

**INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (of UNESCO)**

**ICG/NEAMTWS Expert Meeting 2022**

**Implementing NEAMTWS 2030 Strategy Opportunities and Actions to Explore**

**28 and 30 November 2022**

**SUMMARY REPORT**

1. **General Discussion of the ICG/NEAMTWS Steering Committee**

The expert meeting on 28 November took place at the Vesuvius Observatory in Ercolano, Italy, following a visit tour which lasted for an hour. Mr Denis Chang Seng, ICG/NEAMTWS Technical Secretary, welcomed all the participants with words of encouragement; this was the first in-person meeting of the Intergovernmental Coordination Group for the North-eastern Atlantic, Mediterranean and Connected Seas Tsunami Early Warning and Mitigation System (ICG/NEAMTWS) Steering Committee (SC) since Covid 19 Pandemic. The experts meeting was co-organised with the National Institute of Geophysics and Volcanology (INGV) because of the need to postpone the ICG/NEAMTWS XVIII session in Naples to March/April 2023, UNESCO Headquarters, Paris, France, due to unforeseen situations. Following the visit to the Vesuvius Observatory, the meeting continued on 29-30 November at the Centro Congressi Federico II, Naples, Italy. The goal of the experts' meeting was the discussion of the main opportunities and actions to implement the ICG/NEAMTWS Strategy (2021-2030) through the expert contributions of the Working Groups (WGs) and Task Teams (TTs).

* 1. **Report of the Chair**

Prof Maria Ana Baptista, Chair of the ICG/NEAMTWS, provided an introductory [presentation](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31252). She thanked the National Institute of Geophysics and Volcanology (INGV), University of Napoli “Federico II” and IOC-UNESCO for the organization of the meeting. The chair introduced the ICG/NEAMTWS Strategy (2021-2030) document as a key to capitalise on the Ocean Decade societal benefits in order to further improve monitoring, detection and data-sharing among Member States and partners. The Performance of the NEAMTWS depends on the implementation of all its components, their sustained operation and the adherence to agreed common principles of operation, interaction and data policy.

Challenges and needs faced by the ICG/NEAMTWS include: 1. Improve the observational networks (use of smart cables and other observation technology); 2. tsunamis generated by non-seismic events, such as volcanoes, landslides and meteotsunamis, atmospheric disturbances; 3. interoperability among Tsunami Service Providers; 4. high Performance computing to produce fast reliable hazard estimations; 5. better understanding of the interaction of tsunami hazards with climate and sea level changes.

Key discussions need to take place to agree about how to share methods and best practices; how and what actions are required to address non-seismic tsunamis in a MHEW context; and how to improve early warning information, reduce alert time and uncertainty.

The Chair informed that outputs of the expert meeting will be presented at the ICG-NEAMTWS -XVIII Session. The Session will be organized in the first quarter of 2023 at UNESCO, Headquarters, in Paris, France.

* 1. **ICG/NEAMTWS Strategy (2021-2030)**

Mr Alessandro Amato, INGV Focal point, [introduced](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31246) the ICG/NEAMTWS Strategy (2021-2030). The strategy outlines key objectives for continuously improving NEAMTWS to meet stakeholder requirements during the period 2021–2030. It is founded on three pillars:

1. Tsunami Hazard and Risk Assessment.

2. Detection, Warning and Dissemination

3. Awareness and Response

These pillars require a foundation of interoperability and sustainability and the enabling activities of research and capacity-building.

The ICG/NEAMTWS will also develop and implement Key Performance Indicators (KPIs) similar to other ICGs based on the three key pillars, and also implement the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG) XIV recommendation to include International Cooperation in its KPIs. Foundation activities to implement the strategy include Interoperability among Tsunami Service Providers (TSPs), other ICGs (TOWS), other ocean hazards warning and mitigation systems; Sustainability; Research; Capacity building; and implementation of annual plans of action of the ICG/NEAMTWS WGs and TTs.

* + 1. **Pillar 1: Tsunami Hazard and Risk Assessment**

Ms Audrey Gailler, Co-chair of Working Group 1 on Hazards Assessment and Modeling, provided a [presentation](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31244) on Pillar 1 of the ICG/NEAMTWS Strategy (2021-2030). Presently, pillar 1 is focused on the evaluation of the potential tsunami threat and quick response for appropriate actions based on TWS decision matrices built on the relationship between first earthquake source parameters and expected tsunami size. Pillar 1 is organized in 4 different objectives:

1. *Objective 1.1. Implementation of Probabilistic Methodologies:*Regional Probabilistic Tsunami Hazard Assessment (PTHA) as input for tsunami risk assessments and warning systems.
2. *Objective 1.2. Member states to develop specific tsunami hazard/risk assessment for vulnerable national sub-regions:*Work on a common understanding of the best viable practices in regional and national PTHA to comply with scientific and policy standards at a global level; and pursue deterministic studies.
3. *Objective 1.3. Develop regional hazard assessment for landslide-generated tsunamis.*
4. *Objective 1.4. Multi-sourced tsunami hazard:*Consider the different sources generating tsunamis, their relative intensities, probability of occurrence and uncertainties.
   * 1. **Pillar 2: Detection, Warning and Dissemination**

Mr Alessio Piatanesi, Co-Chair of Task Team on Operations, provided a [presentation](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31243) on Pillar 2. All TSPs in the NEAM region are using Decision Matrices (DM) to define the tsunami alert levels at predefined Forecast Points (FPs), however, there is a need to develop better forecast methods, with more precision and able to quantify the intrinsic uncertainty associated to the forecast. Pillar 2 consist of 7 different objectives:

1. *Objective 2.1. Increase, densify and ensure sustainability of the detection networks:*Where stations exist, ICG and IOC are promoting effective data-exchange policies by reinforcing international cooperation with the common goal of protecting the coast of all countries of the NEAM region.
2. *Objective 2.2. Installation of multi-hazard observation systems*
3. *Objective 2.3. Plan and implement an “Inter-Operability Tool”:*The first steps towards the development and implementation of the Inter-Operability Tool (IOT) have been taken. The IOT will allow TSPs and NTWCs to exchange data, compare solutions and report results, maps and other products.
4. *Objective 2.4. Develop and implement additional monitoring tools:*deep sea pressure recorders, Laser Interferometry (LI) and Science Monitoring and Reliable Telecommunications (SMART) cables, etc.
5. *Objective 2.5. Implement Probabilistic Tsunami Forecasting*
6. *Objective 2.6 Threat levels:*TSPs in the NEAM region release messages specifying alert levels (Information, Advisory, Watch) at a suite of Forecast Points (FPs). However, TOWS-WG recommends alert level terms should be replaced by threat level terms, in order to make clearer that alert levels are the responsibility of national/local authorities.
7. *Objective 2.7. Additional sources of tsunami observations***:** e.g. amateur and/or surveillance video.
   * 1. **Pillar 3: Awareness and Response**

Ms Cecilia Valbonesi, Chair of Working Group 4 on Public Awareness, Preparedness, and Mitigation provided a [presentation](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31248) on Pillar 3. Pillar 3 is organized in 8 different objectives:

1. *Objective 3.1. Understanding perceptions of coastal hazards and risks:* Different risk perception studies in the NEAM region, e.g. CoastWAVE Sea Level Related Hazards Risk Perception Survey Questionnaire; Review paper on global+NEAM risk perception studies; New results from several Italian regions ([Cugliari et al., NHESS, 2022](https://www.google.com/url?q=https://nhess.copernicus.org/articles/22/4119/2022/nhess-22-4119-2022.pdf&sa=D&source=docs&ust=1675251335677596&usg=AOvVaw1FrP1hgg5q5TnTh6L-fH09)); and TASOMA project in France (Universities Avignon and Montpellier).
2. *Objective 3.2. Strengthen public and local authority awareness of tsunami and associated hazards and how to prepare to respond:* Exercises and drill, e.g. NEAMWave23; World Tsunami Awareness Day (WTAD) activities in different countries.
3. *Objective 3.3. Develop tsunami-related curriculum programmes for all levels of education.*
4. *Objective 3.4. Develop and deliver suitable and sustainable capacity-building programmes to facilitate effective and efficient response and coordination:* Through CoastWAVE project and Tsunami Ready related activities.
5. *Objective 3.5. Develop and maintain the NEAMTIC tsunami information website:* Development of articles, videos, posters, etc.
6. *Objective 3.6. Establish rapid and effective evacuation mechanisms given the risk assessment guidance and data:* Through PTHA to evacuation maps; increased interaction with WG1.
7. *Objective 3.7. Develop and conduct regular exercises to test early warning systems and evacuation mechanisms:* Monthly exercises by TSPs; WTAD; NEAMWave; and Drills.
8. *Objective 3.8. Roll out the “Tsunami Ready” initiative in coastal communities.*
   1. **Reports of Tsunami Service Providers**

***CENtre d'Alerte aux Tsunamis (CENALT, CEA, France)***

Ms Hélène Hébert, Co-Chair of Task Team on Tsunami Watch Operations for TOWS-WG, provided a [presentation](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31245) about CENALT activities since the ICG/NEAMTWS Steering Committee meeting 8-11 April, 2022. In 2022, CENALT is celebrating the 10 years since it became operational and has organized a scientific workshop on 29-30 September 2022 at Bruyères le Châtel, France. The workshop brought together nearly 40 experts such as scientists and representatives (national authorities and UNESCO) to discuss achievements and opportunities. In addition, Risk Prevention authorities of the Ministry of Ecological Transition visited CENALT on the 10 October. A press visit was finally organized on 21 October, with both Risk Prevention and Civil Security authorities from the Ministry of Interior and Overseas Territories, and the Ministry of Ecological Transition, respectively.

CENALT reported a need for a more robust data exchange system, citing a lack of data in North Africa (seismic, sea level) as a critical concern. There is a need for scientific and technical improvements in hazard and risk assessment such as tsunami events modeling, forecasting, and support for the Benchmarking Project (NEAMBP). In addition, preparedness continues with the implementation of Tsunami Ready in France (Cannes).

***National Institute of Geophysics and Volcanology – Tsunami Alert Center (CAT-INGV, Italy)***

Mr Alessandro Amato, INGV Focal point, provided a [presentation](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31237) about INGV activities. In 2014, INGV began operation as a candidate Tsunami Service Provider (TSP) for the NEAM region and in September of 2016, it was accredited as a TSP by the ICG/NEAMTWS.

Through the National Plan of Recovery and Resilience, INGV has submitted a proposal which has been approved for an improvement of the national sea monitoring system, including 2+2 DART Buoys, numerous seismic and GNSS stations and cabled observatories (Smart cables). In addition, INGV reported that ISPRA has installed additional high quality tide gauges and pressure sensors on offshore oil platforms.

The Probabilistic Tsunami Forecasting procedure is currently under continuous test in parallel with the Decision Matrix - at least 6 months. INGV has been involved in the improvement of the local Stromboli volcano Tsunami Early warning System and ensuring its integration in the Italian and NEAM TWS. INGV has been responsible for managing and developing the system in Stromboli since September 2022.

***Instituto Português do Mar e da Atmosfera (IPMA, Portugal)***

Mr Fernando Carrilho, IPMA representative, provided a [presentation](https://oceanexpert.org/document/31470) about IPMA activities. IPMA is composed of 83 Broadband, 28 short-period and 97 accelerometers (real-time), and 70 tide gauge stations. It has 9 forecast points on the mainland and 11 on the Portuguese islands (Madeira, Porto Santo, and Azores Islands). IPMA operations started in January 2018, and was accredited as a NEAMTWS TSP in 2019. To this present date, it has issued a total of 37 tsunami messages.

For World Tsunami Awareness Day 2022, a tsunami awareness walk along coastal hazard evacuation routes, took place in the city of Sesimbra, Portugal. The walk, organized in collaboration with the Municipal Civil Protection Office of the Sesimbra City Hall, followed coastal evacuation routes from four different starting points and participants were invited to take a quiz on how to respond to a tsunami.

IPMA is engaged in a new submarine cable ring connecting Portugal Mainland-Azores-Madeira. It provides an opportunity for a Sensor Monitoring And Reliable Telecommunications system (SMART- CAM). Presently, the public tender of this project is in preparation.

