Tsunami awareness raising activities in Italy for the World Tsunami Awareness Day 2022

1. The exercise “Sisma dello Stretto 2022” (“Earthquake of the Strait 2022”)

From 4 to 6 of November 2022, the Regions of Calabria and Sicily are the protagonists of the exercise "Earthquake of the Strait 2022" which aims to test the operational response of the National Civil Protection Service to a seismic event followed by a **tsunami alert**, in an area of high hazard for both earthquakes and tsunamis. The coordination of the exercise is carried out by the **Italian National Department of Civil Protection**, in agreement with the Regions involved and the Prefectures - UTG of **Reggio Calabria and Messina**, and with the involvement of tens of technical, scientific and administrative bodies.

As known, both cities lie along the Strait connecting the Tyrrhenian to the Ionian Seas, and were strongly hit by the **1908 earthquake and tsunami**. The earthquake had magnitude 7.1-7.3 and was due to the activation of a normal fault crossing the Strait.

Observed run-up reached 12-13 meters on both the Sicilian and the Calabrian sides of the Strait.

There are numerous components and operational structures participating in the test (see Annex 1).

The historical reference event for the exercise scenario is the earthquake that on January 16, 1975 struck the area of the Strait of Messina, with its epicenter in the hinterland of Reggio Calabria.

To make the response more significant in terms of emergency management, including the tsunami warning, the magnitude of the event was increased in the simulation (from ML = 4.7 of the real 1975 shock, to **ML = 6 / Mw = 6.2**), capable of **triggering a (moderate) tsunami**, as well as other secondary effects on land, such as landslides and liquefactions.

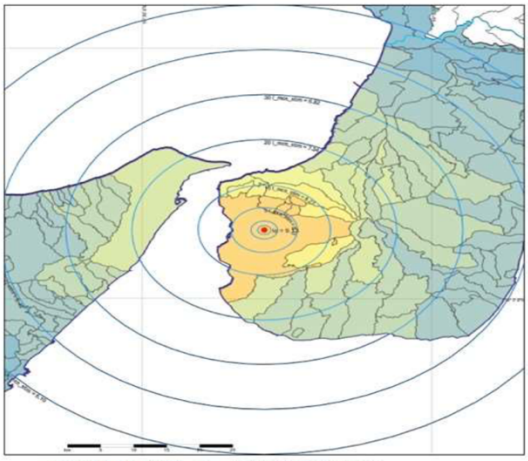

Fig. 1. Epicenter of the Mw6.2 earthquake, and the municipalities involved in the exercise

From November 4 to November 6, **37 municipalities of the Province of Reggio Calabria and 19 municipalities of the Province of Messina** will be involved in the exercise. About half of these lie on the coasts of either the Tyrrhenian or the Ionian Sea and will be therefore involved in the tsunami exercise.

2. The tsunami alert chain

The National Tsunami Warning Center (CAT: Centro Allerta Tsunami of INGV, the National Institute of Geophysics and Volcanology) will issue tsunami alert messages in the morning of November 4.

Two different alert scenarios were hypothesized, both based on the event described above.

The procedure used by CAT is currently based on a Decision Matrix approved by ICG/NEAMTWS in 2016, when CAT was appointed as Tsunami Service Provider for the whole Mediterranean basin. With a magnitude **Mw=6.2**, **an Advisory message would be issued as Initial message** (meaning less than 1 meter of expected run-up).

Two scenarios were prepared. The first involves the issuance of the initial local **ADVISORY** message (Annex 2) and subsequent **cancellation**; the second scenario also provides for the issuance of the initial local **ADVISORY** message, but with the confirmation of the tsunami in progress, with the **issuance of ONGOING messages**.

2.1. Scenario 1. Alert (ADVISORY) and Cancellation

The first scenario involves the issuance of an initial ADVISORY message, based on the event selected from DPC for the exercise:

- *Coordinates of the epicenter: 38.137 N – 15.711 E*
- *Hypocentral depth: 20.0 km*

In this scenario, the first message will be issued a few minutes after the earthquake. Considering the timing of the events handled by the CAT between 2017 and 2022, and the good coverage of the seismic network in the Calabrian-Sicilian area, the initial message will be issued about 7 minutes from the origin time of the simulated event, therefore at 10:07 Italian time.

