ICG/PTWS-XXX
NATIONAL REPORT
Submitted by FRANCE (FRENCH POLYNESIA)

BASIC INFORMATION

1. ICG/PTWS Tsunami National Contact (TNC)

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2. ICG/PTWS Tsunami Warning Focal Point (TWFP) and National Tsunami Warning Centre (NTWC)

2.1 TWFP Agency Name:

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Direction de la Protection Civile (DPC)
High Commissioner of Republic in French Polynesia

TWFP Agency Contact

Name:
Position: Director (Colonel)
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TWFP 24x7 point of contact :

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2.2 NTWC Agency name:

Laboratoire de Géophysique de Tahiti (LDG-Tahiti) (CEA)
Centre Polynésien de Prévention des Tsunamis (CPPT)
French Polynesian Tsunami Warning Center

NTWC Agency Contact

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3. Tsunami Advisor(s),

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4. Tsunami Standard Operating Procedures for a Local Tsunami

The Laboratoire de Géophysique de Tahiti (LDG-Tahiti) is monitoring regional seismicity and submarine volcanic activity since 60 years.
Currently, based on the seismic historical activity in French Polynesia, there is no local tsunami hazard from local earthquake. On the other hand, volcanic activity in French Polynesia region is not significant to be considered potentially tsunamigenic.

Nevertheless, there is a very rare occurrence of very localized tsunami generated by cliff failure (at Fatu-Hiva, Marquesas archipelago,1999) or submarine landslide (underwater scars).

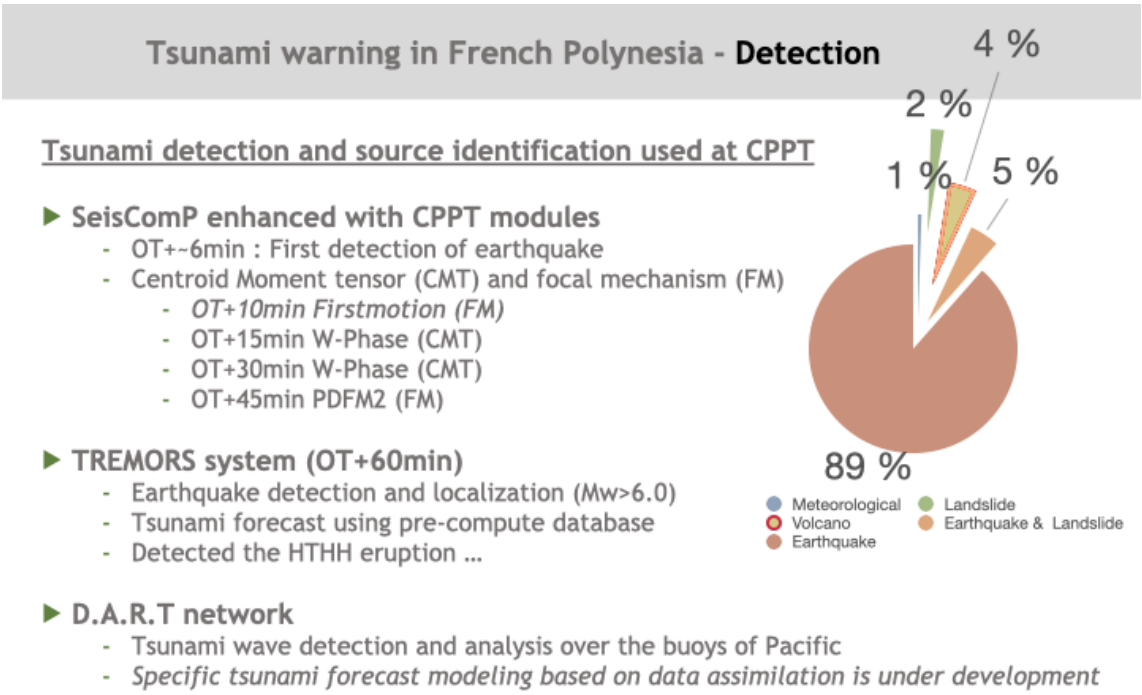
Procedure related to local tsunami are not implemented.