***Kandilli Observatory and Earthquake Research Institute (KOERI, Turkey)***

Ms Didem Cambaz, Co-chair of Working Group 2 and 3 on Seismic, Geophysical and Sea Level Measurements, provided a [presentation](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31265) about recent KOERI activities. KOERI became a national tsunami warning center in 2011, and after a one-year period it became operational as a candidate tsunami Service Provider on 1 July 2012. To celebrate its 10 years in operations, KOERI organized a WTAD Tsunami Drill Exercise on 4 November 2022, in the CoastWAVE project municipality of Büyükçekmece. The tsunami drill exercise was followed by an exercise evaluation meeting and a Tsunami Early Warning & Risk Mitigation - Workshop on 5 November.

KOERI has issued 42 alert messages since 2012, 6 of those messages in 2022 (including the Düzce Earthquake on 23 November 2022). The sea level and seismic station network is composed of 260 seismic sensors and 27 tide gauge stations. KOERI plans to install 20 new sea level stations in the next 2-3 years in the Marmara Sea.

***National Observatory of Athens - Hellenic National Tsunami Warning Centre (NOA-HL-NTWC, Greece)***

Mr Marinos Charalampakis, Co-chair of Task Team on Tsunami Exercise, provided a [presentation](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31240) about NOA-HL-NTWC. The center has issued 4 Tsunami Warning Messages since the Steering Committee meeting in April 2022 and updated its forecast point list since August 2022. NOA-HL-NTWC is participating in theCoastWAVE (2022-2024); Geo-INQUIRE (2022-2025); EPOS Tsunami TCS (2021-X); and BALANCE (2021-2022) projects.

A table-top exercise with the National CPA was initially scheduled for November 2022 but was postponed for January 2023. Ongoing developments include: Preparation of local SOPs, following the guidelines and recommendations of the National SOP; Use of Emergency Communication Service for message dissemination to the public; and development of a national tsunami warning page to publish information related to tsunami events for the public.

1. **Tsunami Hazards and Risk Assessment** 
   1. **From PTHA to planning and evacuation maps in Italy**

Mr Fabrizio Romano, INGV, and Pio Di Manna, ISPRA, provided a [presentation](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31299) on this item. The methodology, NEAM Tsunami Hazard Model 2018 (NEAMTHM18) is a probabilistic hazard model for tsunamis generated by earthquakes. In this online data product, the hazard results are provided by hazard curves calculated at Points of Interest (POI). Maps derived from hazard curves are Probability maps for Maximum Inundation Heights (MIH). The model was prepared in the framework of the European Project TSUMAPS-NEAM[[1]](#footnote-1).

The Italian Tsunami Early-Warning System (SiAM) is working on an empirical approach for inundation maps. It adopted a Geographic Information System (GIS) based approach following an empirical model of propagation and inundation. Following Fraser & Power (2013), a linear attenuation rule between the R (run-up) values and D (maximum expected inland inundation distance) is applied.

Combining the run-up values and the related maximum expected inundation distance from the coast, SiAM elaborated the alert/evacuation zones based on a tsunami hazard model and inundation maps for the Italian coastal regions (tsunami map viewer- ​​http://sgi2.isprambiente.it/tsunamimap/). The now available SiAM evacuation maps could be considered as a preliminary version, subject to improvement and periodical updates and changes.

The ultimate goal from inundation and evacuation maps include: 1. PTHA: disaggregation; 2. Pilot sites and data: bathymetry, topography, and grids; 3. Inundation modeling: explicit numerical simulations, metrics, and political choices; 4. Evacuation modeling and planning: preparatory analysis, evacuation routes and maps.

* 1. **The Stromboli Tsunami Early Warning System**

Mr Giorgio Lacanna, University of Florence (Italy), provided a presentation on this item. The Stromboli volcano has been in activity since 1000 b.c. It has 13 explosions per hour every day with a magma input rate of 0.3 m3/s. When magma input rate is higher than 0.3 m3/s, explosive activity is interrupted by flank effusive eruptions (every 4/5 years). The effusive eruptions of the volcano constitute the main hazard because magma intrudes and generates flank instability. The most recent volcano eruption event generated 10 m tsunami waves on 28 December 2002.

A tsunami can reach the coast of Stromboli in less than 200 seconds or 3 minutes, and the coast in Calabria in 15-20 minutes. For this reason, the volcano is monitored on a daily basis to evaluate the increase of magma input rate, and the shift from explosive to effusive state.

The first mile of the tsunami EWS is important. It is critical to design the EWS as close as possible to the source. The TEWS infrastructure is based on two elastic beacons, with 2 pressure sensors IDROMAR of 125 Hz. Sea noise is attenuated by dispersion and the Algorithm (Short Time Average (STA)/Long Time Average (LTA)) is used to detect the tsunami at the onset. The STA/LTA ratio greater than 20 detects a tsunami wave with a period up to 180s. The system has successfully detected tsunamis generated in Stromboli (3 July 2019, 28 August 2019, and 19 May 2021) since its operationalization.

The alert system is connected directly to the sirens located on the island and in Sicily, and a mobile phone application is also available to receive alerts and access information produced by the system, including escape routes, while additionally serving as an educational tool.

* 1. **Global Tonga Tsunami**

Mr Rachid Omira, IPMA, provided a [presentation](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31301) on the global Tonga tsunami. The Hunga Tonga-Hunga Ha'apai volcanic explosion took place on 21 December 2021, in the Tongan archipelago in the southern Pacific Ocean. The tsunami arrival time to Tonga was approximately 10 to 15 minutes after the explosion with a maximum wave amplitude of 1.2 meters. The Tonga tsunami reached nearby islands in the Pacific such as Fiji, American Samoa, and Vanuatu. It also reached New Zealand, Japan, the United States, Peru, and Chile. In the case of Chile, the tsunami arrival was 9 hours with a maximum wave amplitude of 1.5 meters.

Violent volcanic explosions can cause global tsunamis by triggering acoustic-gravity waves that excite the atmosphere–ocean interface. The point source tsunami model showed maximum wave heights from 277 sea level stations around the world, with results of near and far field maximum tsunami wave amplitudes very comparable. The acoustic-gravity wave propagated several times across the globe.

