

REPORTE TÉCNICO

DEPARTAMENTO DE INVESTIGACIÓN Y SERVICIOS GEOFÍSICOS. SECCIÓN DE SISMOLOGÍA.



INSTITUTO NACIONAL DE SISMOLOGÍA, VULCANOLOGÍA,
METEOROLOGÍA E HIDROLOGÍA

National Report submitted by TNC of Guatemala

INSIVUMEH

DEPARTAMENTO DE INVESTIGACIÓN Y SERVICIOS
GEOFÍSICOS
SECCIÓN DE SISMOLOGÍA

March 21, 2024



Ministerio de
**Comunicaciones,
Infraestructura y
Vivienda**

INSTITUTO NACIONAL DE SISMOLOGÍA. VULCANOLOGÍA, METEOROLOGÍA E HIDROLOGÍA



1. Tsunami Standar Operating Procedures for a Local Tsunami

The Instituto Nacional de Sismología, Vulcanología, Meteorología e Hidrología (INSIVUMEH) has a protocol for tsunami threat warning based on four main classifications, within which different criteria are considered, such as:

- The distance from the epicenter to the nearest coastal areas.
- The tectonic context of Guatemala's seismic sources (reverse or normal fault for the Mesoamerican Trench, strike-slip fault for the Cayman Trench).
- Preliminary messages about the size of wave arrivals to the coastal areas of Guatemala sent by PTWC, PTWC/Caribe-EWS, or CATAAC.
- The magnitude of the seismic event.

This classification is useful for the person in charge of seismic monitoring to know what actions to take depending on the type of alert that should be issued, which helps to take timely and appropriate actions for the different possible scenarios.

To classify whether the seismic source of a tsunami is local, the criteria established by Ota Kulháněk (1990) are used, where a local seismic source is defined as one located within a range of 0° - 10° . In addition, for local sources, there is a further subclassification for local events associated with the Seismic Threat Assessment in Central America, proposed in the RESIS II Project (2008), where seismic zones along the Mesoamerican Trench were established. These zones range from 0° - 1° for the Guatemala subduction zone, as well as other "local" seismic sources ranging from 1° - 5° (comprising the intraplate subduction seismic zones Gsp10, Ssp6, Nsp17 and the interface subduction seismic zones Gs19, Ss15, Nsi15, Nsi16).

In figure 1, the most critical alerts are established, presenting the scenarios where the threat is imminent for the coastal areas of Guatemala. It also outlines the criteria considered to initiate the response protocols of INSIVUMEH to issue a tsunami warning.

Type of Alert	Technical Criteria for a Local Tsunami Threat
Orange	<ul style="list-style-type: none">▪ Occurrence of an earthquake with a magnitude of 7.0 or greater near the Mesoamerican Trench (Pacific Ocean) or the Cayman Trench (Caribbean Sea), and/or▪ An alert bulletin for Guatemala from PTWC or CATAAC.
Red	<ul style="list-style-type: none">▪ Occurrence of an earthquake with a magnitude of 7.0 or greater off the coast of Guatemala, near the Mesoamerican Trench (Pacific Ocean) or the Cayman Trench (Caribbean Sea).▪ Arrival of tsunami waves to the coastal areas of Central American countries and/or southern Mexico, with wave heights greater than 1 meter and the potential arrival of waves in Guatemala, or▪ Arrival of tsunami waves to the coastal areas of Guatemala.

Figura 1. Critical Tsunami Threat Scenarios for Guatemala and the Alert Level.

Based on the description above, INSIVUMEH has established three protocols that summarize the actions to address tsunami threats in the country, applicable to any possible scenario (local or distant). These protocols begin with continuous monitoring, followed by the issuance of bulletins with information about the tsunami-generating event, and the cancellation of the alert issued if there is no threat or if the threat has passed.

Figure 2 shows a description of the actions to be taken in Protocol A, which involves continuous monitoring 24 hours a day, every day of the year without fail. Beside it, the flowchart of the actions to be taken by the person on duty at the INSIVUMEH National Seismic Monitoring Center.

