Collection of the available meteo-tsunami risk management plan for the IT test site

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1. Introduction

We emphasize that there is no evident risk of meteotsunami or tsunami for the Italian test site of Ferrara. Furthermore, there is currently no available specific plan of meteotsunami risk management for Italy. However, the present deliverable collects the main tsunami management plans that have been released by the Italian Civile Protection Agency (https://rischi.protezionecivile.gov.it/en/tsunami/activities) and the associated campaign "I don't take risks" (https://iononrischio.protezionecivile.it/static/5766c6f9d0b89d1f467f330aa7d68e0b/maremoto-scheda-eng.pdf) in terms of signage systems, leaflets, and informative materials available to general public. Most of this material has been released in 2021 after the start of the PMO-project.

As a general remark, the reader is recommended to make reference to the documents cited herein for an exhaustive insight about the Italian management plan regarding the tsunami risk.

2. The tsunami risk management plan for Italy

The following information is excerpted from from the web page of the Italian Agency of Civil Protection https://rischi.protezionecivile.gov.it/en/tsunami/activities

Every coast of the Mediterranean Sea is exposed to tsunami risk due to the high seismicity and to the presence of various active volcanoes, both emerged and submerged. Over the past thousand years, along the Italian coasts, tens of tsunamis have been reported, but only some of them were destructive. The most affected coastal ares are the ones of Eastern Sicily, Calabria, Puglia and Eolie archipelago. Minor tsunamis were recorded also along Ligurian, Tyrrhenian and Adriatic coasts. Italian coasts can also be reached by tsunamis generated far from our country (e.g. following a strong earthquake in the waters of Greece).

Since 2005, Italy takes part to the international alert system for the tsunami risk in the North East Atlantic, Mediterranean and linked seas NEAMTWS, under the coordination of IOC – Unesco Intergovernmental Oceanographic Commission. This system is similar to the one already operating in the Pacific, Caribbean and Indian Ocean, where Early Warning systems are already in place, with the difference that in a small sea, such as the Mediterranean Sea, wave arrival times are short thus reducing the time needed to alert the population.

In 2017 the SiAM - National Alerting System for Earthquake Generated by Earthquakes was established by a Directive of the President of the Council of Ministers, which includes three institutions: Ingv - National Institute of Geophysics and Volcanology operating through the Cat - Tsunami Alert Center, Ispra - Higher Institute for Environmental Protection and Research and the Department of Civil Protection. On November 15, 2018, the indications that the Head of the Civil Protection Department addresses to Components and Operational Structures for the updating of their civil protection plans for the tsunami risk were published in the Official Gazette.

2.1 Description of the risk

Mediterranean coasts are exposed to tsunami risk, not only for the high seismicity of the area, but also for the presence of various volcanoes, both emerged and submerged. However, if a tsunami occurred in the Mediterranean Sea - a closed and quite shallow basin - it would not be as intense as one developing in the Oceans, where earthquakes with higher magnitude than the ones of the Mediterranean area can occur and water masses are much greater. Nevertheless, history has demonstrated that, following very energetic seismic events or submarine landslides, destructive tsunamis can occur, also due to the high urbanization of the coastal areas.

The tsunami is a rapid rise of the sea level, exactly like a water wall that tears down coasts, causing an inundation that invades the coastal belt. Sometimes an initial and sudden withdraw of the sea can be observed, leaving dry ports and coasts. Tsunami waves have a much greater force compared to sea storms and are able to move inland for hundreds of meters (even kilometres, if the coast is very low), dragging everything along the path: vehicles, boats, trees and other material, that will increase the destructive potential.

Propagation and effects of the wave on the coast are affected by morphological factors - such as the line of the coast or the topography of the sea bed and of up-country - and anthropic, linked to the use of the soil. The structure of port areas, for example, may amplify the energy of the tsunami, whereas the presence of buildings and docks along the coast can reduce the propagation of the wave inland. Tsunami waves can also climb up from outlet of rivers and streams along their flow. propagating inland.

Besides the effects linked directly to the action of the moving wave, a tsunami can trigger a series of secondary effects: the inundation can in fact cause landslides, groundwater

pollution, or fires. The impact on ports and industrial plans can cause the emission and diffusion of polluting substances.