Subsequently, the "tsunamologist" on shift and the official on duty will follow the procedure, checking the signals of the tide gauges in the area (Messina, Reggio Calabria, Catania, Milazzo etc.) but will not send any confirmation. After about two and a half hours, as per the CAT procedure, the Cancellation message will be sent.

The sequence of messages would therefore be as follows:

1. OT: Origin time of the earthquake

2. OT + 7min: Initial Message 001 - Advisory Level (Orange)

3. OT + 150min: Alert Cancellation Message 002

Immediately after the earthquake and after sending the first message, the CAT officer is notified by the CAT shift worker (as per job description) while the CAT Coordinator is notified by the CAT officer; if on site, both go to the CAT workstation to follow the evolution of possible changes in sea level. At this point, they make themselves available to the INGV Crisis Unit and one of them could be diverted to the Operational Committee at the DPC.

2.2. Scenario 2. Alert, Confirmation and End of alert

Also in this scenario, the first message would be issued a few minutes after the earthquake. Considering the timing of the events handled by the CAT between 2017 and 2022 and the good coverage of the seismic network in the Calabrian-Sicilian area, the initial message will be issued about 7 minutes from the origin time of the simulated event, therefore at 10:07 Italian time.

In order to make the exercise more realistic, tsunami confirmation messages are expected to be issued in this scenario. To do this, it was necessary to carry out a simulation of the tsunami propagation after modifying the characteristics of the seismic event.

The simulation was based on the earthquake parameters described above and a hypothesized normal fault compatible with the expected seismic moment.

In order to have realistic sea level readings, a simulation was computed using a normal fault with the following characteristics (Fig. 2):

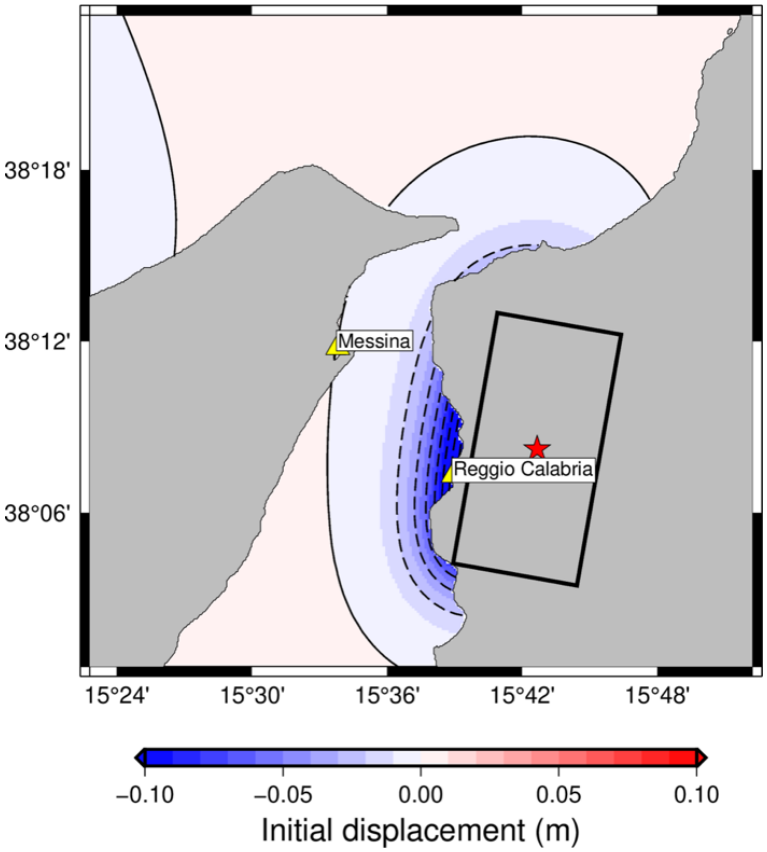

Fig. 2. Position of the fault plane centered on the hypocenter of the exercise scenario chosen by the DPC, with a depth of 5.7 km. The star represents the epicenter of the earthquake, the black rectangle the surface projection of the fault. The black lines in the Strait and the blue color represent the deformation of the seabed.