Sea-level, atmospheric and satellite data from across the globe demonstrated that this tsunami was driven by a constantly moving source in which the acoustic-gravity waves radiating from the eruption excited the ocean and transferred energy into it by means of resonance. The models also show that the unusually fast travel times and long duration of the tsunami, as well as its global reach, are consistent with an air–water-coupled source. [[2]](#footnote-2)

1. **Detection, Warning and Dissemination**
   1. **Seismic Early Warning Systems**

Mr Antonio Scala, University of Naples, provided a [presentation](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31298) on this item. An automatic Earthquake Early Warning System (EEWS) system is able to identify an ongoing earthquake and provide a warning before the ground shaking reaches the target site. The network based EEWS issues an alert dependent on the rapid determination of the earthquake location and magnitude. For this reason they are also denoted as source based EW systems. Source based EWS are designed to provide fast and accurate source parameter estimation, but they are less reliable in the prediction of the potential ground shaking.

Important EWS include the Probabilistic and Evolutionary early warning system (PRESTo). PRESTo is a free and open source software platform for Earthquake and Early Warning. It integrates recent algorithms for real time, rapid earthquake location, magnitude estimation and damage assessment. The QUAKEUP EEW method tracks the expected strong shaking zone while the earthquake rupture is still ongoing.

INGV ran a simulated scenario for a magnitude 7 event occurring in the Messina strait using the two early warning methods (PRESTo and QUAKEUP EEW). At the time when PRESTo achieves a stable location and magnitude we observe 95% of Successful Alerts and only 5% of false alerts in a radius of 100 km. The blind zone has a radius of 34 km, lead times vary between 2 and 21 seconds between 40 and 100 km distance. The performance of QuakeUp for the quality of the impact prediction (in a radius of 100 km from the epicenter, at the time of stabilization 17 sec) has a majority of successful alerts with 2 missed alerts and 4 false alerts. The blind-zone has a radius of 50 km, and lead-times vary between 3 and 16 seconds in a range of 60 to 100 km.

* 1. **Sisma-exe Exercise in the Messina Strait**

Mr Luigi d’Angelo, Italian Civil Protection Department (DPC), [reported](https://oceanexpert.org/document/31469) that the DPC and the Calabria and Sicily regions have agreed to test the civil protection operability in the framework of the national programme for seismic risk through a national exercise that took place from 4 to 5 November 2022. The exercise was followed by a hot wash-up debriefing on 6 November. The exercise focused on the Provinces of Messina and Reggio Calabria with participation of all 37 Calabria and 19 Sicily coastal municipalities. In addition, 3500 civil protection actors, 2000 volunteers, and 2000 people from the public were involved in the Command post exercise.

The scenario simulated an earthquake of 6.2 M, able to trigger onshore environmental effects such as landslides, liquefaction and tsunamis. The exercise objectives included the activation of the Coordination Centres at the different territorial levels with the emergency telecommunications test, test of the pilot public alert system (IT-Alert) tsunami, theoretical and operational training activities, among others.

The Italian Civil Protection Department has carried out tests of the pilot public alert system (IT-Alert) using immediate notification (messages via cell broadcast technology) on smartphones in a specific geographic area, in order to inform the citizens for those events classified as “severe emergencies and to alert people of an upcoming catastrophe”. On the test conducted on 4 November, there were 440,000 cell broadcast messages. 20,000 people replied to the questionnaires, and 50% answered to be prepared in case of tsunami risk.

For the commemoration of World Tsunami Awareness Day 2022, the DPC visited schools in Stromboli to teach children about the tsunami early warning system and conducted an exercise with the kids on the tsunami civil protection plan.

* 1. **Six new sea level observation stations for the Italian Tsunami Warning System**

Ms Elena Giusta, National Institute for Environmental Protection and Research (ISPRA), provided a [presentation](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31297) on this item. Within the SiAM- Italian National Alert System for Tsunamis framework, ISPRA launched in May 2021 a program for enhancing the implementation of a high precision and high-frequency long wave measurement network with the installation of six new stations for sea-level measurement able to withstand severe operating conditions. The new stations will support coastal defense, research, and the monitoring of sea level and sea state at high precision and accuracy, thus enhancing the detection and monitoring of tsunamis and other sea-level related hazards in that particular region.

The new sea level tide gauge stations are located almost offshore in Cetraro Lido (Calabria), Capo Teulada (Sardinia), Portopalo di Capo Passero (Sicily), Roccella Jonica (Calabria) and on the small islands of Marettimo (Sicily) and Pantelleria (Sicily). The new sea-level gauges have been placed in such locations to help improve timely alerts and confirm potential tsunami events along the Central and Southern Tyrrhenian Sea, the Sicilian Channel and the Ionian Sea.

The innovative sea-level stations are equipped with a piezometric sensor[[3]](#footnote-3) and a thermistor and a video camera with real-time data transmission system (UMTS and Iridium) onboard. They are acquired at a high sampling rate, with very robust infrastructures, and linked to the Italian national tide gauge network (RMN). The stations provide instantaneous detection of the physical parameter H (height of the sea level), and prompt notification to ISPRA in the event of deviations greater than 10% and 30%, with respect to the mean sea level expected, also considers both the astronomical and meteorological components.

They are also currently used for tsunami monitoring by the Italian National Institute of Geophysics and Volcanology (INGV), which is serving as one of the five Tsunami Service Providers for the ICG/NEAMTWS. The data are available in real-time to the public through the ISPRA-SiAM-TAD-Server at the following platform:  <https://tsunami.isprambiente.it/TAD_Server/Home>.

The six sea level stations were adopted into the Global Sea Level Observing System (GLOSS) and can be found in the Sea Level Station Monitoring Facility developed from collaboration between Flanders Marine Institute (VLIZ) and the ODINAFRICA project of IODE.