2.2 Tsunami Warning System. The Pacific Ocean Model

Based on what reported on https://www.protezionecivile.gov.it/it/approfondimento/tsunami-warning-system--il-modello-dell-oceano-pacifico, on the island of O'ahu, in Hawaii, the Ptws - Pacific Tsunami Warning System has been in operation since 1948, a tsunami warning system, consisting of a network of 26 Pacific States in which 30 tidal stations operate, i.e. which measure the height of the tides.

The PTWS can take advantage of the support of another hundred stations managed by the Noaa - National Oceanic and Atmospheric Administration and is able to receive data from hundreds of seismic stations throughout the country, through the NEIC - National Earthquake Information Center of Colorado. The PTWS also coordinates the activities of the tsunami alert centres of Alaska, Polynesia, Chile, Japan and Russia.

The system is able to calculate the arrival time of the first tsunami wave through a model that calculates the speed of the waves, taking into account the depth of the basin. When an earthquake with a magnitude equal to or greater than 7 on the Richter scale is generated in an area of the Pacific Ocean, in less than half an hour the PTWS is able to identify the exact location of the epicenter and the magnitude of the earthquake. Thus begins the tsunami warning for all those areas that could be hit in less than three hours. Since the time required to confirm the tsunami is longer than it takes to implement the evacuation procedures, the latter are immediately initiated.

Usually, the first indication of a tsunami wave comes from the tidal station closest to the place where the tidal waves appear larger and faster than those recorded normally. However, the signal of a single station is not sufficient: if the anomaly is not confirmed by the PTWS through the recording of other anomalous signals, the alert and warning are cancelled. If, on the other hand, the tsunami is confirmed, we immediately pass from the attention phase to the alert phase and then to the alarm phase, according to this procedure:

• Three hours before the arrival of the first wave, the sirens send out the warning signal. The population knows that they must turn on the radio and follow the evolution of the phenomenon through the news and indications broadcast by all the stations.

• The sirens sound again two hours before the expected arrival, and then again, an hour before and half an hour before. These signals are always accompanied by the information broadcast by the radios.

In case of need, it is the Civil Protection staff who coordinates the evacuation of the population, starting from the lower coast areas that can be hit first.

In addition to the ability of the scientific community to predict the possible arrival of a wave, the Pacific warning system for defence against tsunamis is also based on the awareness of the risk on the part of the population and on the knowledge of the rules of behaviour to be adopted in the event of emergency. Alongside a series of structural prevention measures adopted on the Hawaiian Islands - for example, buildings inhabited from the first floor up and the ground floor dedicated to open parking - the strategy chosen by the Government provides for the widespread dissemination of information on risk and plans emergency, both among residents and tourists.

3. SIAM Alert System

In 2017, the SiAM - Sistema di Allertamento Nazionale per i Maremoti Generati da Sisma was instituted in Italy. Three organizations cooperate in this system: the Ingv - National Institute of Geophysics and Volcanology, which operates through the Cat - Tsunami Warning Center; Ispra - Superior Institute for Environmental Protection and Research; and the Department of Civil Protection.

The INGV's CAT assesses the possibility that an earthquake with an epicenter at sea or near the coast could trigger a tsunami. Based on these assessments, the Civil Protection Department broadcasts alert messages with the aim of activating, as quickly as possible, the National Civil Protection Service and informing the population. Finally, the maritime data provided by Ispra allows for the confirmation or non-confirmation of a possible tsunami.

SiAM is part of the international warning system that was established in the Mediterranean on the model of those active in the Caribbean Sea and the Pacific and Indian oceans.

Compared to these, however, it has limitations because in a shallow sea like the Mediterranean, wave arrival times are very short, which reduces the possibility of alerting the population. It is therefore important to be well aware of the rules of conduct while remembering that tsunami risk inevitably involves false alarms.

See the Reference: Direttiva del Presidente del Consiglio dei Ministri: Istituzione del Sistema d'Allertamento nazionale per i Maremoti generati da sisma – SiAM (https://www.protezionecivile.gov.it/en/normativa/direttiva-pcm-istituzione-siam)

3.1. Area of competence, forecast point definition of levels of alert

The area of competence of the CAT is defined as the geographical area such that, if an earthquake has epicenter within it, it can activate the CAT procedures for the evaluation of the tsunamigenic potential and, in cascade, the SiAM procedures.

The CAT area of competence includes the entire Mediterranean Sea (Figure 1 below). West includes a tolerance zone in the Atlantic Ocean, from the Strait of Gibraltar to the longitude 7 ° W. N-NE of the Aegean Sea the area of competence includes another area of tolerance, which includes the Sea of Marmara and a part of the Bosphorus, up to latitude 41.15 ° N.

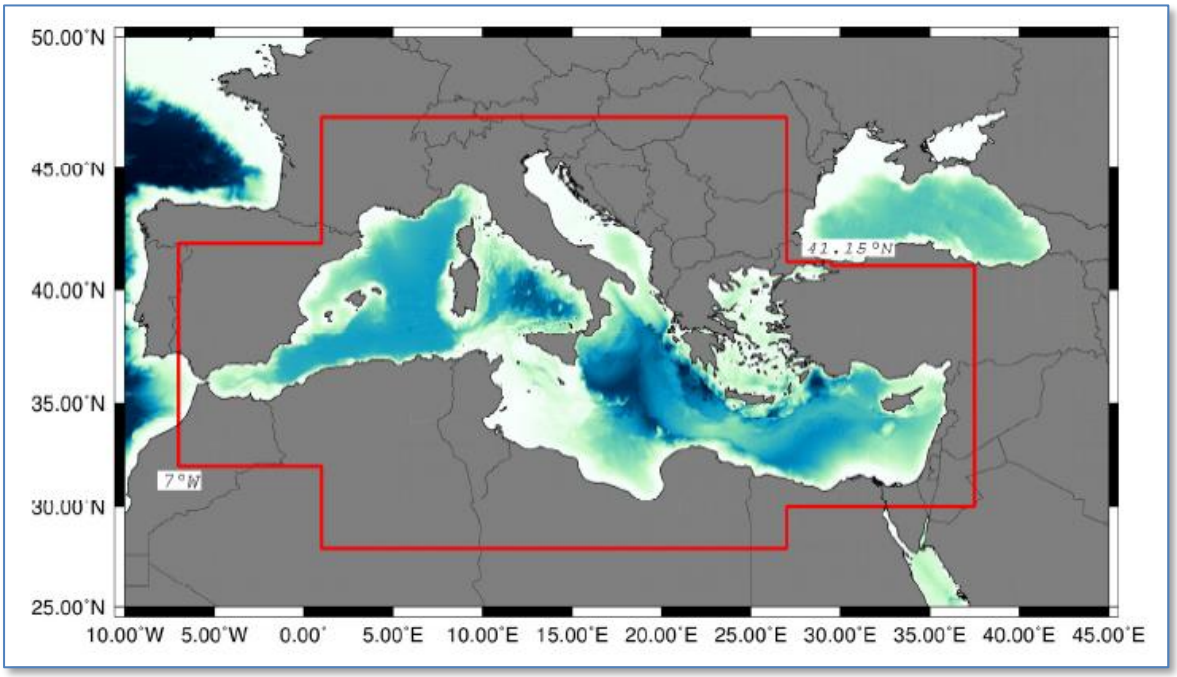


Figure 1: zone pertaining to CAT's control.

Forecast points (Figure 2) are defined as the points on which an alert level is estimated and the theoretical arrival time of the first tsunami wave. The forecast points coincide with those defined by the IOC Member Countries and transmitted to the ICG / NEAMTWS (green triangles in Figure 2).

Exceptions are some forecast points defined autonomously by the CAT and communicated to the ICG / NEAMTWS as TSP, in front of the coasts of countries that do not yet have defined or transmitted its forecast points, or where the coverage of the forecast points provided it is not sufficiently homogeneous (yellow triangles in Figure below).

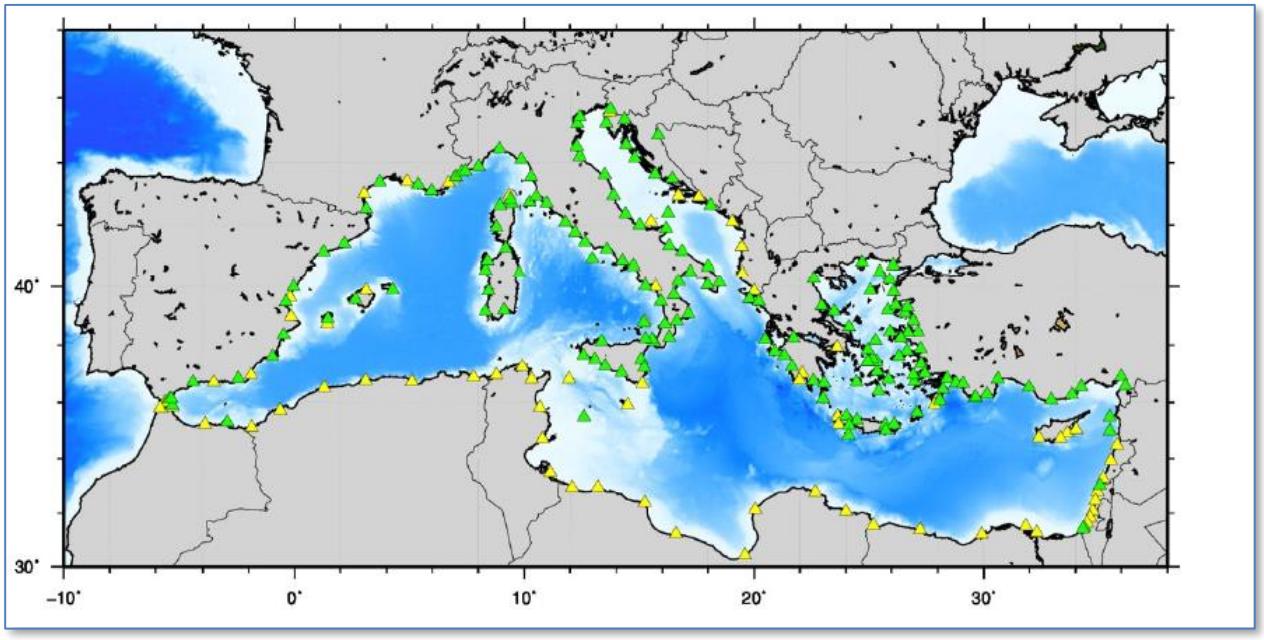


Figure 2: forecast point. In green the ICG / NEAMTWS forecast points. In yellow the forecast points defined and used by SiAM in the absence of forecast points officially transmitted by some member countries. The stations that are closest to Ferrara are Ravenna and Chioggia.

3.1 Definition of alert levels

In the SiAM area - 2 different levels of alert are adopted depending on the severity estimated tsunami on the Italian coasts, the red level (watch) and the orange level (advisory), which coincide with the similar alert levels adopted in the area ICG / NEAMTWS, described in the document "Interim Operational Users Guide for the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and Connected Seas (NEAMTWS) ". In analogy with what is used in ICG / NEAMTWS scope, for the SIAM system the Information does not constitute a level of alert, but it is to be considered a message sent for appropriate information to the subjects of Annex 3 of the Directive.

In addition, the alert levels related to the SiAM messages are also reported coasts of other Mediterranean countries affected by the event.

The 2 alert levels for the Italian coasts are defined as follows:
• The RED WARNING LEVEL (WATCH) indicates which coasts may be hit by a tsunami wave with a height above sea level greater than 0.5 meters and / or a runup greater than 1 meter.
• The ORANGE ALERT LEVEL (ADVISORY) indicates that the coasts may being hit by a tsunami wave with a height above sea level less than 0.5 meters and / or a run-up of less than 1 meter.
The INFORMATION message indicates that it is unlikely, according to estimation methods adopted internationally described in the document "Interim Operational Users Guide for the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and Connected Seas (NEAMTWS) ", which any tsunami produces a significant impact on the Italian coasts. However, in a range of about 100 km from the epicentre of the earthquake, variations in the anomalous currents and wave motions, within the port basins.

