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NATIONAL REPORT Submitted by Ecuador

BASIC INFORMATION

1. ICG/PTWS Tsunami National Contact (TNC)

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Organization: Instituto Oceanográfico y Antártico de la Armada
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E-mail Address:
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2. ICG/PTWS Tsunami Warning Focal Point (TWFP)

TWFP Agency name: Instituto Oceanográfico y Antártico de la Armada
(if different from NTWC agency)
TWFP Agency Contactor Officer in Charge *(if different from NTWC Agency):*
Name:
Position:
Telephone Number:
Email Address:
Postal Address:

TWFP 24x7 point of contact (office, operational unit or position**, not a person**):

Name of office, operational unit or position:
E-mail Address:
Telephone Number:
Cellular phone number:
Fax:

National Tsunami Warning Centre (if different from the above)

NTWC Agency Name: Instituto Oceanográfico y Antártico de la Armada NTWC
Agency Contact or Officer in Charge (person):
Name: Michael Arturo Linthon Alvarez
Position: TNNV-SU, NTWC Director, Head of the Tsunami Unit
Telephone Number:
Email address:
Postal Address:

3. Tsunami Advisor(s), if applicable Name:
Title:
Postal Address:
E-mail Address:
Emergency Telephone Number:
Emergency Fax Number:
Emergency Cellular Telephone Number:

4. Tsunami Standard Operating Procedures for a Local Tsunami (when a local tsunami hazard exists)

INOCAR, as Ecuador's focal point for the Pacific Tsunami Warning and Mitigation System - PTWS - and National Tsunami Warning Center - CNAT - for the monitoring and diagnosis of tsunamis affecting the Ecuadorian continental and insular coasts, receives information from the Pacific Tsunami Warning Center - PTWC, the regional centers (Colombia, Peru, and Chile) and from Instituto Geofísico de la Escuela Politécnica Nacional- IGEPN for the threat analysis and response. Figure 1.

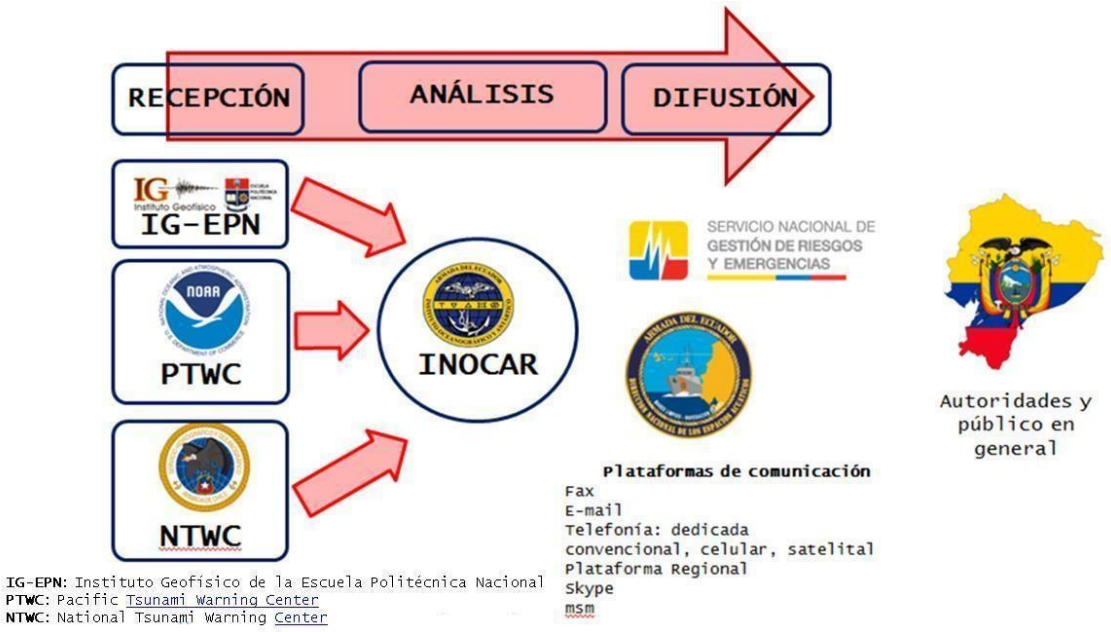


Figure 1. Schematic showing the flow of information for tsunami hazard analysis in Ecuador. Source: INOCAR, 2020.