- *Lat-Lon of the epicenter: 38.137 N - 15.711 E*
- *Hypocentral depth: 5.7 km*
- *Depth of the fault top: 1 km*
- *Strike / Dip / Rake: 10/30/260*
- *Fault size L/W: 16.5 / 9.4 km*
- *Slip: 0.6 m*

The following list reports the timeline of the messages that will be sent by CAT after the simulated earthquake origin time (09:00 UTC, 10:00 Italian time). Although the observed tsunami waves are small (around 20 cm), the test will be carried out with a suite of messages to test the response of the whole system, including the release of **one Initial message, followed by two Ongoing confirmation messages, and one End message** after three hours:

1. *OT: Earthquake origin time*
2. *OT + 7min: Initial message 001 – Livello Advisory (Orange)*
3. *OT + 9min: Message 002 (Ongoing) reporting the following sea level readings:*
   - *Reggio Calabria: OT+7min: Amplitude (on s.l.) 17cm / period 5min*
   - *Messina: OT+8min: Amplitude 6cm / Period 6min*

4. *OT + 33min: Message 003 (Ongoing): with the the following further reading:*
    - *Catania: OT+32: Amplitude 2cm / period 16min*
5. *OT + 180min: Message 004 End of Alert*

The simulated mareograms are reported in Fig. 3.