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Update Date: 15/04/2025	Instituto Nacional de Sismología, Vulcanología, Meteorología e Hidrología -INSIVUMEH-		
Review Date: 15/04/2025			
Protocol A: Tsunami Monitoring.			
Responsible:	Person in charge at the National Seismic Monitoring Center of INSIVUMEH.		
Support:	INSIVUMEH staff in charge of tsunami threats for Guatemalan territory, coordinator of the seismology section.		
Description of the steps to be followed by the responsible at the National Seismic Monitoring Center:	Protocol A corresponds to the continuous monitoring carried out during shifts at the National Seismic Monitoring Center, regardless of whether or not a major event occurs. It involves attending to and reporting any eventuality that could potentially affect the coasts of the Pacific Ocean or the Caribbean Sea.		
Step 1:	Continuous monitoring of local and regional seismic activity through the national seismic network, as well as responding to emails sent by tsunami warning agencies such as PTWC, CARIBE-EWS, CATAC, among others.		
Step 2:	If a seismic event occurs that exceeds any of the established thresholds, the tsunami arrival protocol (Protocol B) will be initiated.		
Step 3:	If the earthquake does not pose a threat to the country, continuous monitoring will be maintained (Protocol A).		

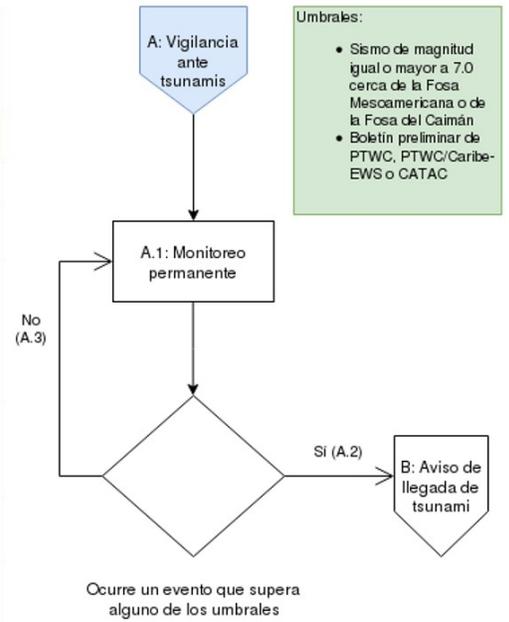


Figura 2. Continuous monitoring 24 hours a day.

Figure 3 shows a description of the actions to be taken in Protocol B, which involves generating bulletins with information regarding the characteristics of the tsunami event. Beside it, the flowchart of the actions to be taken by the person on duty at the INSIVUMEH National Seismic Monitoring Center.

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Update Date: 15/04/2025	Instituto Nacional de Sismología, Vulcanología, Meteorología e Hidrología -INSIVUMEH-	
Review Date: 15/04/2025		
Protocol B: Tsunami Arrival Alert.		
Responsible:	Person in charge at the National Seismic Monitoring Center of INSIVUMEH.	
Support:	INSIVUMEH staff in charge of tsunami threats for Guatemalan territory, coordinator of the seismology section.	
Description of the steps to be followed by the responsible at the National Seismic Monitoring Center:	<p>Protocol B will be activated when a seismic event occurs that exceeds the established thresholds, considering the following criteria:</p> <ul style="list-style-type: none"> i) Occurrence of an earthquake with a magnitude of 7.0 or greater near the coasts of the Pacific Ocean. ii) Occurrence of an earthquake with a magnitude of 7.0 or greater near the coasts of the Caribbean Sea. iii) Receipt of a tsunami threat alert or emails with preliminary information about a tsunami-generating event from tsunami warning agencies such as PTWC, PTWC/Caribe-EWS, or CATAAC. iv) Message from Global Seiscomp regarding the occurrence of a large-magnitude seismic event. 	
Step 1:	The protocol is activated when a seismic event exceeds the established thresholds, both for local and regional earthquakes, as well as for more distant events with tsunami-generating characteristics. The staff responsible must generate a preliminary bulletin with the information received from tsunami warning centers and share it through available communication channels with the relevant entities/authorities.	
Step 2:	The staff responsible will need to analyze the event with the National Seismic Network and stay updated with information received from intergovernmental tsunami warning agencies via email. The event characteristics will be verified, and confirmation or cancellation bulletins (Protocol C) will be sent, as appropriate.	
Step 3:	If the threat persists, the staff responsible must stay updated with information about the tsunami-generating event received from tsunami warning agencies via email and send bulletins with updated information based on the relevant technical assessments, without unnecessary delays and maintaining constant monitoring.	
Step 4:	Once the threat is considered over, the tsunami alert cancellation protocol (Protocol C) is implemented.	