5. Tsunami Standard Operating Procedures for a Distant Tsunami

- ***What organization identifies and characterizes tsunamigenic events?***
  Laboratoire de Géophysique de Tahiti / Centre Polynésien de Prévention des Tsunamis
  LDG-Tahiti/CPPT (French Polynesian Tsunami Warning Center)

- ***What is the threshold or criteria for declaring a potential tsunami emergency?***
  Seismic alarm is triggered at the CPPT as soon as we detect an earthquake of a Mw > 7.0, then an automatic tsunami warning is disseminated to the Direction de la Protection Civile – DPC (= Direction of Civil Defense) with an automatic adaptative response following the source parameters.

  The NTWC has currently 3 independants mode to trigger its preliminary alarm based on earthquake detection by the Seiscomp System and TREMORS system and also from the Pacific DART® Buoys network detection that alert the duty officer by SMS as soon as one of the station triggered.



Note: In consequence to the South Sandwich event Mw 8.3 of 12th August 2021, in 2022, the monitoring area of Pacific region has been extended to include the Scotia sea and subduction zone.

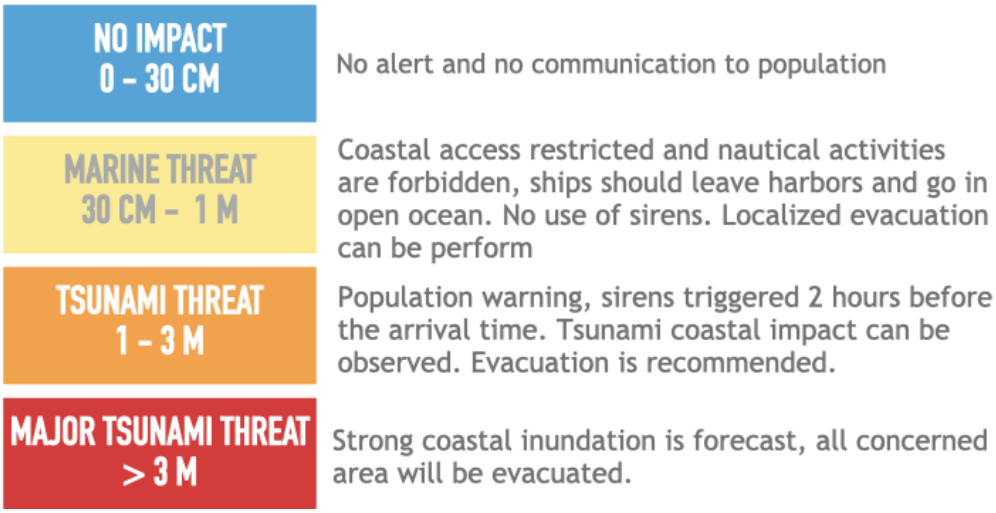
For earthquake with a preliminary magnitude >= 7.3 located in the Pacific region or located at a tsunami travel time <= 13 hours from French-Polynesia, an automatic and preliminary tsunami threat is sent by mail and fax to the NDMO - DPC in less than 15 minutes after the origin time based on the initial earthquake parameters.

The tsunami maximal heights forecast is automatically updated along earthquake parameters (Moment magnitude and CMT or FM) are updated.

Then, the NTWC agent on duty will analyze and send reviewed bulletin with forecasts in the following hour to the NDMO.

Based on tsunami forecast the tsunami warning threat is based on the following table:

Tsunami warning level is based on tsunami heights forecast and fixed by the civil defense authority in French Polynesia.



- ***What organization acts on the information provided by the agency responsible for characterizing the potential tsunami threat?***
  The agency is : Direction de la Protection Civile – DPC
  This is the Direction of Civil Defense, under the responsibility of High-Commissioner, representative of the French Government.
  The tsunami threat is determined in function of the tsunami forecast heights transmitted by the NTWC: LDG/CPPT.

- ***How is the tsunami information (warning, public safety action, etc) disseminated within country? Who is it disseminated to?***
  The tsunami warning level is disseminated via *the media* (TV, radios), the telemetered siren network implemented in French Polynesia archipelagos and GSM network by the Direction of Civil Defense.