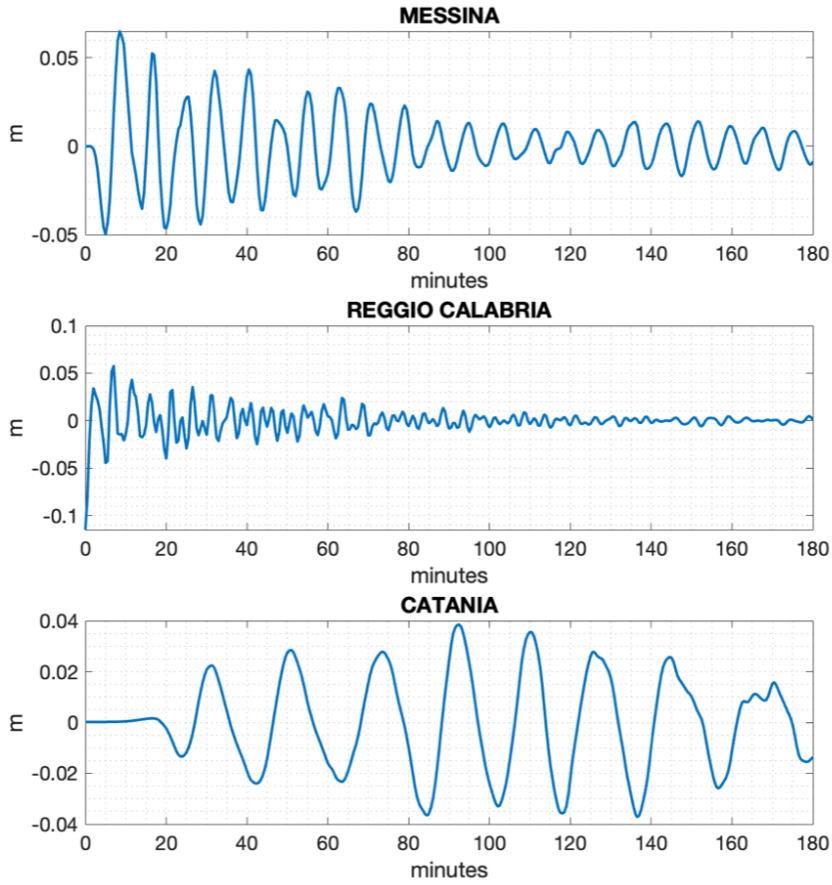

Fig. 3. Synthetic mareograms calculated at the three Forecast Points of Messina, Reggio Calabria and Catania. For the first two it is noted that sea level variations are evident just a few minutes after the earthquake (time 0). Furthermore, at time zero the coseismic displacement determined by the movement of the fault is noted at the tide gauge of Reggio (as a sudden of lowering); in this case the height of the tsunami would be larger than the observed value (0.17m instead of 0.07m). In Catania the first wave would arrive after about 20 minutes and would be negative (sea retreat).

Immediately after the earthquake and after sending the first message, the CAT officer is notified by the CAT shift worker (as per job description) while the CAT Coordinator is notified by the CAT officer; if on site, both go to the CAT workstation to follow the evolution of possible changes in sea level. At this point, they make themselves available to the INGV Crisis Unit and one of them could be diverted to the Operational Committee at the DPC.

2.3. Choice of scenario

Based on various organizational and communicative considerations, the DPC proposed to adopt Scenario n. 1. Therefore, only two messages will be sent, the initial ADVISORY (Orange) alert and the Cancellation one, as described above (2.1).

3. Activities and civil protection organization

Before the three days of the exercise, several formation activities have been carried out with remote webinars and on site courses, involving officials of the municipal administrations, civil protection volunteers, etc.

The exercise consists of a real part for testing the effective use of resources at national and local level in a whole series of **civil protection activities and a part of table-top activities**, such as the verification of communication channels between operational centers activated at different territorial levels. Special observers of these activities are the representatives of foreign consulates in Italy visiting the places of the exercise.

On the afternoon of November 4, the "DICOMAC" (National Center for Civil Protection Coordination) will be installed in Reggio Calabria, whereas 37 municipal Coordination Centers in Calabria and 19 in Sicily will be installed in all the municipalities involved in the exercise. The scheme of Civil Protection coordination is the following (Fig. 4).

A detailed program of all the activities that will be carried out between November 4 and 6 are reported on the DPC website:

https://www.protezionecivile.gov.it/it/approfondimento/esercitazione-sisma-dello-stretto-2022-0

