Historical Tsunami Effects near the New Hebrides Trench (1849-2019)

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Introduction

Vanuatu and New Caledonia are vulnerable to local, regional, and distant tsunamis generated around the Pacific. NOAA's National Centers for Environmental Information (NCEI) and co-located World Data Service (WDS) for Geophysics, and the International Tsunami Information Center (ITIC), a UNESCO/IOC-NOAA partnership, have collaborated to produce a poster showing historical tsunami effects in New Caledonia and Vanuatu. NCEI/WDS provides long-term archive, data management, and access to global tsunami data. ITIC works to mitigate the effect of tsunamis throughout the Pacific, and has collected post-tsunami event information to support hazard assessment since its inception in 1965.

New Caledonia and Vanuatu lie on either side of the Northern New Hebrides Trench, a convergent plate boundary where the Australia plate subducts eastwards beneath the Pacific. Along this boundary the convergence rate between the Australian and Pacific plates has been estimated as 60–120 mm per year. Large subduction zone earthquakes are most common along the northern portion of the New Hebrides Trench, though occasional strike-slip earthquakes occur near the D'Entrecasteaux ridge. A reverse fault in the back-arc of Vanuatu is segmented by transverse faults. In 1999, the reverse fault generated one of two known deadly events in the region. A total of 17 volcanoes are in the area, however, none are known to have generated a historical tsunami.

Tsunamis in New Caledonia and Vanuatu

Examination of the NCEI/WDS Global Historical Tsunami Database reveals that the earliest confirmed historical account of a tsunami impacting either New Caledonia or Vanuatu was in 1849. This tsunami was generated by an earthquake off of Kamchatka, Russia, and was observed in Vanuatu. The first tsunami observed in both New Caledonia and Vanuatu was generated by an earthquake off of Loyalty Islands in 1875. This tsunami resulted in 25 deaths and a 2.5 meter wave at Lifou Island, New Caledonia. The only larger recorded tsunami wave in New Caledonia was the 3 meter tsunami wave in 1942 generated by an unknown source, a local earthquake and/or landslide are suspected sources.

The only other confirmed historical tsunami to cause deaths in the region occurred in 1999, generated on the previously described reverse fault in the back-arc of Vanuatu. The tsunami resulted in a 6.6 meter wave and five deaths at Baie Martelli, Vanuatu. The death toll could have been much higher had it not been for indigenous knowledge, as well as public outreach conducted three weeks prior by the Vanuatu National Disaster Managment Office. The highest historical tsunami wave runup in Vanuatu is 12 meters on Tanna Island generated by a nearby earthquake in 1878.

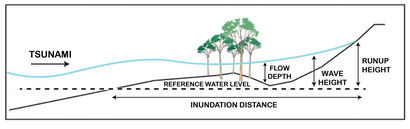
Distribution of Tsunami Sources

From 1849 to 2019, there were over 75 confirmed tsunamis observed in Vanuatu and New Caledonia. Approximately 40% of the tsunamis were observed only in Vanuatu, while just under 25% were observed only in New Caledonia. Approxmiately 35% of the tsunamis where observed in both island groups. Of these confirmed tsunami observations, approximately 55% originated from local/regional sources (<1000 km from the observed location).

Vanuatu has observed tsunami waves primarily from local/regional sources (70%). Moreover, Vanuatu has not observed runups >2m from sources ≥200 km in distance.

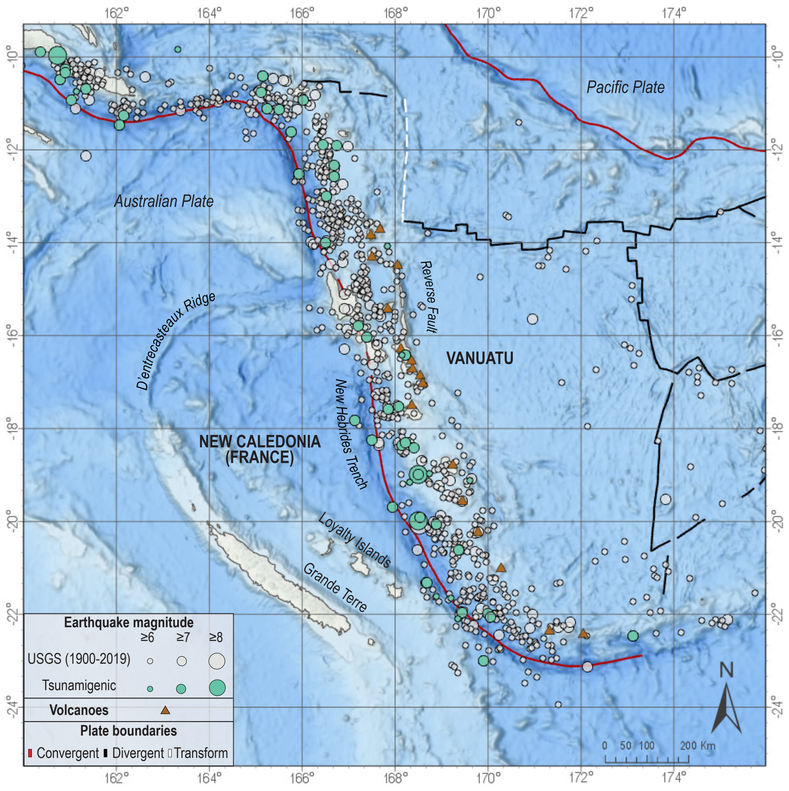
Approximately 60% of tsunami waves observed in New Caledonia were from distant sources (>1,000 km). New Caledonia has observed tsunami waves ≥1 m from three separate distant source tsunami events.

After 2001, the tide gauge network in the region was expanded, resulting in increased detection of small amplitude tsunamis. A total of 59 tsunami events have registered on tide gauges in Vanuatu and New Caledonia. Of the tsunami events detected by tide gauges, less than 20% were also observed by eyewitnesses or post-tsunami surveys. As such, tide gauges are historically important for observing tsunamis in Vanuatu and New Caledonia, particularly from distant source tsunamis that make up 50% of the tsunami tide gauge observations.

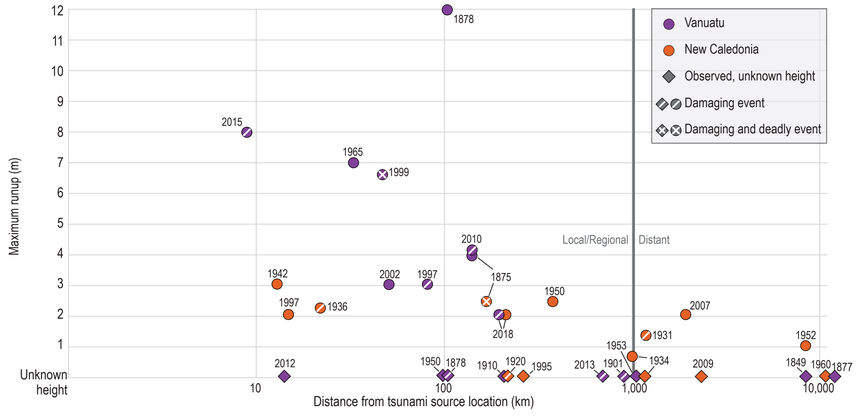


Tsunami hydrodynamic data terminology (after ITST Post-Tsunami Survey Field Guide, 2nd ed, IOC MG 37, UNESCO, 2014).