* 1. **SMART Cables**

Mr Fernando Carrilho, Co-chair of Task Team on Operations, provided a [presentation](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31291) on SMART Cables in Portugal. IPMA is seeking the opportunity to deploy a new submarine cable ring connecting Portugal Mainland-Azores-Madeira for a SMART system (SMART CAM) by 2024/2025. The Portuguese government and ANACOM have requested additional services on the new infrastructure, namely public services for civil protection and scientific research. There is also a vision to attach geophysical sensors and other environmental sensors to the submarine telecommunication repeaters/cables.

The advantages that the CAM system will provide include:

* Real-Time data allowing early warning for earthquakes and tsunamis
* Permanent power supply;
* Marginal costs increased between 5% to 10% of the infrastructure.
* Wide coverage of relevant areas of the Atlantic (repeaters every 70 to 80 km).

The SMART CAM will consist of 10 more sensor stations, increasing detection time in the South West San Vincent Cape area by 5 seconds. There will be a gain in Early Warning time for tsunamis greater than 10 minutes in a wide area between 23**°** West and Portugal and Moroccan coasts, while, for a large area of the Gloria fault and South West of Cadiz Gulf the gains are larger than 30 minutes. The public tender is currently being prepared and the project budget is approximately equal to 154 million Euro.

1. **Awareness and Response**

Ms Cecilia Valbonesi, Chair of Working Group 4, provided a [presentation](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31281) about WG4 work on awareness and response. There will be an increase in interaction with Working Group 1, and even more with the Task Team on Tsunami Ready and the CoastWAVE project. WG4 will continue supporting the development and activities of the NEAMTIC website, the risk perception studies in the NEAM region including those to be carried out on the Island of Stromboli.

Mr Ignacio Aguirre Ayerbe, Co-chair of the Task Team on Tsunami Ready, provided a [presentation](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31282) about Tsunami Ready (TR). He noted the formation of the Task Team on Tsunami Ready with Terms of Reference (ToRs) as a recommendation of the ICG/NEAMTWS XVII Session, 24-26 November 2022. The TT TR, recommended to conduct in person and online events (1-2 times a year) to explain and promote the TR Programme. In addition, he pointed out that the TT TR has the role to monitor the implementation of the indicators for each community to address gaps, challenges and find solutions, while synergizing with other ICGs to learn from their experiences and knowledge exchange.

* 1. **The Next NEAMWave Exercise**

Ms Ceren Sozdinler, Co-chair of the Task Team on Tsunami Exercise, provided a [presentation](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31284) on the next NEAMWave exercise. The exercise is planned to be conducted in November-December 2023. Given the postponement of the ICG/NEAMTWS XVIII Session to March-April 2023, the TT-TE will start the preparation of NEAMWave23 in advance, especially, the exercise scenarios pending official decision at the next session.

There is a need to have a stronger engagement with the Civil Protection Agencies (CPAs). For this matter, the TT-TE is preparing informative material (NEAMWAVE exercise concept papers, best practices, etc) to share with the national CPAs, and online meetings between CPAs and the European Civil Protection Mechanism. In addition, the TT-TE has requested the Civil Protection Authorities to prepare a one-page guiding document describing their experience in implementing Phase B of NEAMWave Exercise to share with other non-experienced CPAs.

There is an agreement among TSPs to implement 2 exercise scenarios, (North-eastern Atlantic: IPMA and CENALT; Mediterranean Sea: INGV, NOA, KOERI).

CoastWAVE project countries will need to decide if they will make the NEAMWave23 exercise a CoastWAVE action or not. The TT-TE will conduct a revision of online tools and finalize the concept paper to distribute to CPAs.

* 1. **World Tsunami Awareness Day Contributions**

Ms Didem Cambaz, KOERI focal point, provided a [presentation](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31331) about the Tsunami Drill Exercise conducted in the municipality of Büyükçekmece, Istanbul, Turkey on 4 November 2022. The exercise took place to celebrate the 10 year Anniversary of KOERI in operations and the World Tsunami Awareness Day. In addition to the exercise, a tsunami evaluation meeting and a complementary workshop (5th November) were also organized.

The exercise aimed to evaluate the achievements in tsunami risk reduction, simulate the communication chain and improve the operational procedures, and gain community experience at the CoastWAVE Project pilot district: Büyükçekmece. It simulated an earthquake and tsunami scenario of M 7.2 in the Marmara Sea. The tsunami drill exercise was coordinated by Kandilli Observatory and Earthquake Research Institute (KOERI) with the support of Gebze Technical University (GTU), Middle Eastern Technical University (METU) for the preperation of the earthquake scenario and Disaster and Emergency Management Presidency (AFAD), Istanbul Metropolitan Municipality (IMM), the provincial security directorate, provincial gendarmerie command, district governorship/prefecture and other civilian authorities in the evacuation part. The Representatives of UNESCO/IOC (Dr. Denis Chang Seng) and EC-JRC (Dr. Öcal Necmioğlu) have been invited and acted as the Observers of the Exercise.

In the tsunami exercise drill, KOERI disseminated the alert message to local authorities after 7 minutes of the earthquake, students in the school then proceeded to evacuate to the “tsunami safe zone”. In the evaluation meeting and workshop, institutes/agencies shared their views to improve future exercise drills and discussed the operational procedures in Tsunami Early Warning and Risk mitigation, respectively. Presently, Istanbul is the only city in Turkey displaying tsunami evacuation signage and the signage was adopted according to international standards.

On 5 November 2022 the United Nations Disaster Risk Reduction (UNDRR) launched a new World Tsunami Awareness Day initiative with a public-facing campaign “#GetToHighGround”, holding tsunami awareness walks along coastal hazard evacuation routes, kicking off with action in the city of Sesimbra, Portugal. The walk, organized in collaboration with the Municipal Civil Protection Office of the Sesimbra City Hall, followed coastal evacuation routes from four different starting points and participants were invited to take a quiz on how to respond to a tsunami.

A [summary](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31286) report of WTAD activities conducted in Italy and specifically the [Minturno](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31287) municipality, were shared by INGV, but no presentation was provided.