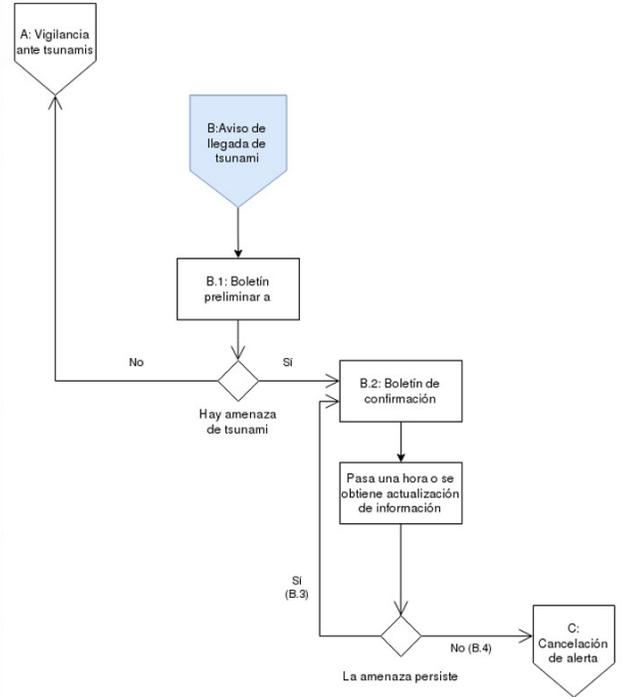


Figura 3. Generation of bulletins with tsunami-related information.

Figure 4 shows a description of the actions to be taken in Protocol C, which involves the cancellation of the tsunami threat alert for the tsunamigenic event.

Update Date: 15/04/2025	Instituto Nacional de Sismología, Vulcanología, Meteorología e Hidrología -INSIVUMEH-	
Review Date: 15/04/2025		
Protocol C: Tsunami Alert Cancellation.		
Responsible:	Person in charge at the National Seismic Monitoring Center of INSIVUMEH.	
Support:	INSIVUMEH staff in charge of tsunami threats for Guatemalan territory, coordinator of the seismology section.	
Description of the steps to be followed by the responsible at the National Seismic Monitoring Center:	<p>Protocol C consists of informing that the tsunami threat has passed, or that it was nonexistent for the coastal areas of Guatemala, based on the following criteria:</p> <ul style="list-style-type: none"> i) The tsunami-generating event does not pose any threat to the coastal areas of Guatemala due to distance or information received from tsunami warning agencies such as PTWC, PTWC/Caribe-EWS, or CATAAC. ii) It is considered that the effects of the tsunami that impacted the coastal areas of Guatemala have already passed. iii) The seismic event did not trigger a tsunami. 	
Step 1:	The staff responsible must prepare the tsunami threat alert cancellation bulletin based on the information received via email from tsunami warning agencies such as PTWC, PTWC/Caribe-EWS, or CATAAC. The bulletin will then be sent to the relevant entities/authorities (SE-CONRED, state entities, rescue teams, and media outlets).	
Step 2:	INSIVUMEH will provide detailed information about the cancellation of the alert through official communication channels to the general public.	
Step 3:	Once the information is verified, INSIVUMEH will declare the tsunami alert over and resume the monitoring process (Protocol A).	
Step 4:	INSIVUMEH will prepare a technical report on the tsunami-generating event.	

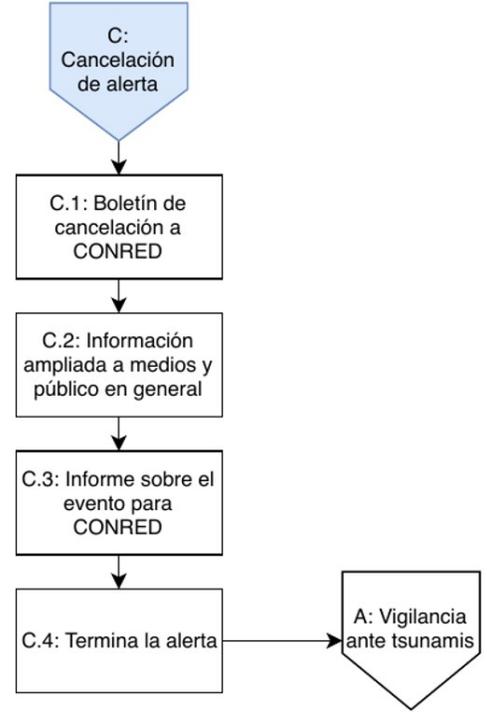


Figura 4. Cancellation of the tsunami threat alert.

2. Tsunami Standar Operating Procedures for a Distant Tsunami

To classify whether the seismic source of a tsunami is distant, the criteria established by Ota Kulháněk (1990) are used, where a seismic source is considered local if it falls within the range of 10° - 20° , and earthquakes occurring beyond 20° (teleseisms) are classified as distant. Additionally, for distant sources, there is a subclassification for local events associated with the Seismic Threat Assessment in Central America, proposed in the RESIS II Project (2008), where seismic zones along the Mesoamerican Trench were established as "distant" seismic sources beyond 5° . These include the intraplate subduction seismic zones Gsp14, Gsp15, Gsp16, and the interface subduction seismic zones Csi11, Csi12, Csi13.

Figure 5 outlines less critical alerts, presenting scenarios where the threat to the coastal areas of Guatemala may or may not be imminent. It also includes the criteria considered to initiate INSIVUMEH's response protocols for issuing a tsunami warning.

Type of Alert	Technical Criteria for a Distant Tsunami Threat
Green	<ul style="list-style-type: none">▪ Occurrence of an earthquake with a magnitude of 7.0 or greater in the basins of the Pacific Ocean and the Caribbean Sea, far from the Mesoamerican Trench (Pacific Ocean) and the Cayman Trench (Caribbean Sea).
Yellow	<ul style="list-style-type: none">▪ Occurrence of an earthquake with a magnitude of 7.0 or greater in the Mesoamerican Trench (Pacific Ocean) or the Cayman Trench (Caribbean Sea), and/or▪ A bulletin from PTWC or CATAC indicating potential impact to Guatemala.

Figura 5. Less Critical Tsunami Threat Scenarios for Guatemala and the Alert Level.

These types of alerts can also suppose a threat to the coastal areas of Guatemala, which is why they may also trigger Protocols B and C, with the order adjusted based on the level of threat and the updates received from tsunami warning centers such as PTWC, PTWC/Caribe-EWS, or CATAC. See Figure 2, Figure 3, and Figure 4.

3. National Sea Level Network

Currently, INSIVUMEH has three tide gauge stations located in Izabal, Escuintla, and Retalhuleu (Table 1).

The station is equipped with an OTT RLS sensor, a non-contact radar sensor that uses pulse technology to measure the average sea level every minute. It is connected to an OTT netDL data logger, which records the data and transmits it via an OTT HDR 1200 satellite transmitter. Once transmitted, the data is stored on the Sea Level Station Monitoring Facility website (Intergovernmental Oceanographic Commission (IOC) (2023), Sea Level Station Monitoring Facility, 2023), and later downloaded for processing.

NO.	Departamento	Sitio 3	Latitud	Longitud	En operación
Dato 1	Izabal	Comando Naval del Caribe	15.6946	-88.6220	Diciembre-2014
Dato 2	Escuintla	Comando Naval del Pacífico	13.9222	-90.8010	JUnio-2023
Dato 3	Retalhuleu	Empresa Portuaria Nacional de Champerico	14.2966	-91.9157	Marzo-2024

Tabla 1. Información de las estaciones mareográficas operadas por INSIVUMEH



Figura 6. Estaciones mareográficas operadas por INSIVUMEH, Guatemala

Currently, the three previously mentioned tide gauge stations are operational. However, there is a projection that, in the medium and long term, Guatemala may expand its tide gauge network. This expansion envisions the inclusion of new sites of interest along both the Atlantic and Pacific coasts, as shown in the attached figures, which illustrate the proposed locations for future development.

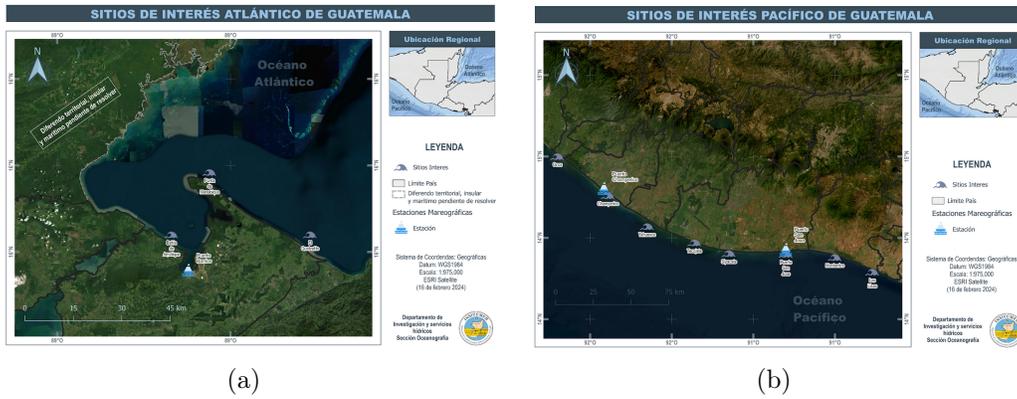


Figura 7. (a) Sitios de interés para el atlántico (b) Sitios de interés para el pacífico.