Regardless of the alert level, an earthquake of magnitude having occurred estimated greater than or equal to 5.5, induced phenomena could occur that cannot be foreseen by SiAM (landslides and other gravitational phenomena) which in turn could induce a tsunami.

Height above sea level means the positive anomaly (wave amplitude) caused by the tsunami near the coast; the anomaly refers to the sea level in the absence of tsunami.

Runup denotes the maximum topographical altitude reached by the tsunami wave during its ingression (flood).

Figure 3, runup concept

3.2 Subjects alerted and / or informed by the SSI-DPC

The SSI of the DPC disseminates the messages received from the INGV CAT to:

- Operational structures at national and territorial level: National Brigade Corps of Fire, Police Forces, Armed Forces through the Summit Operational Command Joint Forces, Italian Red Cross,
- Port Authorities;
- Regions and Autonomous Provinces;
- Companies providing essential services and to entities and companies that provide services for mobility on a national scale equipped with an operational room operating 24/7 (ANAS SpA; Autostrade per l'Italia SpA; Italian State Railways Group; Manager of Energy Services - GSE SpA; TERNA SpA; ENEL SpA to; VODAFONE; WIND; TELECOM; H3G; ENAC - National Agency for Civil Aviation; ENAV SpA – Entity National for Flight Assistance; ENI SpA;
- Prefectures - UTG of the coastal provinces;
- Coastal municipalities;
- Ministry of Economic Development and ENEA.

3.3 Communication procedures between CAT-INGV AND SSI-DPC

Upon the occurrence of a potentially tsunamigenic seismic event, the CAT processes sends messages from the alert system to the SSI of the DPC. Even before of the processing of such messages, the CAT sends to the SSI itself a communication of "Evaluation in progress", in order to inform you of the start of the event analysis activities potentially tsunamigenic seismic. This evaluation may be followed by one communication of "evaluation completed", where the conditions for a tsunami alert, or by one or more messages according to the specifications indicated in the following.

The message sent by the CAT-INGV to the SSI-DPC can be of information or of alert and must be sent within 14 minutes of the estimated time of origin of the earthquake and, in any case, as soon as possible in the case of unforeseeable technical impediments (anomalies in the data flow, malfunctions of automatic systems, other impediments that may also temporarily limit the operation of the CAT), or in the event of difficulty in arriving to reliable estimates of the parameters of the earthquake in particular areas where the coverage of seismic networks is insufficient.

3.4 Glossary of the Italian Acronyms

GLOSSARIO/ACRONIMI

CAT - Centro di Allerta Tsunami

cTSP - candidate Tsunami Service Provider

DG-ECHO – Directorate-General (Department) - European Civil Protection and Humanitarian Aid Operations

DPC – Dipartimento della Protezione Civile

ERCC - Emergency Response Coordination Centre

ICG/NEAMTWS -Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and Connected Seas

INGV - Istituto Nazionale di Geofisica e Vulcanologia

IOC - Intergovernmental Oceanographic Commission

ISPRA - Istituto Superiore per la Protezione e la Ricerca Ambientale

JRC – Joint Research Centre

NTWC - National Tsunami Warning Center

PCM – Presidenza del Consiglio dei Ministri

RMN - Rete Mareografica Nazionale

SSI- Sala Situazione Italia

TNC - Tsunami National Contact

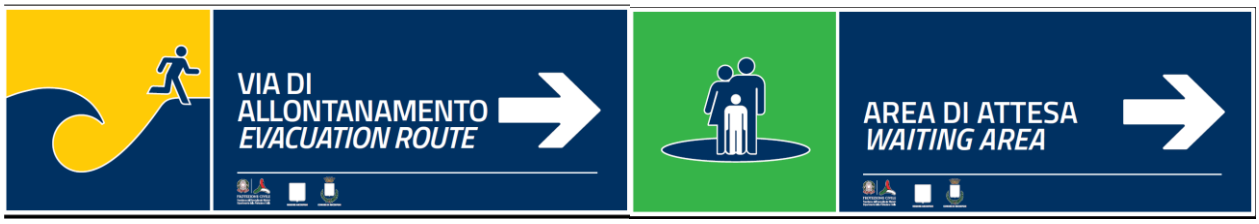
TSP - Tsunami Service Provider

TWFP - Tsunami Warning Focal Point

UNESCO – United Nations Educational, Scientific and Cultural Organization

3.5 Signage system prepared by the Italian Civile Protection Agency

We report hereafter the alert signage system that advises the population about how to react to a tsunami event.



4 Risk reduction and readiness level

The use of monitoring networks, the study of past events and wave propagation models are some of the actions that reduce the tsunami risk. These measures in the field of development and spatial planning, carry out a safety intervention of the areas at risk a civil protection plan. Being aware and prepared is the best way to prevent and reduce the consequences of a tsunami.

In a sea as small as the Mediterranean, the arrival times of the waves are very short. Authorities may not have time to issue an alert. So, if you live, work or go on vacation in a coastal area, it is even more important to learn to recognize the phenomena that can signal the arrival of a tsunami:

- a strong earthquake that one has directly felt or of which he/she has heard;
- a dull and growing noise coming from the sea, like that of a train or a low-flying plane;
- a sudden and unusual retreat of the sea, a rapid rise in sea level or a large wave spread over the entire horizon.

One should remember that houses and buildings near the coast are not always safe:

- the safety of a building depends on many factors, for example the type and quality of the materials used in the construction, the altitude at which it is located, the distance from the shore, the number of floors, the more or less direct exposure to the impact of the wave;
- the upper floors of a reinforced concrete building, if the building is well constructed, can offer adequate protection.

5 The “I don't take risks” informative campaign - Tsunami

The Italian I don't take risks - Tsunami campaign was introduced in 2013 during the international exercise Twist - Tidal Wave In Southern Tyrrhenian Sea. In the squares where the campaign takes place, citizens meet civil defence volunteers trained and prepared to spread knowledge about the risk and the adoption of good practices to reduce the consequences of a tidal wave.

To best convey information, volunteers bring to the squares the timeline, an installation with which one can take, a symbolic journey through past events and from which valuable lessons can be learned in terms of awareness and prevention.

In the next pages the flyers of the informative campaign are reported.

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What to do DURING a tsunami

If you are at the beach or in a coastal area

and receive an alert message that indicates the possible arrival of a tsunami wave, or recognize at least one of these phenomena:

- A strong earthquake you have felt or that you have heard about
- A sudden and unusual retreat of the sea, a rapid rise in sea level or a big wave extending across the whole horizon
- A deep and increasing noise coming from the sea, like that of a train or a low flying aircraft

Move away from the water and quickly reach the nearest elevated area (such as a hill or the upper floors of a building).

Warn those around you of imminent danger

Run on foot following the fastest escape route. Do not go by car, it could become a trap.

If you are at sea,

you may not be aware of the phenomena accompanying the arrival of a tsunami, so it is important to always listen to radio press releases:

If you are in a boat and you get news of an earthquake on the coast or at sea, move further offshore; if you are in a port, leave the boat in port and move to safety in a higher place.

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What to do AFTER a tsunami

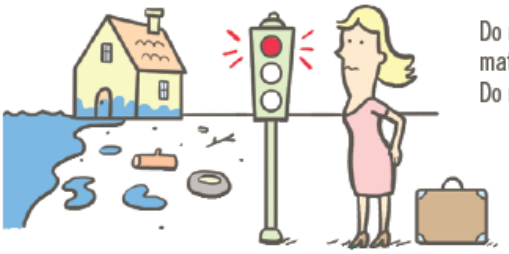
Stay in the area you have reached and discourage anyone from going back to the coast: the first wave might be followed by more dangerous ones.

Check the health conditions of the people around you and, if possible, give first aid assistance.

Listen to the authorities to find out when it's safe to leave and what you need to do.

Use the phone only for emergencies.

If your home has been affected by the tsunami, do not return without permission.



Do not eat foods that have come into contact with the water and materials transported by the tsunami: they may be contaminated. Do not drink tap water.

A tsunami can be generated by an earthquake or volcanic activity: be informed, therefore, about what to do in case of an earthquake or eruption.

Hang this card in a place visible to all the members of your family: it will help you to remember some useful tips in case of emergency

- www.protezionecivile.gov.it
- www.reluis.it
- www.anpas.org
- www.isprambiente.gov.it
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