* 1. **Tsunami Risk Perception in the NEAMTWS Region**

Mr Lorenzo Cugliari, INGV, and Adrea Cerase, Sapienza Uniroma, provided a [presentation](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31288) on tsunami risk perception. The INGV has prepared a review paper on global and NEAM risk perception studies, which shows that most tsunami risk perception studies have been carried out in the Indian and Pacific Oceans. In the NEAMTWS, only few specific studies were conducted, mostly within the EU-funded ASTARTE project (2013–2017) and more recently in a few extensive surveys on tsunami risk perception conducted in Italy between 2019 and 2021 (Cugliari et al., 2022; Cugliari et al., FRONTIERS in Earth Science, 2022).

The ASTARTE project (2013-2016) risk perception questionnaire, involved six communities in the Mediterranean Sea and three in the North-Eastern Atlantic, where each was surveyed on their perception about tsunamis, pollution, earthquakes, and flooding. A total of 1512 interviews were held in the different test sites.

In Italy, the INGV Tsunami Alert Center has been promoting the tsunami risk perception study since 2018. To date, it has conducted 3 survey phases through the administration of a structured questionnaire to a representative sample of the population living along the coasts of 8 regions:

* First phase: 2018, Apulia and Calabria - 1021 questionnaires collected.
* Second phase: 2020, Molise, Basilicata and Eastern Sicily - 614 questionnaires collected.
* Third phase: 2021, Latium, Campania, Sardinia, southern and northern Sicily - 4,207 questionnaires were collected

There is a low tsunami risk perception in the Adriatic coast and Bari metropolitan city influenced by the absence of recent tsunami events. The situation is different for Reggio Calabria city where the tsunami risk perception is on average high. This is likely related to the 1908 tsunami, which had a strong impact on the territory, causing widespread damage and about 2,000 casualties. INGV is planning the fourthphase to complete the coverage of the national coastal territory including a qualitative research for in-depth analysis.

CoastWAVE project member states such as Cyprus, Malta, Morocco, Egypt and Spain are preparing to conduct a sea level related hazards risk perception survey for tsunami, storm surge and sea level rise.

* 1. **The CoastWAVE Project**

Ms Derya Vennin, UNESCO-IOC Associate Project Officer, provided a [presentation](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31289) on this item. The project has been endorsed by the United Nations Decade of Ocean Science for Sustainable Development (2021-2030) and it contributes to the ICG/NEAMTWS 2030 Strategy specifically its three pillars on Tsunami Hazards and Risk Assessment; Detection, Warning, and Dissemination; and Awareness and Response.

The CoastWAVE project aims to build on the risk perception and communication of tsunami and other sea level related hazards (multi-hazard context) in the NEAM region; install a detection and monitoring system (Inexpensive Device for Sea Level Measurement (IDSL) stations); install an alerting system (Tsunami Alert Device (TAD) servers); and to have at least 7 Tsunami Ready Recognized Communities by 2023-2024, a process accomplished by the adaptation of Global Tsunami Ready Standards and Guidelines (Manuals and Guides 74) and its 12 Tsunami Ready Indicators.

CoastWAVE project member states such as Cyprus, Malta, Morocco, Egypt and Spain are preparing to conduct a sea level related hazards risk perception survey for tsunami, storm surge and sea level rise. Member States will provide a national report and the UNESCO-IOC Secretariat will synthesize the information provided.

In addition, Member States are working towards adopting Standard Operating Procedures (SOPs) for Tsunami Early Warning at national and local level. A workshop on SOPs for CoastWAVE partner Member States was co-organized with the support of the European Commission Joint Research Centre (EC-JRC) on 5-6 October 2022 in Ispra, Italy to review governing tsunami related regulations, gaps and possible challenges on establishing tsunami SOP plans. The workshop aimed to guide project partners on the SOP preparation workflow for stakeholders and communities, and share experiences/lessons learned from other ICGs (e.g. PTWS and IOTWMS).

CoastWAVE will maintain and repair currently installed IDSL devices by focusing on project countries in priority. In addition, CoastWAVE aims to install IDSL stations in 4 CoastWAVE benefiting member states. An assessment will be carried out to establish a framework and decision regarding the longer term sustainability of the stations. A Tsunami Ready workshop will take place online on 16-17 February 2023, with the purpose to discuss Tsunami Ready implementation among CoastWAVE countries.

1. **Related Initiatives**
   1. **Ocean Decade Tsunami Programme**

Mr Denis Chang Seng, provided a [presentation](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31302) on this item. The Ocean Decade Tsunami Programme was endorsed at IOC Executive Council 55, June 2022 and as a decade action with the aim to have transformational advances in tsunami Disaster Risk Reduction (DRR) from enhancing:

1. Risk Knowledge: Improve our understanding of the tsunami hazard by expanding our knowledge of past and other potential tsunami sources; and fully understand the impacts to critical infrastructure and marine assets and how to minimize them.
2. Warning Dissemination and Communication: Ensure full integration of tsunami services within a multi-hazard early warning framework; and facilitate development of warning dissemination and communication options that are appropriate to geographic, demographic, and infrastructure conditions.
3. Response Capability: Tsunami evacuation maps are available for all coastal communities; capacity Development and attention to SIDS and LDCs; and ensure 100% of communities at risk of tsunami are ready.

The ODTP has established a Scientific Committee (SC) which is mandated to develop a 10-Year Research, Development and Implementation Plan. The aim is to endorse the implementation plan at the TOWS-WG meeting in February 2023. An International coalition on Tsunami was also put in place to build synergies and raise the profile, and increase funding resources for implementation of tsunami ready.

* 1. **Accelerating Global science In Tsunami HAzard and Risk analysis (AGITHAR) Cost Action**

Mr Jörn Behrens, University of Hamburg, provided a [presentation](http://www.ioc-tsunami.org/index.php?option=com_oe&task=viewDocumentRecord&docID=31300) on AGITHAR Cost Action. AGITHAR faces the challenges to: assess, benchmark, improve, and document methods to analyze tsunami hazard and risk; understand and communicate the uncertainty involved, and Interact with stakeholders in order to understand the societal needs and thus contribute to their effort to minimize losses.

AGITHAR aims to assess and provide a common inventory of Probabilistic Tsunami Hazard Assessment (PTHA) and Probabilistic Tsunami Risk Assessment (PTRA) approaches; identify and develop performance metrics and test cases (benchmarks) for individual components; provide open access data repositories with standardized interfaces; develop a structure for standardized PTHA and PTRA workflows; have a quality assurance for PTHA and PTRA; and support the implementation and dissemination of PTHA and PTRA methods to stakeholders and end users.