- ***How is the emergency situation terminated?***
  Via the media (TV, radios), the telemetered siren network and GSM network.

- ***For Distant Tsunami Procedures:***
  What actions were taken in response to warnings issued by PTWC, WC/ATWC, and/or JMA NWPTAC during the intersessional period?

  The ***PTWC, WC/ATWC, and JMA NWPTAC messages*** are part of the French Polynesian tsunami warning system to secure the seismic/tsunami detection of the CPPT.

  NWPTAC and PTWC bulletins are received at the NTWC (CPPT) in addition to the NDMO (DPC) and the headquarter of the French Army in French Polynesia as a telecommunication back-up. NWPTAC and PTWC bulletins are the backup system in case the NTWC is down.

6. National Sea Level Network

Currently there are 12 tide gages installed in harbors in French Polynesia with data shared via “IOC-sea-level facility web page”, are owned/maintained by **University of French Polynesia (UPF), SHOM, PTWC, LDG & University of Hawaii** (UHSLC)**.**

Station ID (IOC)	City/ Island	Archipelago	Longitude	Latitude	Owner
nuku	Nuku-Hiva	Marquesas	-140.084683	-8.914847	UPF / UHSLC
uapo	Ua Pou		-140.046471	-9.35789	UPF
hiva	Hiva-Oa		-139.034469	-9.804869	UHSLC
rangi	Rangiroa	Tuamotus	-147.706037917	-14.945834667	UPF
make	Makemo		-143.5691	-16.6269	UPF
huahi	Huahine	Society	-151.032445833	-16.721563333	DPC
pape	Papeete Tahiti		-149.572678	-17.533092	UHSLC
pape2	Papeete Tahiti		-149.573165	-17.53237	SHOM
vair	Vairao Tahiti		-149.295298	-17.805923	UPF
tubua	Tubuai	Australes	-149.475529583	-23.341802611	UPF
gamb	Rikitea Mangareva	Gambiers	-134.968888	-23.117774	UPF
riki	Rikitea Mangareva		-134.966628	-23.122189	UHSLC