4. Information on Tsunami Network

■ Pacific Tsunami Warning Center

In 1968, under the auspices of the United Nations, the Intergovernmental Oceanographic Commission (IOC) established the Intergovernmental Coordination Group for the Pacific Tsunami Warning System (ICG/PTWS). Later, the United States provided a new headquarters and renamed this warning system as the "Pacific Tsunami Warning Center" (PTWC).

The information provided by PTWC is divided into several products. The products used by INSIVUMEH, as the main institution in Guatemala for monitoring seismic events, include text products and some graphics received via email. To describe the text products—which are used to generate a tsunami bulletin—it is necessary to understand the process by which PTWC generates information in the event of a tsunami threat caused by an earthquake.

- 5–10 minutes after the earthquake occurs, PTWC sends preliminary seismic information without numerical prediction.
- 20–30 minutes after the earthquake, the seismic mechanism is determined, allowing for numerical tsunami prediction.
- The numerical prediction is then refined using direct measurements from buoys and sensors located in the ocean and along the coasts as the tsunami progresses.
- PTWC continues to provide information until all coasts in the threatened region are no longer at high risk of tsunami impact.

■ Central America Tsunami Advisory Center (CATAC)

The Central America Tsunami Advisory Center (CATAC) is an entity based in Nicaragua, responsible for providing information to Central America in the event of a tsunami threat.

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

As part of future improvements to Guatemala's tsunami warning and mitigation system, the implementation of at least two simulation exercises per year is planned. These will include participation in the Caribbean Wave exercise held in March, focused on the Caribbean region, and a proposed drill specifically for Guatemala's Pacific coast, taking advantage of the International Day for Tsunami Awareness on November 5. This latter date is proposed to be institutionalized as a national activity aimed at strengthening preparedness in Pacific coastal communities.

Currently, there are 17 tsunami inundation maps developed for 17 coastal communities. In order to expand this coverage, technical staff will soon receive specialized training in the use of pre-modeled events, enabling the generation of additional maps and direct work with communities to establish evacuation routes and zones. These tools will be essential for decision-making during emergencies or alert phases.

Strategic sites have also been identified for the installation of tide gauge stations along the country's coasts. These stations will be key for real-time sea level monitoring and will allow for the verification and updating of information during a tsunami event, thus enhancing communication with affected communities. The implementation of these monitoring tools will significantly strengthen the country's response capacity.

Finally, in collaboration with the Hydrology Section, the development of outreach materials such as banners and posters for social media is planned, with the goal of educating and informing the public about what a tsunami is, its implications, how to respond to warnings, and general preparedness information. Efforts will also be renewed to engage with a pilot community—Izabal being the main candidate—to pursue recognition under UNESCO's Tsunami Ready program.

6. Executive summary

Below is a description of the main actions carried out in Guatemala since the last National Report regarding the strengthening of the tsunami warning system. It outlines modifications to operational procedures, mitigation activities, preparedness exercises, and educational programs. These actions aim to improve response capacity and raise awareness of tsunami risk in the country.

INSIVUMEH has a Manual for the Issuance of Bulletins and Follow-Up in Case of Tsunami Threats, which is currently under the responsibility of the Department of Research and Geophysical Services. This document has been recently updated to include modifications in the execution codes used for generating and sending tsunami warning bulletins. Based on the results of the National Report on Capacity Assessment of Tsunami Preparedness survey, INSIVUMEH, in coordination with the national risk management authority (CONRED), established a direct communication line by appointing specific officials as focal points to strengthen tsunami-related capacities. These include monitoring officers, staff from the Department of Planning and Procedures, national organization technicians, and research department personnel.

As part of tsunami mitigation activities, participation has taken place in exercises such as PacWave24, during which communication channels for issuing warning bulletins were tested. This exercise was conducted on November 5, in commemoration of the International Day for Tsunami Awareness. In addition, participation took place in the Caribe Wave 2025 tsunami drill, which was preceded by a preparatory workshop aimed at staff from the Seismology Section, Hydrology Section, and CONRED secretariat technicians. The workshop included a theoretical introduction to tsunamis, the generation of products in case of a warning, and a detailed explanation of the response timeline, as well as the procedures that technical personnel should follow in the event of a real incident.

Finally, INSIVUMEH actively and continuously participates in public outreach activities related to natural disasters, particularly in risk management fairs aimed at the general population and students from local communities. In addition, the institute produces and disseminates publications with images and informational capsules about what a tsunami is and what to do in case of a warning. These actions are intensified on key dates such as the International Day for Tsunami Awareness and Tsunami Drill Day, with the goal of strengthening the culture of prevention and preparedness for such events.