In addition, it addresses the planning, uncertainties, modeling, and research gaps aspects of Probabilistic Tsunami Hazard and Risk Analysis. AGITHAR is a strongly based inter-disciplinary identity working towards closer collaboration between natural and social sciences. Presently. AGITHAR is working on a “Cookbook” for PTHA/PTRA which includes important information on the framework, components, gaps, good practices and examples of success stories in PTAH/PTRA.

* 1. **The Global Tsunami Model – GTM**

Mr Finn Løvholt, Norwegian Geotechnical Institute, provided a presentation on the Global Tsunami Model. The GTM network dates back to 2015, it was born under the initiative of the Global Assessment Report on Disaster Risk Reduction. It aims to assess and provide community-based standards, good practices and guidelines for Probabilistic Tsunami Hazard and Risk Analysis (PTHA and PTRA). The GTM overall vision and goals are to collaboratively achieve a thorough understanding of tsunami hazard and risk, together with the processes that drive them by improving PTHA/PTRA standards, guidelines, methods, tools; establishing reference pool of experts; and providing a consistent input and contribution to multi-hazard risk assessment. It is an initiative from the tsunami community itself.

The GTM has been linked/supported for example the TSUMAPS-NEAM project; AGITHAR COST Action (to consolidate GTM); the European Tsunami Community as a candidate Thematic Core Service (TCS) of the EC infrastructure EPOS-ERIC.; and presently the Makran Trench UNESCAP project where modeling is completed under the supervision of GTM experts. All these initiatives are related to the common goals of better services and standards for tsunami risk analysis.

Presently, GTM is mainly focused in Europe through networking, software provision and guidelines for hazards and risk analysis. The GTM informal consortium is constituted by the organizations who have signed a Letter of Interest (LoI), where they declared to share GTM's vision and goals and appointed their own institutional liaison. It includes members such as CENALT, IPMA, INGV, NOA, and KOERI. Possible next steps on the potential for a formalisation of GTM beyond being an informal network will be discussed in AGITHAR meetings.

* 1. **EPOS Candidate Thematic Core Service Tsunami (cTCS Tsunami) and EU Projects: Geo-INQUIRE, DT-GEO, ChEESE-2P.**

Mr Stefano Lorito, INGV, provided a presentation on this item. After three years of preparation, in 2021, the European tsunami community attained the status of Candidate Thematic Core Service (cTCS) within the European Plate Observing System (EPOS) research infrastructure.

Currently, the core group is working for the consortium agreement, creating the governance and structure for the cTCS, and setting up the service delivery framework. The cTCS Tsunami is composed of 4 pillars of the service delivery framework: Pillar 1 on support to tsunami service providers; Pillar 2 on tsunami data; Pillar 3 on numerical models; Pillar 4 on hazard and risk products.

A virtual access to several services of the categories mentioned is available, and plans are established to provide transnational access to laboratories and to workflows. There are two ways to distribute service and data in EPOS, one through the Thematic Core Service portal, and the other to integrate the data into the centralized framework of EPOS. There are 20 thematic services that will be validated soon.

Important projects include the Center of Excellence for Exascale in Solid Earth – Second Phase (ChEESE-2p), about high performance computer numerical simulations, will deliver an updated GTM global tsunami hazard map and a large simulation of the Tonga eruption and tsunami. ChEESE-1P was important in urgent computing for tsunami forecasting or rapid post-event assessment.

Geosphere Infrastructure for Questions into Integrated Research (Geo-INQUIRE) has been developed based on a bottom-up process, meaning it has exploited a wide-reaching consultation process with various components of the major geoscience and georesources RI communities. The project provides access to all the services developed in e.g. ChEESE, EPOS, etc.

The Digital Twin for Geophysical Extremes (DT-GEO) project, driven by the need to respond to climate change, combines different elements to realize a digital replica of the earth. It is driven by the volcano, computational seismology and anthropogenic science community. The DT-GEO plan to have a tsunami forecasting digital twin component with GNSS, tsunami data in real time, and rapid source assessment as a trigger for landslides into probabilistic forecasting.

1. **Important Observations, Overall Discussion and Way Forward**

* The expert meeting outcomes will provide important inputs to the Sixteenth Meeting of the Working Group on Tsunamis and Other Hazards related to Sea Level Warning and Mitigation Systems (TOWS-WG-XVI), 27 February–3 March 2023 (IOC CL 2914) and the ICG/NEAMTWS-XIII session planned in March/April 2023;
* The ICG/NEAMTWS 20230 Strategy coupled with the Ocean Decade Tsunami Programme are instrumental in terms of providing new purpose, high level aims, better defined objectives as well as dedicated actions to WGs and TTs, as well as other supporting experts not directly involved in ICG;
* Improved collaboration between actors/institutions, in particular involving other hazard experts (e.g., volcano-Tsunami EWS and in its integration in NEAMTWS);
* Several countries/partners are spearheading several state-of-the-art scientific programmes/projects that will help advance NEAMTWS to the next level. EPOS is a new complimenting architecture (European Plate Observing System-Tsunami). These projects will need to be exemplified in more detail in the near future on a case-by-case basis;
* There is relatively high motivation and interest among experts to collaborate on UNESCO-IOC Tsunami Ready and to connect with CoastWAVE project;
* Pillar three on Education, Awareness is rapidly improving and expanding in a couple of countries;
* There is an agreement to have Manuals and Guides 74 translated in other local languages different from the 6 UNESCO official languages. Italy is already translating the document to Italian.
* Interest is high on the IT-Alert system and its operability status. The aim of the DPC is to have the system in operation in the first quarter of 2023.
* Specific legal changes are needed in Turkey which would allow local school/educational institutions to release children (only as part of evacuation process) following a tsunami event. This is due to the present rules which state that school principals are not allowed to release children after a tsunami natural disaster.

The Secretariat welcomes and encourages Member States and partners to continue hosting and co-organising such technical workshops in the future.