The technical protocol for evaluation and definition of tsunami warning (Version 3.0) has determined three domains for seismic monitoring, based on the level of competence to execute the tsunami warning evaluation originated by local earthquakes and based on the national level Ecuadorian monitoring capacity.

Domain 1- ECC-1 includes continental zone, Latitude: 4°N to 5.3° S and Longitude: 83° W to 73°W.

Domain 2 - ECG-1 corresponds to the island zone, Latitude: 4°N to 5.3°S and Longitude: 93°W to 89°W.

Domain 3 - ECF-1 includes oceanic area from 83°W - 89°W where the National Seismograph Network do not coverage the monitoring, it is poor. In this case, the information sources are USGS and PTWC.

Ecuador's CNT does not have the capacity to monitor local seismic events; however, it manages the national sea level network consisting of coastal tide gauges and ocean sensors and receives information from El Instituto Geofísico de la Escuela Politécnica Nacional - IGEPN, the United States Seismological Service - USGS and the Pacific Tsunami Warning Center - PTWC. Figure 2.

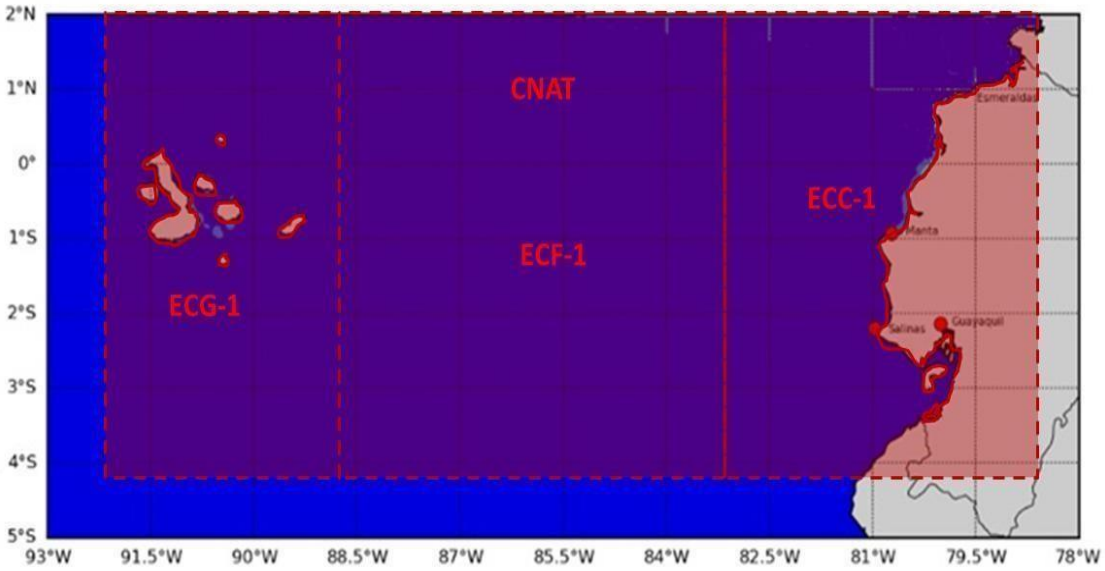


Figure 2. National Tsunami Warning Center responsibility Area. The subdivision area is in accordance with the monitoring capacity to the National Tsunami Warning System institutions have. Source: INOCAR, 2020.