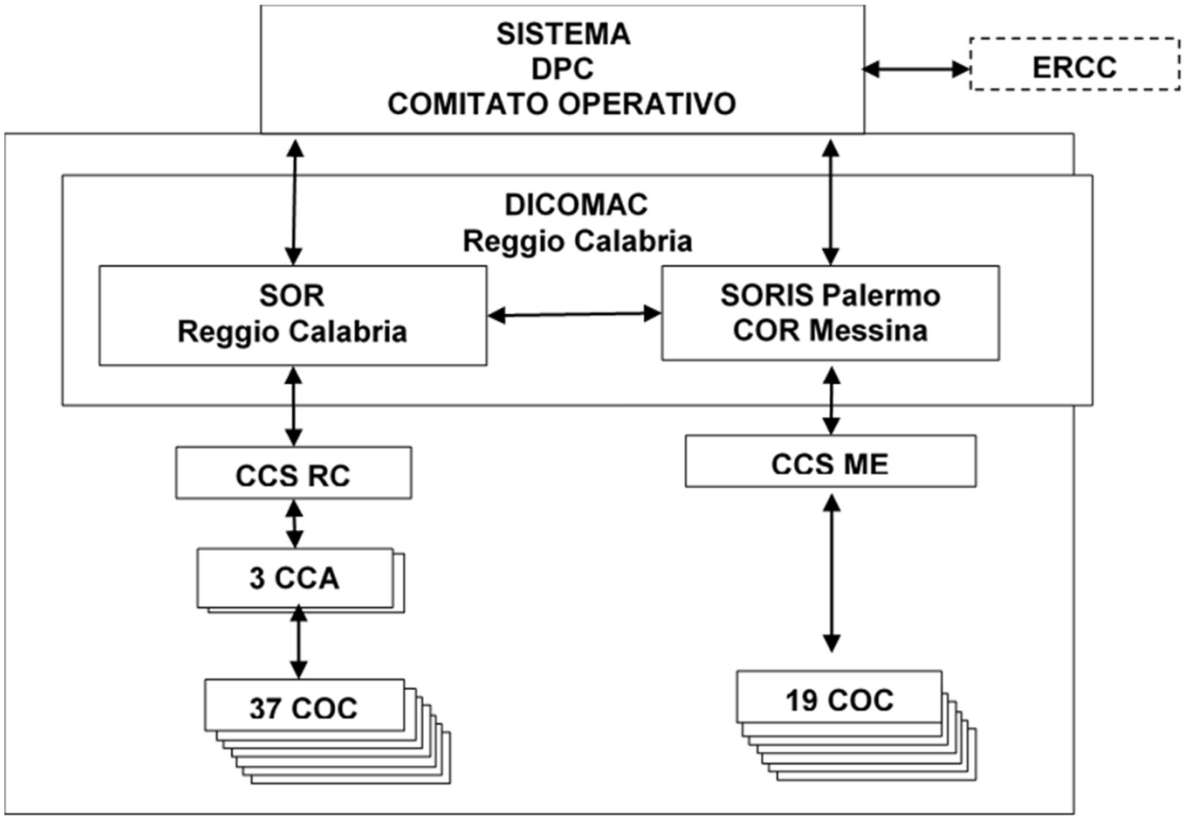

Fig. 4. " Earthquake of the Strait 2022" exercise: Intervention scheme and civil protection coordination among the various levels from national to local.

The Reggio Calabria municipality has announced the exercise to the citizens through their institutional web site (Fig. 5).

Fig. 5. From the website of the Reggio Calabria municipality, "TO ALL THE CITIZENS: Civil Protection Exercise "Sisma dello Stretto".

During the first two days of the exercise (November 4 and 5), several activities will be carried out on the territory, including all the bodies involved in an emergency (Police, Carabinieri, Red Cross, Coast Guard, Military forces, etc.). All the operations that will be carried out during the exercise are described in detail in the attached document (in Italian). These will include activities on the territory, at sea, and the activation of a **NaTech event at the Milazzo refinery**. On November 6, the activities will end, after a debriefing.

The **Messina municipality** will organize for November 5 a simulation in the area of **Capo Peloro**, the northernmost tip of the Messina area, where several warning sirens are going to be installed in the next few weeks.

4. IT-alert (cell broadcasting for direct alert delivery)

During " Earthquake of the Strait 2022" a new experimentation of the **national public alarm system IT-alert** (see http://www.it-alert.it/) is planned to inform citizens who live, work or transit in the coastal municipalities involved in the exercise with respect to the possible arrival of tsunami waves due to the simulated earthquake. Instant notifications will be sent to several hundreds thousand mobile phones in Sicily and Calabria. Figure 6 shows the web page of the Reggio Calabria municipality announcing the IT-alert test (see https://www.reggiocal.it/Notizie/Details/2906).

Fig. 6. Web page of the Reggio Calabria municipality announcing the IT-alert test

Fig. 7 shows the appearance of the IT-alert message, displayed on the website to prepare the population.

Fig. 7. Message that will be delivered by IT-alert for the tsunami warning, in Italian and English, on November 4, 2022.

Other activities

On November 5, a training activity on tsunami induced by volcanic eruptions and collapses will be carried out by Civil Protection officers and INGV experts in a primary and a secondary school on the **Stromboli** island, including a laboratory on the local civil protection plan.

5. Activities in the candidate Tsunami Ready municipalities

The "Sisma dello Stretto" exercise activities will involve one of the three Italian municipalities running for the Tsunami Ready recognition, namely **Palmi in Calabria**, where the Tsunami evacuation signs have been put in place in the last few days (Fig. 8).

Another Tsunami-Ready candidate municipality in Sicily (**Pachino/Marzamemi**) will not participate to this activity because out of the area defined for this exercise. However, it will be the site of a **specific local tsunami exercise that will be held on November 26**.