Table 1 : French-Polynesian sea level network

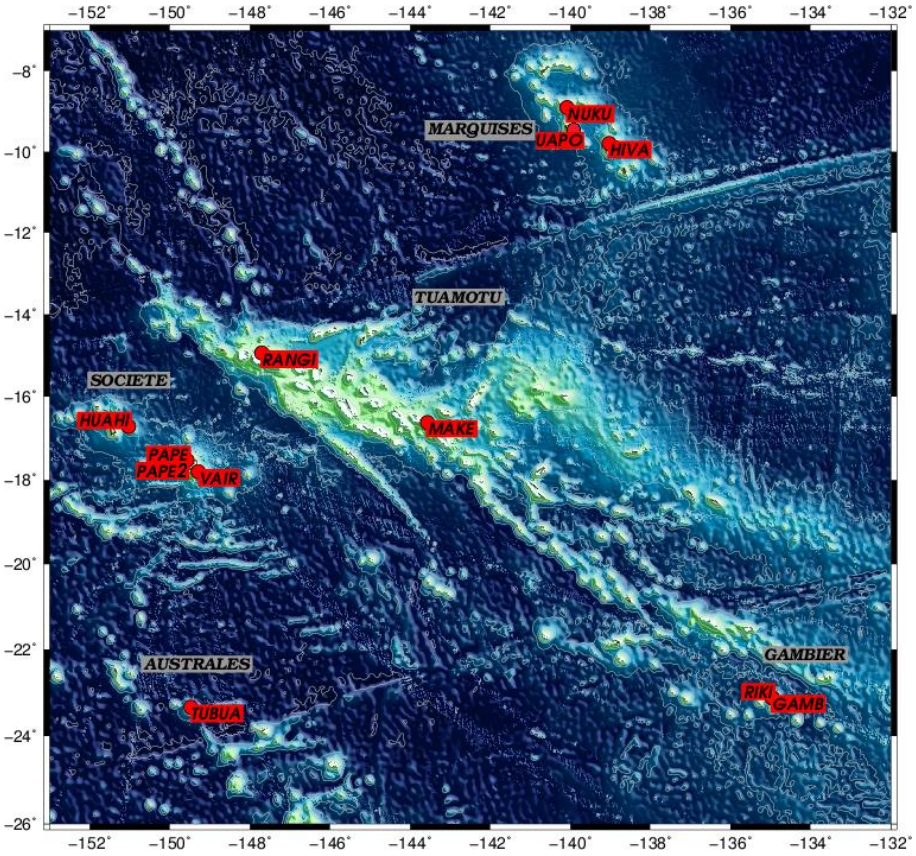


Figure 1 : Tide gages map over French Polynesia.

7. Information on Tsunami occurrences between 2019-07-01 and 2023-07-01

7.1 Synthesis

Since 2019-07-01, we consider 20 significant events to take into account in this intersessional synthesis. Over the 20 events shown in the table below, 4 tsunamis were recorded in French-Polynesia with only one significant impact above 30cm (O-Crest) from the Hunga Tonga Hunga Ha'apai (HTHH) tsunami.

Between 2019 and 2023, NTWC issued tsunami bulletins for 18 over the 20 events detailed in the table, events that reached the tsunami warning threshold at the NTWC (CPPT) that trigger an automatic initial tsunami warning message sent to the NDMO (DPC) .

Since 2019 only one event trigger a NDMO's tsunami warning to the population with a maximal threat fixed to *minor tsunami threat*. It was the tsunami generated by the earthquake of Kermadec Islands on the 04-03-2021 of Moment magnitude Mw=8.1.

Origin Time (OT) UTC	Region	PDE at OT+15min			First Detection (minutes after OT)	Preliminary Magnitude OT+15min	CPPT Mw OT+30min	GCMT Mw	French Polynesia		
		Depth (km)	Latitude	Longitude					Maximal Observation (m)	NTWC tsunami criteria reached	Max. Tsunami warning level Threat (NDMO)
2020-03-25 02:49:20	East of Kuril Islands	10	48.974	157.624	6	7.51	7.46	7.5	None	Yes	No-Threat
2020-06-18 12:49:58	South of Kermadec Islands	10	-33.357	-177.888	4	7.26	7.37	7.4	None	Yes	No-Threat
2020-06-23 15:29:08	Oaxaca, Mexico	10	16.154	-95.716	4	7.49	7.27	7.4	None	Yes	No-Threat
2020-07-17 02:50:22	Eastern New Guinea Reg., P.N.G.	71	-7.855	147.706	4	7.17	7.05	7.0	None	Yes	No-Threat
2020-07-22 06:12:44	Alaska Peninsula	10	55.155	-158.625	3	7.53	7.85	7.8	None	Yes	No-Threat
2020-10-19 20:54:39	South of Alaska	10	54.684	-159.756	3	7.54	7.57	7.6	None	Yes	No-Threat
2021-02-10 13:20:02	Southeast of Loyalty Islands	10	-22.832	171.402	5	7.14	7.83	7.7	None	Yes	No-Threat
2021-02-13 14:07:52	Near East Coast of Honshu, Japan	10	37.759	141.683	3	7.19	7.07	7.1	None	Yes	No-Threat
2021-03-04 13:27:36	Off E. Coast of N. Island, N.Z.	10	-37.451	179.355	5	7.08	7.27	7.3	None	Yes	No-Threat
2021-03-04 17:41:20	**Kermadec Islands, New Zealand**	10	-29.628	-177.911	4	6.93	7.46	7.4	**0.06**	Yes	No-Threat
2021-03-04 19:28:34	**Kermadec Islands, New Zealand**	10	-29.515	-177.071	4	7.39	7.87	8.1	**0.22**	**Yes**	Minor Tsunami Threat
2021-07-29 06:15:49	Alaska Peninsula	29	55.627	-157.980	2	7.89	8.10	8.2	None	Yes	No-Threat
2021-08-12 18:33:05	***South Sandwich Islands Region***	131	-57.401	-25.093	7	6.88	7.9	8.3	**0.18**	**No**	No-Threat
2022-01-15 04:20:00	***Tonga Islands, HTHH***	0	-17.1	-171.2	60	None	6.00	None	**0.67 (1.20 *)**	**No**	No-Threat
2022-03-16 14:36:37	Near East Coast of Honshu, Japan	84	37.798	141.481	2	7.36	7.29	7.3	None	Yes	No-Threat
2022-09-10 23:46:59	Eastern New Guinea Reg., P.N.G.	89	-6.239	146.471	5	7.43	7.45	7.6	None	Yes	No-Threat
2022-11-11 10:48:50	Tonga Islands Region	10	-19.199	-172.360	5	7.14	7.30	7.3	None	Yes	No-Threat
2023-05-10 16:02:01	Tonga Islands	202	-15.487	-174.644	5	6.90	7.56	7.6	None	Yes	No-Threat
2023-05-19 02:57:07	Southeast of Loyalty Islands	10	-23.141	170.668	4	7.34	7.61	7.7	None	Yes	No-Threat
2023-05-20 01:50:58	Southeast of Loyalty Islands	10	-22.933	170.457	5	7.01	7.06	7.1	None	Yes	No-Threat

Table 2: Event list of NTWC warning and tsunami observation in French-Polynesia with maximal tsunami amplitude recorded on tide gages or tsunami maximal run-up marked with (*).

The table 2 highlight also the two tsunamis events that did not fulfill the tsunami risk criteria for French-Polynesia at the NTWC (CPPT):

2021-08-12, South Sandwich event:
The complex South-Sandwich earthquake is located outside the monitoring area of the Pacific ocean. The event occurred during the office hours of the NTWC so geophysicist studied the event in real time, the preliminary and automatic PDE was wrong and this event needed a geophysicist expertise to understand it. Considering near-source observations at the time of the event and that the event was outside the Pacific Region no bulletin was sent to the NDMO by NTWC.

Note: The unexpected tsunami amplitudes (18 cm) recorded over Marquesas islands had major consequences on improving the detection and warning system of the NTWC (CPPT) by extension of the watching area to the South Atlantic Ocean.

2022-01-15, HTHH event:
An automatic detection was made by the NTWC(CPPT)'s TREMORS system based on surface waves analysis, no automatic detection of the volcanic eruption could be made using classic body waves analysis. The TREMORS location was 3000 km away from real location of the HTHH volcano and an associated energy was equivalent to a magnitude 6.0 that did not trigger the NTWC warning. The event occurred between 6 and 7 pm (Tahiti time).
The NTWC duty officer was aware of an on-going tsunami event lately through social media messages shared from New-Caledonia. This allowed NTWC to warn the NDMO one hour before the first tsunami arrival exchange occurred at the time of tsunami. The NTWC was not able to send any tsunami forecast for this event, only real-time observation could be used to advise NDMO that was already dealing with a high-level meteorological threat at the same time of tsunami arrival.

Note: The day following the event, the NTWC (CPPT) implemented an automatic alert based on forwarding by SMS to the on duty officer, any DART detection located into the Pacific.

We detail below the tsunami observations and records in French-Polynesia for the main events listed in the tables above :

7.2. Tsunami generated by Mw 7.4, Kermadec Islands 2021-03-04 at 17:41 UTC

Station ID (IOC)	City/ Island	Archipelago	Maximal Amplitude O-Crest (meters)
nuku	Nuku-Hiva	Marquesas	0.06
hiva	Hiva-Oa		0.03
pape	Papeete Tahiti	Society	0.01
gamb	Rikitea Mangareva	Gambiers	0.02

7.3. Tsunami generated by Mw 8.1, Kermadec Islands 2021-03-04 at 19:28 UTC

The tsunami was observed in all archipelago except Tuamotu (Atoll islands). Based on the forecast of NTWC (CPPT) the NDMO (DPC) define the tsunami alert level was No threat for Tuamotu and Gambier islands (Tsunami < 0.30 m), a marine threat for tsunami amplitude < 1 meter for Marquesas, Society and Austral islands and a minor tsunami threat (amplitude >=1 m but < to 3 m) for the Northern and East coast of Tahiti while the West and South Coast was as similar as Society islands fixed to marine threat.

Station ID (IOC)	City/ Island	Archipelago	Maximal Amplitude O-Crest (meters)
nuku	Nuku-Hiva	Marquesas	0.12
hiva	Hiva-Oa		0.22
huahi	Huahine	Society	0.10
pape	Papeete Tahiti		0.18
vair	Vairao Tahiti		0.08
tubua	Tubuai	Australes	0.06
gamb	Rikitea Mangareva	Gambiers	0.08

The tsunami over-estimation could be then explained afterwards by the depth of the earthquake parameters selected by the NTWC in its last tsunami bulletin forecast, indeed a shallower depth of the earthquake was finally selected for safety to follow preliminary results of all other NTWC, TSPs and Seismic center with a hypocenter more like 25-30 km depth whereas CPPT was the only one with a 50 km hypocenter depth at the time of the event.
The change to a shallower depth increases the forecast significantly raising a forecast on the north coast of Tahiti over one meter. Considering the uncertainties related to the dearth of seismic sensors in the region the worst-case scenario was retained for safety.

This event reveals a real challenge to answer the need of public communication for tsunami risk and awareness. After this event, a more comprehensive communication method and explanation of the tsunami phenomena was started to be developed by NTWC and NDMO to answer to the questions raised by the population.

7.4. Tsunami generated by Mw 8.3, South Sandwich 2021-08-12 at 18:33 UTC

Two records are available for this event only in Marquesas archipelago, at the arrival time of the tsunami a big swell was impacting the other archipelago of French-Polynesia covering any tsunami signal on the sea level network.

Station ID (IOC)	City/ Island	Archipelago	Maximal Amplitude O-Crest (meters)
nuku	Nuku-Hiva	Marquesas	0.18
hiva	Hiva-Oa		0.17

As explained earlier, this event lead to review the geographical limits of the NTWC monitoring area and alert triggering criteria.

7.5. Tsunami generated by Hunga Tonga Hunga Ha'apai, 2022-01-15 at 04:24 UTC

Sea-level network observation:

The tsunami was observed on all active sea level network at the time of the arrival. Most of the sea-level records have seen the earlier arrival of the shockwave.

Station ID (IOC)	City/ Island	Archipelago	Maximal Amplitude O-Crest (meters)
nuku	Nuku-Hiva	Marquesas	0.69
hiva	Hiva-Oa		0.55
make	Makemo		0.03
huahi	Huahine	Society	0.55
pape	Papeete Tahiti		0.30
vair	Vairao Tahiti		0.68
tubua	Tubuai	Australes	0.30
gamb	Rikitea Mangareva	Gambiers	0.35

Field Survey :

A field survey has been done few days after the event over Tahiti island. The tsunami arrives during night, at this time Society island was under a strong meteorological event with heavy rain and a strong swell over North and East coast that make more difficult to read the tsunami impact traces. In the table below, we share the significant and only confident measurement observed mostly on the southern coast of Tahiti where 6 houses were inundated.

Longitude	Latitude	Location name	distance from coast (meters)	Run-up Corrected Height (cm)
-149,330667	-17,731009	Ecole de Voile, Phaeton	3 m	66,5
-149,324885	-17,749848	Mitirapa (A)	9 m	74,5
-149,325022	-17,7498	Mitirapa (B)	4 m	54,5
-149,321899	-17,75157	Mitirapa (C)	3 m	
-149,320062	-17,757868	Poriro		
-149,317181	-17,762392	Aoma River	10m	53,5
-149,308986	-17,773535	Tohaotu,Pk 6.2 Sea side (A)	7.90 m	108,5
-149,30892	-17,773751	Tohaotu,Pk 6.2 Sea side (B)	9m	112
-149,308649	-17,773759	Tohaotu,Pk 6.2 Sea-side avant Punuui (B)	30m	121,5
-149,30964	-17,778319	Vitirini – Angle RT4 at Punuui (A)	29 – 32 m	66,5
-149,309425	-17,778263	Vitirini – Angle RT4 at Punuui (B)	10 m	87,5
-149,310739	-17,778402	Northen shore of Punuui park	1,50 m	82,5
-149,304943	-17,783257	Restaurant Plage de Maui (A)	2 m	99,5