Information provided by the IGEPN, USGS and PTWC is analyzed and related with sea level data of national network to evaluate the tsunami threat for the coasts of Ecuador. At the national level, first, INOCAR receives preliminary seismic parameters (automatic), and then it receives evaluated data by a seismologist on duty, finally INOCAR receives the magnitude moment Mw calculation (of the event). Local events are considered even those generated in the Colombian-Ecuadorian and Peruvian-Ecuadorian coastal boundary. Figure 3.

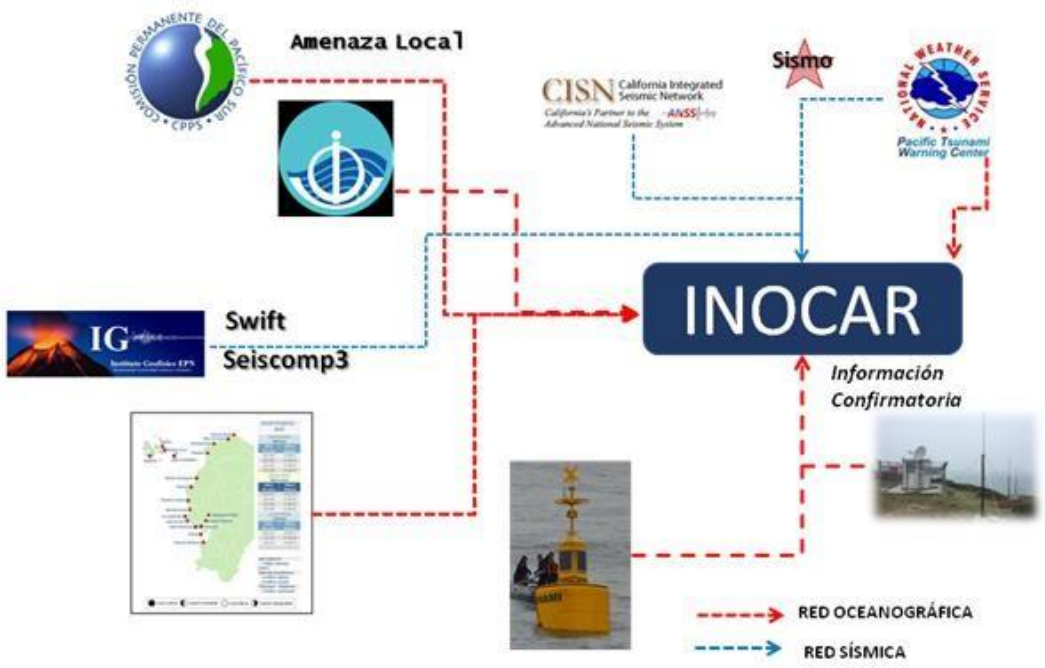


Figure 3. Ecuadorian coasts tsunami hazard monitoring and assessment capacity for the local and international sources providing information for information analysis. Source: INOCAR, 2020.

5. Tsunami Standard Operating Procedures for a Distant Tsunami (when a distant tsunami hazard exists)

For regional and distant events, CNAT will evaluate the graphical and textual products provided by PTWC. Most model and its graphical interface Results are added to this analysis. Figure 2.

For distant events the response time will is six minutes too, since the information reception from the PTWC or USGS. The updates of this information are made according to PTWC information update, and also when we have the results obtained to use models and software available to CNAT, which are the Tsunami Travel Time (TTT), COMMIT/Most, TsuCAT.

For each situation, please provide the following:

- What organization identifies and characterizes tsunamigenic events? Instituto Oceanográfico y Antártico de la Armada del Ecuador.

- What is the threshold or criteria for declaring a potential tsunami emergency?

Bulletin type	Wave amplitude	Warning level	ETA
Warning	H ≥ 1m	Warning	ETA < 3 h
Advisory	0.3m ≤ H < 1m	Advisory	ETA < 3 h
Watching	H ≥ 0.3m	Watching	3 h ≤ ETA< 6 h
Information	H ≥ 0.3m	Information	ETA ≥ 6 h
Information	H < 0.3m	Information	---
Information	H ≥ 1m	Information|	ETA > 3 h

- What organization acts on the information provided by the agency responsible for characterizing the potential tsunami threat?
  The Risk Management Secretary – Secretaría de Gestión de Riesgos (SGR, in Spanish).

- How is the tsunami information (warning, public safety action, etc) disseminated within country? Who is it disseminated to?
  The Risk Management Minister – Ecuador ´s Vice President (now).

- How is the emergency terminated?
  The situation is terminated, when INOCAR cancelled Tsunami Warning (3 hours after the tsunami waves arrived to last point in the Ecuadorian cost).

- For Distant Tsunami Procedures:
  What actions were taken in response to tsunami bulletins issued by PTWC, NWPTAC, and/or SCSTAC during the intersessional period?

  The information provided by PTWC, NWPTAC, and/or SCSTAC is analyzed and compared with that obtained from the application of specific software to determine wave height and arrival time.

6. National Sea Level Network

Stations characteristics detail of the national tide gauge network.

Station	Latitude	Longitude	Sensor type	Recording interval (minutes)	Transmission interval (minutes)	Remarks Operability
San Lorenzo	1.2956	78.8421	SDI-12 SHAFT ENCODER – PRESIÓN GE DRUCK	10	1	Station Ecuador-Colombia coastline
Esmeraldas	0.9909	79.6466	PRESSURE GE DRUCK	10	1	Operative
Bahía de Caráquez	-0.6064	80.4229	SDI-12 SHAFT ENCODER – PRESSURE GE DRUCK	10	1	Operative
Manta	-0.9396	80.7260	PRESSURE GE DRUCK	10	N/A	Operative
Isla Puná	-2.7346	79.9119	SDI-12 SHAFT ENCODER	10	1	Operative
Puerto Bolívar	-3.2612	80.0860	SDI-12 SHAFT ENCODER – PRESSURE GE DRUCK	10	1	Station Ecuador-Peru coastline
Guayaquil	-2.1953	79.8798	SDI-12 SHAFT ENCODER	10	1	Operative
La Libertad	-2.2177	-80.9064	Pressure, Radar Encoder	1, 1, 5	5	Operative

Baltra – Galápagos	-0.433	-90.283	Pressure, Radar, Encoder	1, 1, 5	5	Operative
Santa Cruz – Galápagos	-0.752	-90.307	Pressure, Radar, Encoder	1, 1, 5	5	Operative
Manta	-0.881	-81.664	EBM-24TS	15	180	Operative
Esmeraldas	0.256	-81.216	EBM-24TS	15	180	Operative
West Isabela	0.462	-94.980	EBM-24TS	15	180	Operative
South San Cristóbal	-4.148	-89.008	EBM-24TS	15	180	Operative

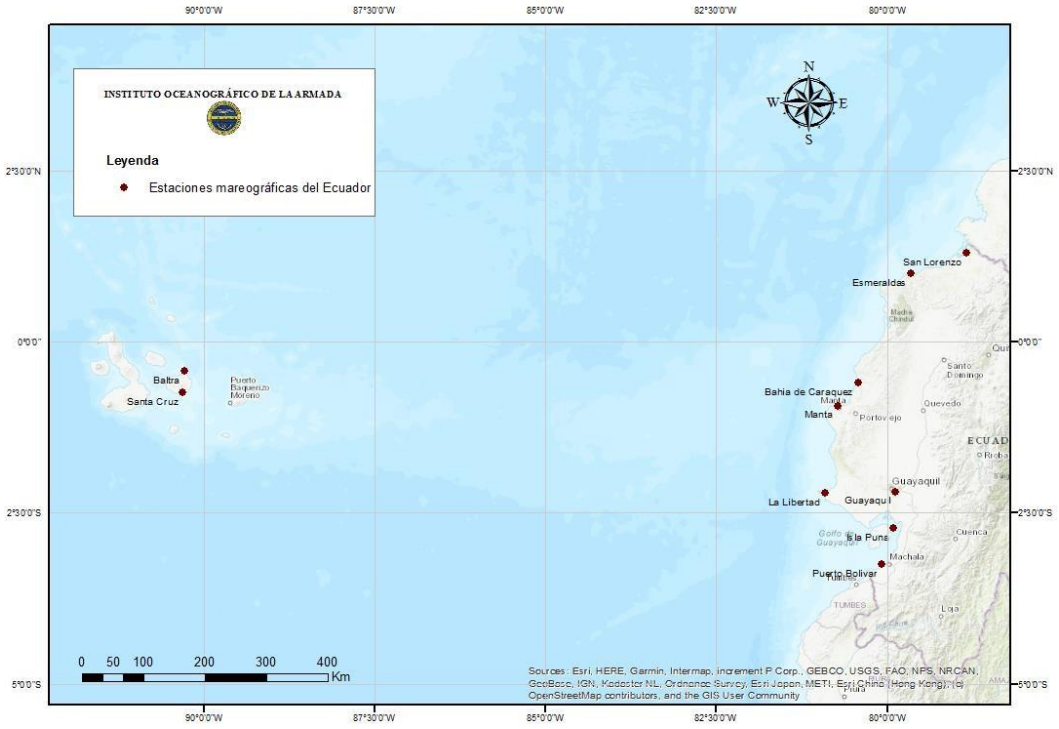


Figure 4. Stations distribution of the tide gauge network along the Ecuadorian continental and insular coasts. Source: INOCAR, 2020.

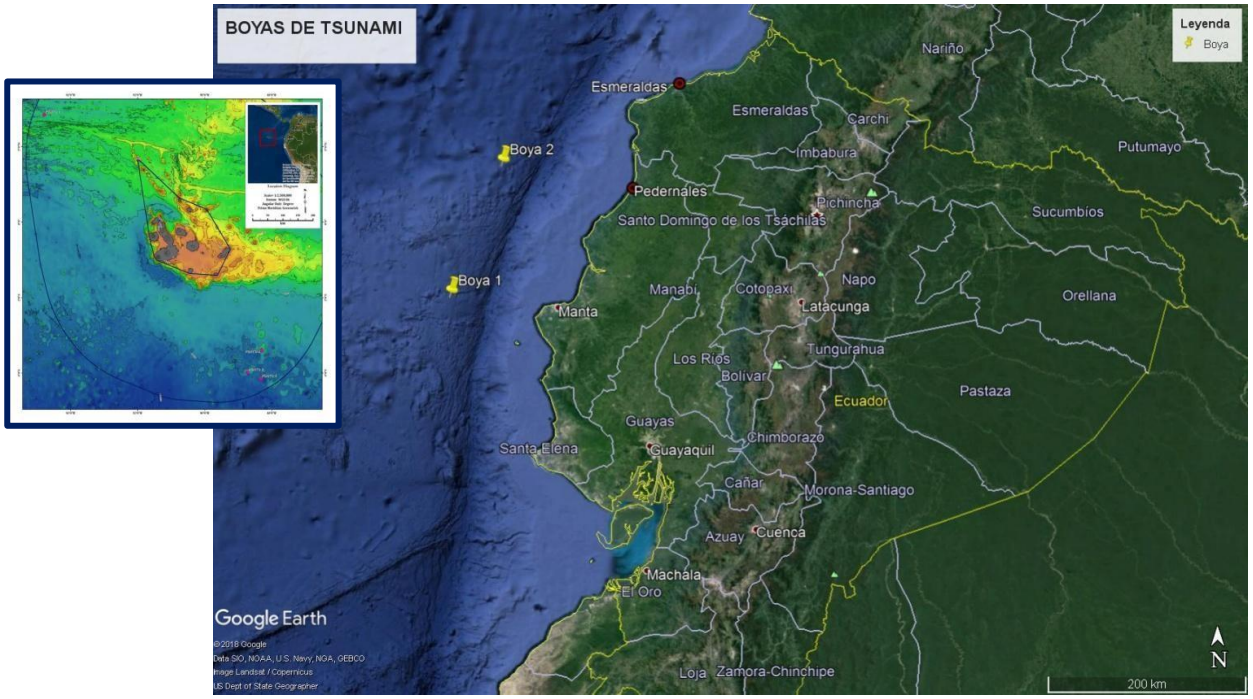


Figure 5. Distribution of the two tsunami detection buoys off the northern and central Ecuadorian coasts. Source: INOCAR, 2020.

7. Information on Tsunami occurrences.

Tonga 2022 Procedures

15/JANUARY/2022				
NUMBER	**TIME (UTC)**	**BULLETIN**	**SOURCE OF INFORMATION**	**RECOMMENDATION**
1	15:21	Observation	SNAM issues bulletin 1 of tsunami threat (volcanic eruption)	Caution in marine activities in Galapagos Islands.
2	16:31	Observation	Buoy No 32413 (NORTHWEST LIMA - 1000 NM WNW of Lima, Peru	Suspension of maritime and recreational activities on the continental and insular coastline.
3	18:30	Observation	Santa Cruz tide gauge detects disturbances.	Suspension of maritime and recreational activities on the continental and insular coastline.
4	19:24	Warning	Santa Cruz and Baltra tide gauges detect disturbances. Significant variations in sea level are recorded in Academia Bay.	Suspension of maritime and recreational activities on the continental and insular coastline.

5	20:15	Warning for Puerto Ayora and Observation for the insular and continental region.	Santa Cruz and Baltra tide gauges detect disturbances. Significant variations in sea level are recorded in Academia Bay, Santa Cruz Island of up to 50cm. Sea level disturbances were recorded from 14:33 in La Libertad, Santa Elena.	Suspension of maritime and recreational activities in the Galapagos Islands.
6	20:56	Cancellation of Tsunami Warning for Ayora port. Observation for the continental and insular coast of the country.	Significant variations in sea level are recorded in Academia Bay, Santa Cruz Island of up to 50cm that have remained stable for two hours. Sea level disturbances were recorded from 14:33 in La Libertad, Santa Elena.	Suspension of maritime and recreational activities in the Galapagos Islands.
7	21:21	Tsunami warning for the continental coast of the country. Observation for the insular coast.	Significant variations in sea level are recorded from 14:33 in La Libertad, Manta and Esmeraldas of 50cm.	Suspension of maritime and recreational activities in the Galapagos Islands.
8	22:23	Cancellation of tsunami warning for the continental coast of the country. Observation for the continental and insular coast.	Significant variations in sea level have been recorded since 14:33 in La Libertad, Manta and Esmeraldas of 50cm that have remained stable for one hour.	Suspension of maritime and recreational activities in the Galapagos Islands.
9	00:26	Observation for the insular and continental coast	According to the records of tide gauges and tsunami buoys located on the coasts of our country, several tsunami waves were recorded that arrived in our country causing sea level disturbances that have not exceeded 50 cm.	Maintain caution in the execution of productive and recreational activities on the continental and insular border.
10	05:01	Observation for the insular and continental coast	Sea level fluctuations associated with residual tsunami waves are recorded	Maintain caution in the execution of productive and recreational activities on the continental and insular border.
11	12:02	Observation for the insular and continental coast	Sea level fluctuations associated with residual tsunami waves are recorded	Maintain caution in the execution of productive and recreational activities on the continental and insular border.
12	17:42	Observation for the insular and continental coast	Sea level fluctuations associated with residual tsunami waves are recorded	Maintain caution in the execution of productive and recreational activities on the continental and insular border.
13	23:59	Cancellation	Sea level fluctuations associated with tsunami residual waves have decreased considerably.	Inhabitants near coastal areas must remain attentive and cautious to the state of the sea.