Fig. 8. One of the Tsunami hazard signs installed along the beach of Palmi, one of the Italian Tsunami Ready candidates.

5.1. Other WTAD activities: Minturno municipality (Latium, Tyrrhenian Sea)

Due to its position (in Latium region, far from the Messina Strait), the Municipality of Minturno is not involved in the "Sisma dello Stretto exercise 2022". However, on occasion of the WTAD, on November 5, Minturno, which is one of the Italian candidates to the Tsunami Ready recognition, will organize activities aimed at sensitizing the population and school groups to the themes of the tsunami risk.

This year the activities will be carried out on the date of November 4th as the school will be closed on Saturday 5th November because it is a holiday.

The activities will be carried out at the schools of the Marina di Minturno locality, lying within the tsunami hazard zone. In particular, a vertical evacuation of students will be carried out at two schools:

Scuola media statale Angelo De Santis Viale Pietro Fedele, 92		N° alunni 175 di cui 15 dis (*1 deambl*)
Scuola primaria Gianni Rodari Viale Pietro Fedele, 89		N° alunni circa 130 di cui 10 dis.

The two school buildings are adjacent to each other and have an internal path connecting them through a passage between the two courtyards.

The exercise will focus on the evacuation of the school building by the "Gianni Rodari" elementary school pupils and the rapid transfer towards the "Angelo De Santis" secondary school building where, through an internal staircase, they will stay in the classrooms on the upper floor.

The purposes of the exercise are:

1) the definition of the methods and timing of evacuation, reaching safe places in the secondary school building;

2) the definition of the routes and priorities for the shift to an upper floor by the different populations school groups;
3) the allocation of the spaces on the first floor of the secondary school for the different school groups.

The alert will be issued through the sound of the mobile siren placed on a volunteer rescue vehicle, this siren will simulate the signal that will come from the permanent warning sirens currently being installed.

Annex 1. List of participants in the "Sisma dello Stretto" exercise (4-6 November 2022) (List from the DPC website: https://www.protezionecivile.gov.it/it/approfondimento/esercitazione-sisma-dello-stretto-2022-0)

1) Citizens present in the 56 municipalities volunteering to participate in the exercise
2) Presidenza del Consiglio dei ministri – Dipartimento della protezione Civile
3) Prefettura - Ufficio Territoriale del Governo di Reggio Calabria
4) Prefettura - Ufficio Territoriale del Governo di Messina
5) Dipartimento regionale della Protezione Civile - Regione Calabria
6) Dipartimento Regionale della Protezione Civile - Regione Siciliana
7) Comune di Reggio Calabria
8) Comune di Messina
9) Città Metropolitana di Reggio Calabria
10) Città Metropolitana di Messina
11) Comuni della provincia di Reggio Calabria
12) Comuni della provincia di Messina
13) Commissione Nazionale per la Previsione e Prevenzione dei Grandi Rischi (CGR)
14) Dipartimento Vigili del Fuoco, del Soccorso Pubblico e della Difesa Civile
15) VVF - Corpo Nazionale dei Vigili del Fuoco
16) Comando Operativo di Vertice Interforze (COVI) – Esercito Italiano – Marina Militare – Aeronautica Militare
17) Polizia di Stato
18) Polizia Penitenziaria Dipartimento dell'Amministrazione Penitenziaria - Ministero della Giustizia
19) Comando Generale dell'Arma dei Carabinieri
20) Comando Generale della Guardia di Finanza
21) Comando Generale delle Capitanerie di porto
22) Comando del Corpo Forestale della Regione Siciliana
23) Ministero della Salute - Azienda Sanitaria Provinciale di Reggio Calabria e Azienda Sanitaria Provinciale di Messina (ASP)
24) Commissione Protezione Civile con il coinvolgimento delle Regioni e Province Autonome
25) Regione Campania
26) Regione Marche
27) Enti Locali UPI
28) Enti Locali ANCI
29) Organizzazioni nazionali di Volontariato di Protezione Civile (CNVPC)
30) Croce Rossa Italiana (CRI)
31) Corpo Nazionale di Soccorso Alpino e Speleologico (CNSAS)
32) Ministero degli affari esteri e della cooperazione internazionale
33) Ministero delle infrastrutture e della mobilità sostenibili e Direzione generale per le dighe, le infrastrutture idriche ed elettriche
34) Ministero della Cultura
35) ENAV Ente Nazionale Assistenza Volo
36) ENAC Ente Nazionale per l'Aviazione Civile