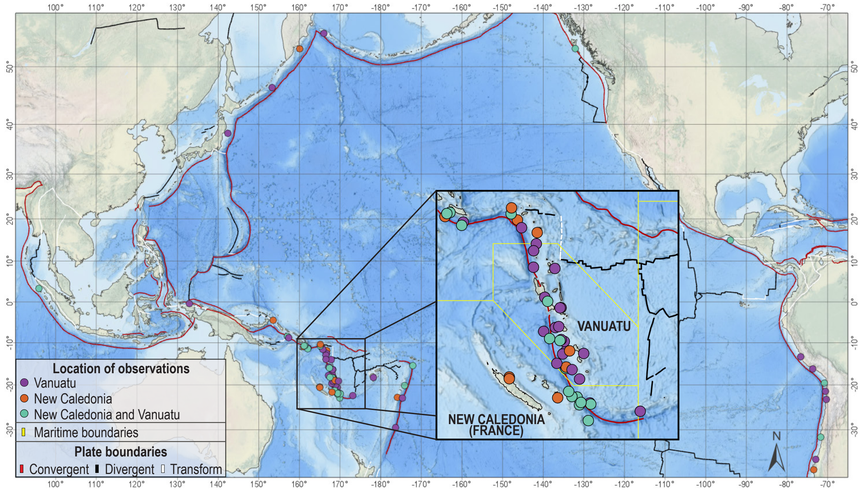
Regional Geologic Context



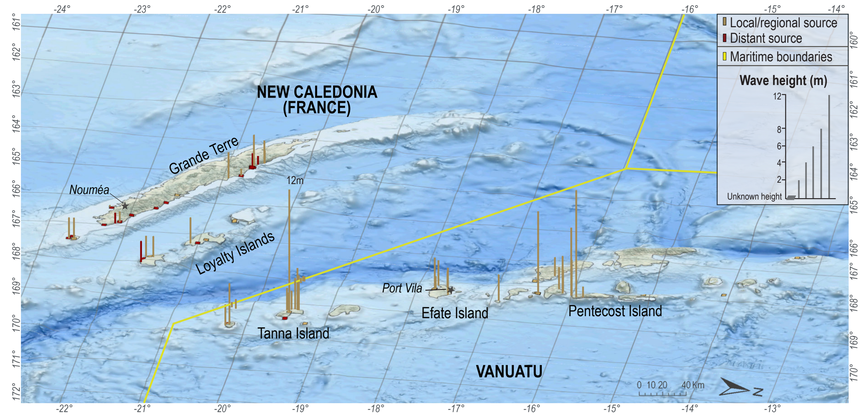
Maximum Tsunami Runups



Confirmed Tsunami Source Locations



Historical Tsunami Observations: Eyewitness or Post-tsunami Survey



Historical Tsunamis in Vanuatu and New Caledonia (≥1 m Runup or Damage)

Year	Source Location	Eq Magnitude	Max Runup Height (m)		Damage (Deaths)		Locations of Effects
			NC	Vanuatu	NC	Vanuatu	
1875	Loyalty Islands, NC	8.0	2.5	4	X (25)		Mou and Thoth, Lifou Is.
1878	Tanna Island, Vanuatu	7.5	-	12		X	Tanna Is.
1901	Loyalty Islands, NC	7.9	-	^OBS		X	Vanuatu Is.
1920	Vanuatu Islands	7.8	^OBS	-	X		Ougnat, Ouvea
1931	San Cristobal Island, SI	7.8	1.3	-	X		Hienghene, Grande-Terre
1936	New Caledonia‡		2.2	-	X		Bwelic, Grande-Terre
1942	New Caledonia‡		4	-			Kade We, Grande-Terre and Ile-des-Pins
1950	Vanuatu Islands	7.8	2.5	^OBS			Poindimié, Grande-Terre and Erakor Is.
1952	Kamchatka, Russia	9.0	1	-			Yate River, Grande-Terre
1961	Vanuatu Islands	7.3	-	0.9*		X	Forari and Port Vila, Efate Is.
1965	Vanuatu Islands	7.0	-	7			Malakula Is.
1997	Santa Cruz Islands, SI	7.7	-	3		X	Linua Is.
1997	New Caledonia‡		2	-			Mare Is.
1999	Vanuatu Islands	7.5	-	6.6		X (5)	Baie Martelli, Pentecost Is. and Tisman Bay Malakula Is.
2002	Vanuatu Islands	7.2	-	3			Port Vila, Efate Is.
2007	Solomon Islands	8.1	2	0.12*			Mare Is.
2010	Vanuatu Islands	7.3	-	4.1		X	Tanna Is.
2013	Santa Cruz Islands, SI	7.9	0.77*	0.33*†		X	Maskelyne Is.
2015	Vanuatu Islands	6.4	-	8		X	Paama Is.
2018	Loyalty Islands, NC	7.5	2	2		X	Aneityum Is.

‡ Unknown source
^Unknown runup height
*Tide Gauge measurement
†Eyewitness observation exists but runup height unknown

The village of Baie Martelli, Vanuatu, was destroyed after the 1999 tsunami. The large concrete village church (center image) was one of the few structures that remained standing following the tsunami. However, water surged over the top of the church (over 4 m above ground surface), crushing its corrugated metal roof. (Image Credits: Costas Synolakis (left), Utku Kanoglu (center, right))

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