8. Web sites (URLs) of national tsunami-related web sites

No tsunami/seismic dedicated web site in French Polynesia, this is an important point of progress:
We need a local web site in the two languages: Reo Tahiti, French that gives access to the following tsunami information:

- Tsunami hazard, evacuation map, warning levels explanation
- CPPT historical database and observations of tsunamis in French Polynesian territories.
- Educational materials

The tsunami brochure for French Polynesia is available here:

http://www.polynesie-francaise.pref.gouv.fr/PUBLICATIONS/Brochure-Alerte-Tsunami/(language)/fre-FR

9. Summary plans of future tsunami warning and mitigation system improvements.

9.1 Tsunami detection and forecast system:

- Update the forecast method and map layout for Tahiti and Moorea Islands for a better efficiency (~75% of French Polynesian inhabitants)

- A preliminary W-Phase solution is testing at OT+10 min for South-West Pacific Region. Results of the study would be shared with WG-PICT and ORSNET.

- A new tide gage from university of French Polynesia would be implemented at Raivavae island, Austral archipelago..

- Long term rebuild the tsunami hazard assessment over French-Polynesia using all the new DEM (Lidar campaign) and multi-grid simulations.

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9.2 Tsunami warning system:

- Improving tsunami evacuation route (enhance the current existing tsunami signs for the evacuation routes and explanation boards);

- Renew or update of Community risk preparedness

- Prepare new communication tool for tsunami hazard and risk awareness;

- Update of the Siren system monitoring and triggering.

10. EXECUTIVE SUMMARY

10.1. French Polynesia tsunami warning system:

- In 2021, The ORSEC/PSS Tsunami (specialized tsunami disaster management, response and procedures) has been updated by the NDMO – DPC to adapt the emergency response and tsunami warning organization to the NTWC forecast tools products and response.

- The tsunami threat level is defined by the maximal tsunami height forecast by simulation on the shoreline. The dedicated high-performance computer has been renewed in early 2020.

- Improve our tsunami propagation model TAITOKO© to be able to predict the tsunami impact duration so the NDMO – DPC could have an idea of the evacuation time duration.

- The area of earthquake detection has been extended to the South Atlantic Ocean (South Sandwich zone)

- The NTWC internal tsunami alarm was enhanced by automatic monitoring and forwarding any DART system detection into the Pacific to the tsunami duty officer.

- Tsunami signs for the evacuation routes and tsunami risk area have been implemented in several communities.

10.2. Tsunami Exercise:

- PACWAVE 2020 was played by NTWC and NDMO to have a recall of the JMA/PTWC products but also it was the opportunity each time to test new products or bulletin format to improve the CPPT system.

- PACWAVE 2022 & PICT Regional exercise was organized into a regional cooperation to test and evaluate the HTHH interim products as well as test direct informational communication between PICT member's NTWC and NDMO.

- On the 13th of June 2023, A tsunami Day has been defined and an enlarged tsunami exercise (involving a community for evacuation exercise) has been conducted for tsunami risk awareness and formation. A press conference has been done to recall and explain the tsunami risk to the media. The success of such enlarged exercise.

- In 2023, A tsunami hazard and risk awareness of population is currently valuated through an online form in order to improve and create new tsunami sensitivity related communication mode.

- Every year, several evacuation exercises are regularly made by the NDMO – DPC involving schools and/or a whole neighborhood (a valley).

10.3. Education:

- Between 2 and 3 Scholars visit per year at the LDG-Tahiti/CPPT.

- DPC (NDMO) & LDG-Tahiti/CPPT used to make some oral presentation on natural hazards risk of French Polynesia for scholar.

- Active participation to Science day for tsunami risk awareness.