37) ANAS
38) ASPI
39) AISCAT
40) Gruppo FS Italiane
41) Viabilità Italia
42) GSE
43) TERNA
44) ENEL
45) ENI
46) SNAM
47) 2i Rete Gas
48) Italgas
49) RAI Pubblica Utilità
50) Rai Way
51) Poste Italiane
52) TIM
53) VODAFONE
54) WindTre
55) Iliad
56) Banca d'Italia
57) UNEM
58) Utilitalia
59) STN – Struttura Tecnica Nazionale dei Consigli Nazionali dei Professionisti tecnici
60) Istituto Nazionale di Geofisica e Vulcanologia (INGV)
61) Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA)
62) Consiglio Nazionale delle Ricerche Istituto di Geologia Ambientale e Geoingegneria e Istituto di Metodologie per l'Analisi Ambientale (CNR-IGAG e IMAA)
63) Centro Europeo di Formazione e Ricerca in Ingegneria Sismica (EUCENTRE)
64) Fondazione CIMA - Centro Internazionale in Monitoraggio Ambientale
65) Agenzia Spaziale Italiana (ASI)
66) Università della Calabria - Cartografia Ambientale e Modellistica Idrologica (UNICALCAMILAB)
67) Consiglio Nazionale dei Geologi - Ordine dei Geologi della Calabria e della Sicilia
68) ReLuis – Rete dei laboratori universitari di ingegneria sismica

Annex 1. Initial tsunami warning message(ADVISORY=ARANCIONE)

ESERCITAZIONE – ESERCITAZIONE - ESERCITAZIONE

TSUNAMI MESSAGE NUMBER 001

NEAM INGV IT-NTWC TSUNAMI SERVICE PROVIDER

ISSUED AT xxxxZ 04 NOV 2022

... TSUNAMI ADVISORY ...

THIS ALERT APPLIES TO ITALY

... TSUNAMI INFORMATION ...

THIS ALERT APPLIES TO ALBANIA ... ALGERIA ... BOSNIA_HERZEGOVINA ... CROATIA ... CYPRUS ... EGYPT ... FRANCE ... GREECE ... ISRAEL ... ITALY ... LEBANON ... LIBYA ... MALTA ... MONACO ... MONTENEGRO ... MOROCCO ... SLOVENIA ... SPAIN ... SYRIA ... TUNISIA ... TURKEY ... UK

THIS ALERT IS ADDRESSED TO ALL COUNTRIES AND INSTITUTIONS SUBSCRIBED

TO THE SERVICES OF INGV IT-NTWC TSUNAMI SERVICE PROVIDER IN ITS MONITORING AREA

THIS MESSAGE IS ISSUED AS ADVICE TO GOVERNMENT AGENCIES. ONLY

NATIONAL AND LOCAL GOVERNMENT AGENCIES HAVE THE AUTHORITY TO MAKE

DECISIONS REGARDING THE OFFICIAL STATE OF ALERT IN THEIR AREA AND ANY

ACTIONS TO BE TAKEN IN RESPONSE.