1. **Close**

The ICG/NEAMTWS expert meeting was closed with the agreement in plenary to conduct the next ICG/NEAMTWS XVIII Session in March-April 2023 at UNESCO Headquarters, Paris, France. The meeting closed on 30 November 2022 at 12:30 pm (CET).

**ANNEX I**

**List of Actions**

**ICG/NEAMTWS Expert Meeting,**

**28-30 November 2022,**

**Naples, Italy**

**Action 1:** Working Groups (WGs) and Task Teams (TTs) encouraged to contribute in the implementation of ICG/NEAMTWS (2021-2030) Strategy, and continue to co-organize technical workshops to further advance NEAMTWS.

**Action 2:** The ICG/NEAMTWS Task Teams and Working Groups to provide support to complement the NEAM Benchmarking Project (NEAMBP).

**Action 3:** The ICG/NEAMTWS Task Team on Documentation with the support of other Working Groups and Task Teams to update the current structure and content of the Interim Operational Users Guide (IOUG, 2011).

**Action 4:** To update ICG/NEAMTWS Task Teams and Working Groups members at the next ICG/NEAMTWS session.

**Action 5:** Task Team on Operations and Working Group 4 to resolve problems highlighted on the Adoption of Tsunami Threat Level in the NEAM region, in particular concerning threat level 0.

**Action 6:** The Secretariat with the support of the Task Team on Tsunami Ready to prepare/apply a standard template to monitor the progress of Tsunami Ready communities in the NEAM region.

**Action 7:** The Task Team on Tsunami Ready to share documents, achievements and best practices on Tsunami Ready implementation in the NEAM region.

**Action 8:** Task Team on Operations toprepare examples of interoperability of TSPs in other basins. The list will serve as a reference to the ICG/NEAMTWS in terms of the preparation of a future web portal / platform for the interoperability of TSPs in the region.

**Action 9:** Working Group 4 with the support of the ICG/NEAMTWS Secretariat to prepare a synthesized document on the state and evolution of sea level and tsunami risk perception for the NEAM region.

**Action 10:** The ICG/NEAMTWS Secretariat and CoastWAVE project to organize a Tsunami Ready workshop on 16-17 February 2023.

**Action 11:** The Task Team on Tsunami Exercise to continue preparations for the next NEAMWave exercise which is expected to be conducted in November 2023.

**Action 12:** The ICG/NEAMTWS Secretariat to organize the next ICG/NEAMTWS XVIII Session on March-April 2023 in UNESCO Headquarters, Paris, France and the ICG/NEAMTWS XIX Session in November 2023.

**ANNEX II**

**Agenda**

|  |  |  |
| --- | --- | --- |
| **Time** | **Day** | **Person/ Group** |
|  | **DAY 1 (Monday 28 NOV) - remote participation:**  <https://meet.google.com/ytw-ruwx-hvt> |  |
| 14:00 | **MEETING in front of Hotel Vesuvio, Via Partenope 45, Naples,** [**https://maps.app.goo.gl/NbW9Ft47GsQAguSdA**](https://maps.app.goo.gl/NbW9Ft47GsQAguSdA)  **Transfer to the Vesuvius Observatory in Ercolano** | Host (A. Amato, INGV, Italy) |
| 14:00-19:00 | **GENERAL DISCUSSIONS -STEERING COMMITTEE RELATED**  **Agenda:** [**NEAM\_SC\_28nov2022**](https://docs.google.com/document/d/1nRIbva_JZMgQAbTBrlfvfw6pIIQEb7KExeMjaVu2R28/edit)  **Visit to the Observatory Preparation for Day 2/3** | Chair (M.A. Baptista, University of Lisbon, Portugal) |
|  | **DAY 2 (Tuesday 29 NOV) - remote participation:**  <https://meet.google.com/ytw-ruwx-hvt> |  |
| 9:30-9:45 | **OVERVIEW/RECALL OF ICG/NEAMTWS 2030 STRATEGY AND GENERAL** | Chair (M.A. |
|  | **CONTRIBUTIONS/ACTIONS** | Baptista, |
|  |  | University of |
|  |  | Lisbon, |
|  |  | Portugal)/Secreta |
|  |  | riat (D. Chang |
|  |  | Seng, |
|  |  | IOC-UNESCO)/ |
|  |  | Host (G. Festa, |
|  |  | University of |
|  |  | Naples, A. Amato, |
|  |  | INGV, Italy) |
|  | ICG/NEAMTWS 2030 STRATEGY AND TARGETED CONTRIBUTIONS/ACTIONS |  |
| 9:45-11:15 | **TSUNAMI HAZARD AND RISK ASSESSMENTS** | WG1 Lead (A. |
|  |  | Gailler, CEA, |
| 9:45-10:00 | **Keynote introductory talk** (Audrey Gailler, Co-Chair WG1, CEA, France**)** | France) |
| 10:00-10:25 | **From PTHA to planning and evacuation maps in Italy** (Fabrizio Romano, INGV, |  |
|  | Pio di Manna, ISPRA, Italy) |  |
|  | **The Stromboli TEWS** (Maurizio Ripepe, LGS University of Florence, Italy) |  |
| 10:25-10:50 | **The Global Tonga Tsunami** (Rachid Omira, IPMA, Portugal) |  |
| 10:50-11:15 |  |  |
| 11:15-11:45 | **COFFEE BREAK** |  |

|  |  |  |
| --- | --- | --- |
| 11:45-13:15 | **DETECTION, WARNING AND DISSEMINATION** | WG 2,3, TT Op, |
|  |  | TOWS Lead |
| 11:45-11:55 | **Keynote introductory talk** (Anna von Gyldenfeldt, Co-chair WG2-3, BSH, | (A.Piatanesi, |
|  | Germany) | INGV, Italy / A. |
|  |  | von Gyldenfeldt, |
| 11:55-12:15 | **Seismic Early Warning Systems** (Antonio Scala, University of Naples, Italy) | BSH, Germany / |
|  |  | H.Hebert, CEA, |

**ANNEX III**

**List of Participants**

|  |  |  |
| --- | --- | --- |
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3. used to measure water level as well as underground water pressure. [↑](#footnote-ref-3)