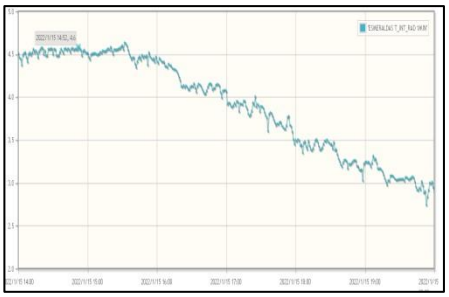
Sea level recording

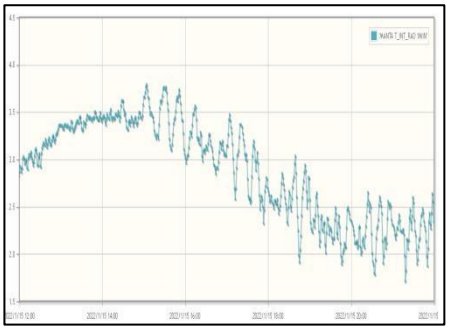
Country	ENM	Start of Tsunami Recording UTC	Initial Amplitude (m)	Max Amplitude (m)	Time Max Amplitude UTC
ECUADOR	La Libertad	15-01-2022 19:47	0.50	1.00	16-01-2022 03:05
	Santa Cruz -Gal	15-01-2022 18:50	0.60	1.50	15-01-2022 20:22
	Baltra - Gal	15-01-2022 19:15	0.55	0.85	15-01-2022 20:55

Tsunami recording

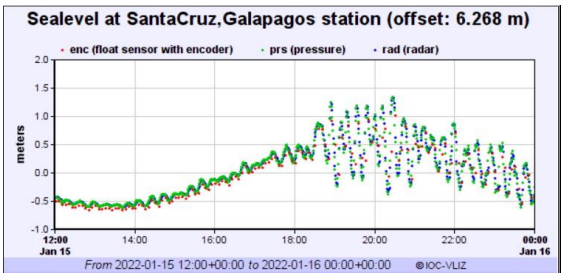
Ecuadorian sea level station

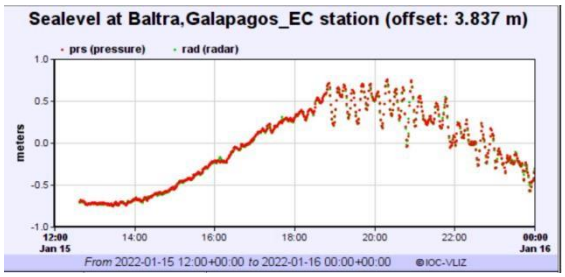
Esmeralda (Ecuadorian norht coast)



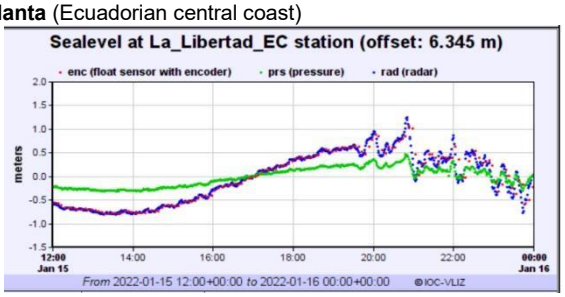


IOC sea level station





Manta (Ecuadorian central coast)



8. Websites @ (URLs) of national tsunami-related websites
https://www.inocar.mil.ec/web/index.php/estudio-de-tsunamis

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

NATIONAL PROGRAMMES AND ACTIVITIES INFORMATION

Ecuador, through the Instituto Oceanográfico y Antártico de la Armada, plans to develop the following future activities:

1. Strengthen the tide gauge network through the acquisition of 5 tide gauge stations that will densify the national network. This is supported by a joint project with the Secretariat of Risk Management.
2. Certify three coastal locations in the island region (Galapagos) as Tsunami Ready cities.
3. Certify continental coastal localities as Tsunami Ready cities.
4. Implement a database with pre-computed scenarios for Ecuadorian distant events.
5. Implement the pre-computed database with local scenarios to evaluate the effects of tsunamis on the Ecuadorian coasts.
6. Increase the number of inundation maps of Ecuadorian coastal areas.
7. Strengthen the infrastructure of Ecuador's main and alternate tsunami warning centers.
8. Seek partnerships to improve the technical capacity of personnel currently working on tsunami inundation mapping in order to improve INOCAR's products.

10. EXECUTIVE SUMMARY

The Instituto Oceanográfico y Antártico de la Armada, as Focal Point and National Contact for the Pacific Tsunami Warning System has improved its tsunami monitoring capability. It has worked in three specific fields such as: Tsunami monitoring, it has acquired four (4) tsunami detection buoys, two of which have been installed in the Galapagos Islands, it has also improved its response capacity and for this it has developed a system that allows to elaborate and issue bulletins during an emergency or tsunami event in a maximum time of 6 minutes, For this purpose, it has implemented a database of pre-computed scenarios that allow it to evaluate the tsunami threat through the use of a diagram similar to the one used by the JMA in Japan. In addition, it has contributed to tsunami risk management, providing different coastal localities with tsunami inundation maps using numerical methods. These maps allow them to develop their contingency, emergency, and evacuation plans, establishing procedures to minimize the threat of tsunamis in Ecuadorian coastal areas. Currently, work is being carried out with three localities in the Ecuadorian insular region, with the purpose of certifying them as Tsunami Ready cities. Finally, it should be noted that Inocar, together with the other institutions that make up the tsunami warning system, has worked permanently on updating the technical procedures or protocols for action during the occurrence of a tsunami.

11. NARRATIVE

From 2021 to the present, the Instituto Oceanográfico y Antártico de la Armada, as Focal Point and National Contact for the Pacific Tsunami Warning System has worked to strengthen its monitoring and technical capabilities. In 2019, it acquired two tsunami detection buoys of Spanish origin, which were installed off the coasts of Manta and Pedernales, these are in the NDBC with code 32068 and 32069. In addition, in October 2022 two new buoys were installed west of Isabela Island and south of San Cristobal Island in Galapagos, these new buoys are coded 3202520 and 3202521.

Since 2016, the first version of the technical protocol for action to assess the tsunami threat in Ecuador was signed. In 2022 the 4th version of this document was made considering a procedure for unusual cases as of January 15th when the eruption of the Hunga volcano generated a tsunami for which there were no established procedures.

To disseminate the messages received by INOCAR from the PTWC or the bulletins evaluated by the National Geophysical Institute, this institute developed a system for issuing semi-automatic bulletins, which makes it possible to produce a message in a short time; this system has grouped software such as TTT, whose information in table format is available in three of the five bulletins generated through the system. These bulletins are: Alert, Warning, Observation, Information, and Cancellation.

In 2022, a database of 22,000 pre-computed local scenarios was implemented. For the implementation of this project, the national historical seismic database was used as a starting point. As a result, the wave amplitudes will be obtained and based on these amplitudes, a graph has been determined where the threat is evaluated according to these amplitudes and the distance of the event to the Ecuadorian coasts. This graph has been called JMA since it was elaborated with the support of the Japanese government.

Another of the actions carried out permanently as a warning center is the elaboration of tsunami inundation maps, whose objective is to provide coastal communities with a tool to evaluate the threat to each population. The purpose of inundation map is people can elaborate evacuation, emergency, or contingency plans to improve their capacity for tsunamis effects.

Three localities of the insular coastal profile (Santa Cruz, San Cristobal and Puerto Villamil) have been proposed for certification as Tsunami Ready localities, with the purpose of strengthening the capacities of coastal communities and populations.

Finally, it is important to mention that INOCAR contributes to tsunami risk reduction in Ecuador through its technical studies, threat assessment, permanent monitoring of sea level and above all with the transfer of knowledge to students from schools, colleges and universities who visit the institution in order to learn how tsunami information is managed in Ecuador.

Date: July 14th 2023

TNNV-SU Michael Linthon Alvarez
Head of the National Tsunami Warning Center