AN EARTHQUAKE HAS OCCURRED WITH THESE PRELIMINARY PARAMETERS

ORIGIN TIME - yyyyZ 04 NOV 2022

COORDINATES - 38.14 NORTH 15.71 EAST

DEPTH - 20 KM

LOCATION - TEST

MAGNITUDE - 6.2

ALERT LEVEL IS ASSIGNED ACCORDING TO THE ABOVE ESTIMATIONS OF

EARTHQUAKE PARAMETERS AND BASED ON THE MODIFIED ICG/NEAMTWS DECISION MATRIX

EVALUATION OF TSUNAMI ADVISORY

IT IS NOT KNOWN THAT A TSUNAMI WAS GENERATED. THIS WATCH IS BASED ONLY ON THE EARTHQUAKE EVALUATION. AN EARTHQUAKE OF THIS SIZE HAS THE POTENTIAL TO GENERATE A TSUNAMI THAT CAN STRIKE COASTLINES WITH A WAVE HEIGHT LESS THAN 0.5M AND/OR CAUSE A TSUNAMI RUN-UP LESS THAN 1M. AUTHORITIES SHOULD TAKE APPROPRIATE ACTION IN RESPONSE TO THIS POSSIBILITY. THIS CENTER WILL MONITOR SEA LEVEL DATA FROM GAUGES NEAR THE EARTHQUAKE TO DETERMINE IF A TSUNAMI WAS GENERATED AND ESTIMATE THE SEVERITY OF THE THREAT. A TSUNAMI IS A SERIES OF WAVES AND THE FIRST WAVE MAY NOT BE THE LARGEST. TSUNAMI WAVE HEIGHTS CANNOT BE PREDICTED AND CAN VARY SIGNIFICANTLY ALONG A COAST DUE TO LOCAL EFFECTS. THE TIME FROM ONE TSUNAMI WAVE TO THE NEXT CAN BE FIVE MINUTES TO AN HOUR, AND THE THREAT CAN CONTINUE FOR MANY HOURS AS MULTIPLE WAVES ARRIVE.

EVALUATION OF TSUNAMI INFORMATION

BASED ON HISTORICAL EARTHQUAKES AND TSUNAMI MODELLING THERE IS NO THREAT THAT A TSUNAMI HAS BEEN GENERATED THAT CAN CAUSE MAJOR EFFECT OR DAMAGE IN THE REGION. THIS MESSAGE IS FOR INFORMATION ONLY.

HOWEVER, AT SOME COASTS, PARTICULARLY THOSE NEAR THE EPICENTER, HIGHER TSUNAMIS MAY ARRIVE THAN OUR ESTIMATION.
AUTHORITIES SHOULD BE AWARE OF THIS POSSIBILITY.

ESTIMATED INITIAL TSUNAMI WAVE ARRIVAL TIMES AT FORECAST POINTS WITHIN THE WATCH AREA ARE GIVEN BELOW. ACTUAL ARRIVAL TIMES MAY DIFFER AND THE INITIAL WAVE MAY NOT BE THE LARGEST. A TSUNAMI IS A SERIES OF WAVES AND THE TIME BETWEEN SUCCESSIVE WAVES CAN BE FIVE MINUTES TO ONE HOUR.
LOCATION, FORECAST POINT COORDINATES, ARRIVAL TIME, ALERT LEVEL (ADVISORY, WATCH)

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ITALY - REGGIO_CALABRIA 38.12N 15.65E zzzzZ 04 NOV ADVISORY

ITALY - MESSINA 38.20N 15.56E zzzzZ 04 NOV ADVISORY

ITALY - CATANIA 37.50N 15.09E zzzzZ 04 NOV ADVISORY

ITALY - STROMBOLICCHIO 38.82N 15.25E zzzzZ 04 NOV ADVISORY

ITALY - GINOSTRA 38.78N 15.19E zzzzZ 04 NOV ADVISORY

ITALY - SIDERNO 38.27N 16.30E zzzzZ 04 NOV ADVISORY

ITALY - MILAZZO 38.21N 15.27E zzzzZ 04 NOV ADVISORY

ITALY - VIBO_MARINA 38.72N 16.13E zzzzZ 04 NOV ADVISORY

SUPPLEMENT MESSAGES WILL BE ISSUED AS SOON AS NEW DATA AND

EVALUATION ALLOWS.

END OF TEST

TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST