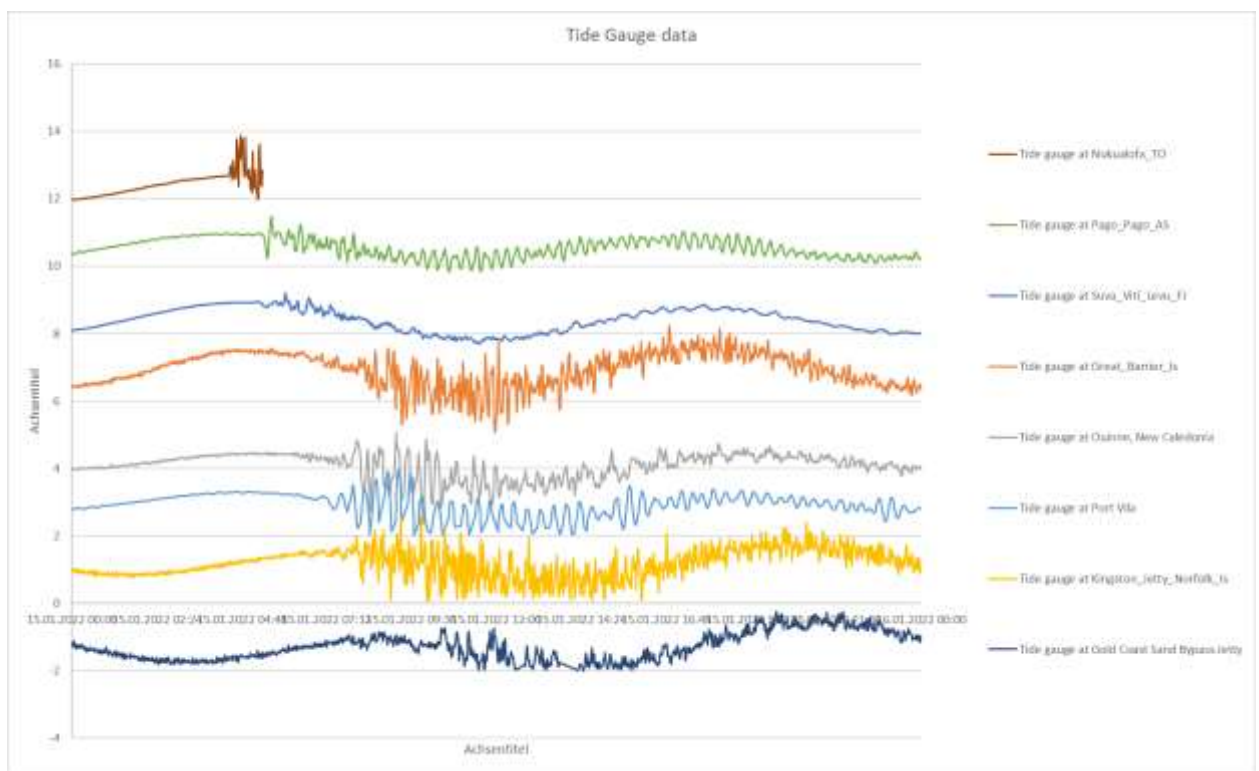
Description:

Local major inundation on Tonga, run-up of 2-5m and local moderate & minor inundation along the Coral Sea (run-up <0.5-3m) and along the Pacific (run-up 0.5-1.5m)

The tsunami reached the coasts of Tongatapu within 15min and many more islands in the following hours. IOC buoys indicate offshore wave heights beyond 2m for Raoul Island (New Zealand), 1.5m Ouinne, New Caledonia and 0.5m for Gold Coast, Australia. Various islands of Tonga experienced partial inundation. The small, uninhabited islands of Nuku and Tau have been completely eroded. Inundation on Tongatapu (especially Hihifo) and Nomuka destroyed several buildings. Coral reefs and barrier islands played a major role in reducing the tsunami's impact.



Wave heights on offshore buoys (source: <http://ioc-sealevelmonitoring.org/map.php>).



Tide Gauge data from various stations around Tonga, each curve has been vertically offset to better compare arrival times.

Preferred Social Impact Information:

Type	Total	Description	Source
Deaths	3(+2)	2 Deaths have been reported from Peru, where 2 swimmers drowned. 2 People on Tonga still missing, with 1 confirmed dead	News reports
Injuries	Several	Reports still coming in from Ha'apai	**
Homeless/Displaced	At least 250	Expected to rise with additional reports	Reliefweb

Preferred Current Economic Impact Information:

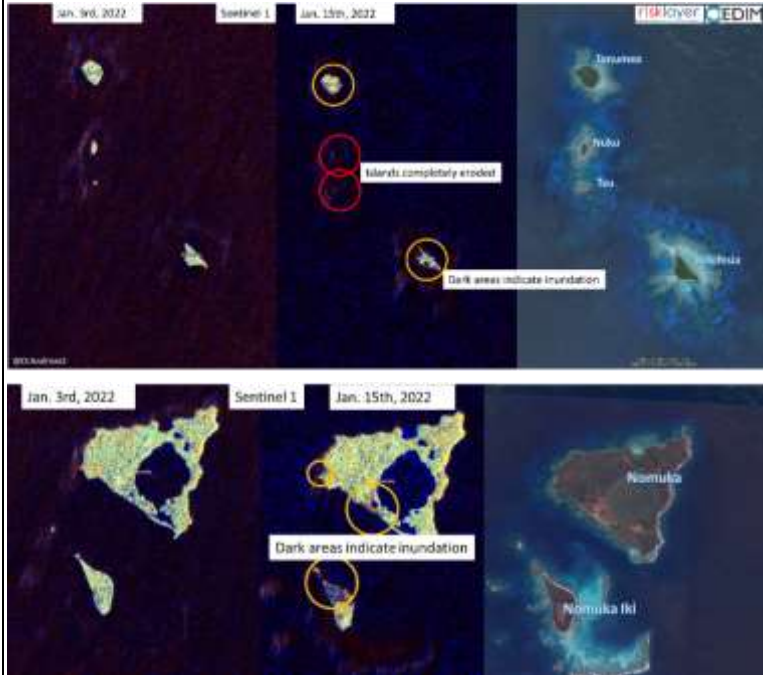
Type	Value	Description	Source
Destroyed Units	>75	Collapsed or washed away	Ground Reports (WHO, Tonga)
Damaged Units	>150	Including minor, moderate and severe structural damage	Ground Reports (WHO, Tonga)
Ships		Mostly small fishing boats	
Total Loss	No estimate	Total loss including infrastructure, residential, public and business and tourism	

The major damage is associated with the breakage of the undersea cable from Fiji to Tonga, with repairs likely to take in the order of 2-3 weeks. In addition, the resorts on the western beaches of Tongatapu appear to be significantly damaged. Major damage has been seen in Ha'apai islands. The economic losses associated with such an outage will be large, given the costs and scarcity of satellite phones. Local phone networks however have been restored, as well as power to most of the capital of Tongatapu. There is a major problem of ash on the runway at Tongatapu, meaning that relief planes are mostly unable to land to deliver aid.

Additional costs associated with the clean up and removal of ash will be needed as well in the agriculture sector (due to significant damages in this sector), as well as potential infrastructure issues with contamination of water supply. So far at least 75 destroyed buildings have been reported (with at least 50 on Tongatapu), and an additional 150 damaged buildings (with at least 100 on Tongatapu).

Fiji also has seen impacts due to the event due to the tsunami as well as volcanic ashfall.

Local Impact:



The tsunami highly affected nearby islands. Some very small islands, including Nuku and Tau both just 0.5 and 1.0 km² respectively, have been eroded. Several other islands, most of them uninhabited, show signs of inundation on Sentinel-1 imagery.

Similarly, Nomuka island, with 300-400 inhabitants also show traces of tsunami inundation. Most other islands further North, including Pangai and Vava'u only experienced minor run-up (<2 m).

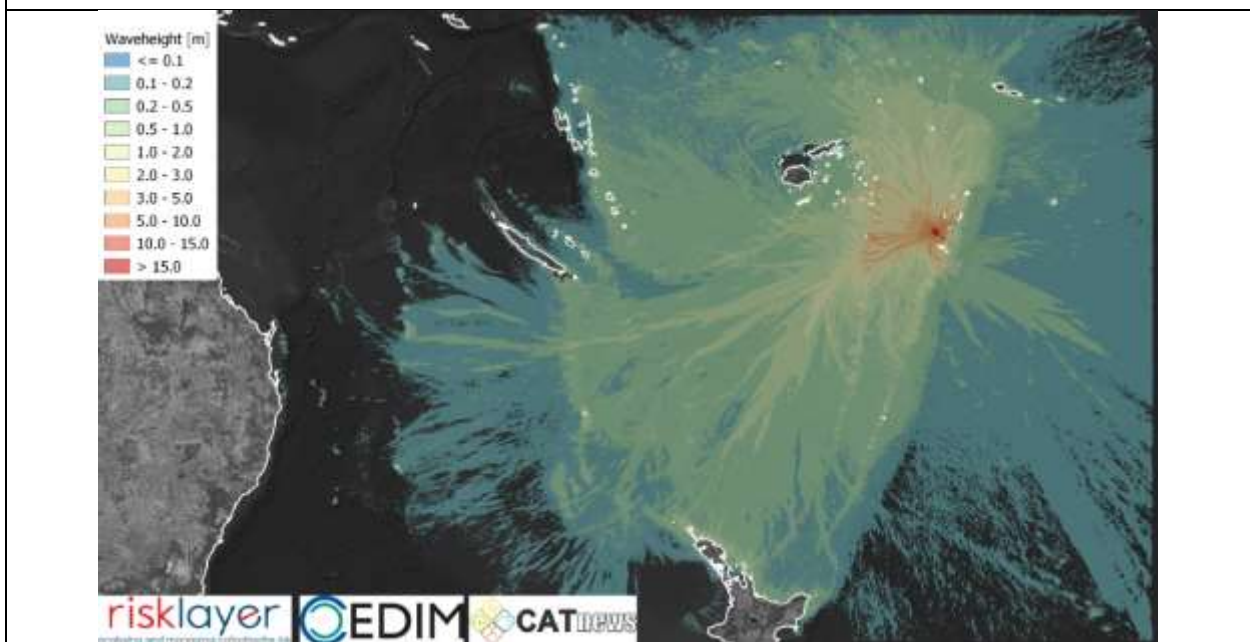
It can be observed that natural coastal protection by coral reefs and barrier islands significantly reduced the impact of the tsunami wave.

This has been confirmed through UNOSAT photos for Nomuka Village, Mu'omu'a District, Ha'apai Division. As part of the international charter, 250 structures were identified, with 104 in a cloud free area, with 41 structures identified as damaged (<https://reliefweb.int/map/tonga/damage-assessment-nomuka-village-muomu-a-district-haapai-division-nomuka-island-17-january>).

All structures have been covered with light ash (<5cm), however this is not deemed enough to cause tephra collapses. Additional costs however will be seen associated with agriculture, with 2-5cm ashfall enough to cause significant losses in most crop types. Vegetables and Fish, make up a large percentage of Exports from Tonga, thus the losses may be significant pending further analysis. However, the level of exports via world standards is very low (ca. \$15mn in total per year), thus comparatively the losses on a global scale will be minute.



Comparison of initial tsunami inundation simulation with first local reports.



Initial estimate of tsunami wave pattern in South Pacific and Coral & Tasman Sea. Wave heights for Fiji, New Caledonia, New Zealand and Samoa close to observation. But underestimation of far-field wave heights including Australia and later-on in the Pacific for Japan, Chile or California.

References:

Cronin, S. J., Brenna, M., Smith, I. E. M., Barker, S. J., Tost, M., Ford, M., Tonga'onevai, S., Kula, T., and Vaiomounga, R. (2017), New volcanic island unveils explosive past, *Eos*, 98, <https://doi.org/10.1029/2017EO076589>. Published on 26 June 2017.

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