European Commission

Tsunami Decision Support Systems TDSS – 2015

Outcomes of the 6th JRC ECML Crisis Management Technology Workshop

Alessandro Annunziato, Chiara Fonio, Francesco Mugnai, Daniele Galliano

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Contact information
Alessandro Annunziato
Address: Joint Research Centre, Via Enrico Fermi 2749, TP 680, 21027 Ispra (VA), Italy
E-mail: alessandro.annunziato @jrc.ec.europa.eu
Tel.: +(39) 0332 78-9519
Fax: +(39) 0332 78-5154

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Abstract

The 6th JRC ECML Crisis Management Technology Workshop on Tsunami Decision Support Systems was held in the European Crisis Management Laboratory (ECML) of the Joint Research Centre in Ispra, Italy, from 2ndto 3rd July 2015. The workshop, co-organized with DRIVER (Driving Innovation in Crisis Management for European Resilience) Consortium Partners, brought together stakeholders in the design, development and use of ICT tools for decision support. 20 participants attended the event. A good mix of regional and national service providers was represented, along with European and non-European systems providers and users.
The purpose of the workshop was to show the status of the technology in this field, the specific requirements and the benefits in the use of one or another solution. During the first day participants presented their tools, while during the second they had to carry out demonstration exercises on the basis of given scenarios. In the last part of the event, they were involved in a discussion which revolved around a set of questions focused on, inter alia, strengths, weaknesses and opportunities of each tool. The main aims of the discussion were to identify both new opportunities for collaboration and for tools integration and also to "bridge the gap" between the scientific and technical level and the operational dimension.
The workshop was a very good opportunity for several research and operational teams to collaboratively discuss Decision Support Systems, lessons learned, ideas for improvements and opportunities for collaboration.

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1 Executive Summary

The 6th JRC ECML Crisis Management Technology Workshop on Tsunami Decision Support Systems was held in the European Crisis Management Laboratory (ECML) of the Joint Research Centre in Ispra, Italy, from 2nd to 3rd July 2015. The workshop was co-organized with DRIVER (*Driving Innovation in Crisis Management for European Resilience*) Consortium Partners. 20 participants attended the event. A good mix of regional and national service providers was represented, along with European and non-European systems providers and users. The following providers participated actively in the workshop through presentations, discussions and demonstrations:

Regional Service Providers:

- INGV – Italy
- RIMES- Thailand
- KOERI – Turkey
- NOA – Greece

National Service Providers:

- SHOA – Chile
- NEMA – Israel
- SINAMOT – Costa Rica

System Providers:

- TRIDEC Cloud – Germany
- NOAA – USA
- JRC – EC
- University of Malaga

The purpose of the workshop was to show the status of the technology in this field, the specific requirements and the benefits in the use of one or another solution. The overall aim was to bring together stakeholders in the design, development and use of ICT tools for Decision Support in crisis room operation in order to provide hand-on experience on systems and collaboratively discuss status of the art, lessons learned, ideas for improvements and opportunities for collaboration. One of the key aspects of this event were the demonstration exercises carried out on the basis of given scenarios. Participants had an initial input of information that they had to map, analyze and then create a bulletin in order to provide a situation assessment for a potential Decision Making authority. The big wall screen in the meeting room was used to give an overview of the execution of tasks. During and after the demonstrations, technology providers complemented the exercise with detailed explanations of action plans and functionalities.

While the first part of the workshop was devoted to the presentations given by the participants, the demonstrations started in the afternoon session of the first day and continued in the second day. In the last part of the event, participants were involved in a discussion which revolved around a set of questions focused on, *inter alia*, strengths, weaknesses and opportunities of each tool.

The workshop was a success for many reasons, one of them being the limited number of participants which allowed room for debate and encouraged active participation. The people involved were willing to share their experience and to provide feedback and insights. Moreover, new opportunities for collaboration emerged and, as shown in Appendix n 8.4, comments from participants were very positive. Needs for further developments and improvements were discussed by all participants.

Among the relevant comments it was mentioned that the formula was very innovative and could be repeated in the future.

The conclusive remarks highlight the need for Decision Support Systems for Tsunami monitoring. In particular, emphasis is given on the flexibility of the tools and on the importance of using probabilistic forecasts which take into account the uncertainties of earthquake parameters.

This report aims to reflect both the presentations and the outcomes of the demonstrations/exercises that were carried out. Additionally, it aims to provide an account of relevant aspects discussed during the last part of workshop. Due to time constraints, not all the questions prepared for the debate were addressed, therefore participants had the opportunity to send their insights in the weeks following the workshop.

2 Introduction

*Situation: at the Monitoring Center XX **during a night shift** a potentially important event occurs. The operators need to decide what to do!*

In order to answer the question above you need to analyse the event. More specifically you need to perform a number of actions:

1. **Seismic events collection > Seismic Monitoring**
2. **Procedures (i.e. Decision Matrix) > Message Creation**
3. **Messages delivery > Communication and dissemination**
4. **Analysis & Monitoring > Sea Level Monitoring**
5. **Tsunami Impact Forecasting > Online vs Scenario**
6. **Update of Alerting Messages > Message Creation**

A Decision Support System will help the operators to perform all the actions above. Some systems will have all the steps integrated, other systems fulfill the objectives combining several software and applications. Each of the actions above contains potential issues that need to be addressed.

Seismic events collection > Seismic Monitoring

Often the seismic source is not unique and it is necessary to establish which the reference magnitude for one event is. Also the source changes with time, as better and better earthquake estimations become available. How to deal with several sources and changing conditions?

Procedures (i.e. Decision Matrix) > Message Creation

Does the Decision Support System cover all the conditions and procedures established by international bodies, such as UNESCO? Are the created messages too conservative or not? Shall the DSS follow Decision Matrices or will use Modelling results (Modelling can be difficult with few information available after few min and therefore the messages could be wrong).

Message Delivery > Communication and dissemination

Has your message been issued? Has your message reached the expected address? What is the latency of the email/SMS/GTS/Fax … systems? Has your message reached the people at risk?

Analysis and Monitoring

Can your system display measured (de-tided) and estimated sea levels? How the estimation is performed: scenario database or online calculations?

A **Tsunami Decision Support System** is ALL of the above. In some cases all is integrated in one system or split among complementing systems. We had representatives from many Monitoring Centres, System Providers, and final Users. This workshop was aimed at giving the possibility to all the developers and users of these systems to present them and to show their capabilities when an unknown event is needed to be analysed.

3 Technical arrangements

The European Crisis Management Laboratory acts as a research, development and test facility for ICT focused solutions which integrate devices, systems, and relevant information sources to support crisis management needs, such as threats analysis, situational awareness, early warning, response and coordination, and collaborative decision making. For the exercise all crisis management systems shall be integrated in the ECML to a reasonable extent (Figure 1). Minimum requirement for participation is the streaming of the respective video outputs to the video wall. Individual setups and most practicable solutions to be clarified bilaterally. The ECML has the following setup:

Video Wall

- 5x3 matrix (5m x 2.22 m) rear projection video wall
- Overall resolution 5120x2304 pixels
- Simultaneous digital & analogue video inputs
- Touchable over the whole surface (single touch, medium precision)

Other hardware

- Samsung SUR 40 multi-touch table
- BARCO Click-Share WiFi to feed up to four different streams onto the video wall
- AppleTV for AirPlay streaming to video wall
- iPad, iPhones, Windows 8 touch tablets
- Professional video conferencing system (Tandberg), landline phones, webcams, microphones
- A0 plotter
- SMART Board interactive whiteboard (single touch)
- Guest WiFi
- Meeting table

Computers

- 4 workstations to feed the video wall, 2 used to control it
- 1 server (Windows 7) to control the video inputs and drive the video wall

Figure 1: European Crisis Management Laboratory (ECML). Briefing of European Commission President Barroso, European Commissioner Geoghegan-Quinn, and EC JRC Director General Ristori

To ensure the best results during the presentations, different tools and technologies were provided to each attendant such as audio and video conferences (Skype® and Google Hangout®, traditional Video Conference System) for live communications, desktop sharing tools (Teamviewer ®, VNC®…) for remote screen streaming and, finally, local mirroring tools from guest devices (Barco Click-Share®, Apple AirPlay®).

Since there were local and remote teams, they were allowed to test and choose in advance the favorite means according to their solutions.

Basically, the Web based solutions were directly browsed and mirrored from the operator client computer to the crisis wall screen at the best suitable resolution and commented live while in audio/videoconference with the remote audience.

For the remote teams, the crisis wall screen was split proportionally to stream simultaneously the video of the speaker, the operator screen or presentation and the live screen of the presented tool.

The portable solutions like virtual machine and software suite were restored in our environment and used directly on the video wall screen.

4 Presentations

In the morning of the first day, regional, national and system providers presented their tools. It should be noted that presentations were always followed by questions and/or comments, thus the workshop was very interactive. In this section, all presentations are described with a focus on the most important aspects.

4.1 DRIVER presentation

The workshop was co-organized with DRIVER (*Driving Innovation in Crisis Management for European Resilience*) Consortium Partners. A representative of ATOS, the project coordinator, attended the event. DRIVER is an FP7 project which deals with crisis management through an all-encompassing approach. A representative of ATOS, the project coordinator, attended the workshop.

During the presentation (Figure 2) emphasis was given to the background ideas of the project and to the DRIVER "paradigm" which revolves around three dimensions:

1. The development of a Pan-European Test bed,
2. The development of a tested and validated portfolio of tools and
3. The creation of a deeper and shared understanding of crisis management (CM) in Europe.

The Pan-European Test bed consists of virtually connected exercise facilities where different stakeholders can progress on new approaches. This test bed is crucial to validate a portfolio of crisis management tools which will deliver solutions for first responders and civil society alike, along with organizational and policy standards. While this won't lead to radical changes, a more deeply shared understanding of crisis management across Europe is likely to emerge. It was highlighted that in DRIVER the word "tool" does not imply an exclusive focus on technology, but rather includes also operational concepts, methodological approaches and policies.

The concept of the "campaigns of experiments" (as opposed to one-shot validation concept) was described and attention was drawn to the final demonstration which will entail a tsunami scenario. The DRIVER methodology was also outlined strengthening the efforts to adapt European CM to future demands through testing, benchmarking and evaluating tools in the context of experiments and/or distributed exercises. Additionally, the sustainability of the project was presented with a specific focus on the DRIVER community which will foster collaboration with and between crisis management stakeholders.

Figure 2 – DRIVER presentation

Participants were particularly interested in the project and asked whether they could join the DRIVER community.

4.2 Participants'presentations

Regional Tsunami Service Providers

4.2.1 INGV

An overview of the implementation status of the Italian Candidate Tsunami Service Provider (IT-cTSP) was given by Alessandro Amato from the Istituto Nazionale di Geofisica e Vulcanologia (INGV). INGV has developed the Centro Allerta Tsunami (CAT), which is in pre-operational stage as cTSP starting from 1 October 2014, in the 24/7 seismic monitoring center at INGV (Figure 3).

Figure 3 - The 24/7 monitoring room at INGV in Rome with personnel on-duty (4). In foreground the Tsunami workstation.

The mandate of CAT is to provide warnings for potential tsunamis within the whole Mediterranean basin to its subscribers, in the framework of the NEAMTWS. To the purpose of continuous testing, training, and validation purposes, CAT also performs monitoring at the global level. The past (first) 9 months of (pre-) operation have shown good performance of the system in terms of speed and accuracy. Tuning and refinements of the software procedures, however, continue in order to improve results accuracy and overall system robustness.

INGV cooperates with ISPRA (Istituto Superiore per la Protezione e la Ricerca Ambientale) which manages the Italian Mareographic Network and sends data in real time to INGV and to IOC. Moreover, INGV cooperates strictly with the Italian National Department for Civil Protection that is in charge of sending alerts to local authorities and citizens.

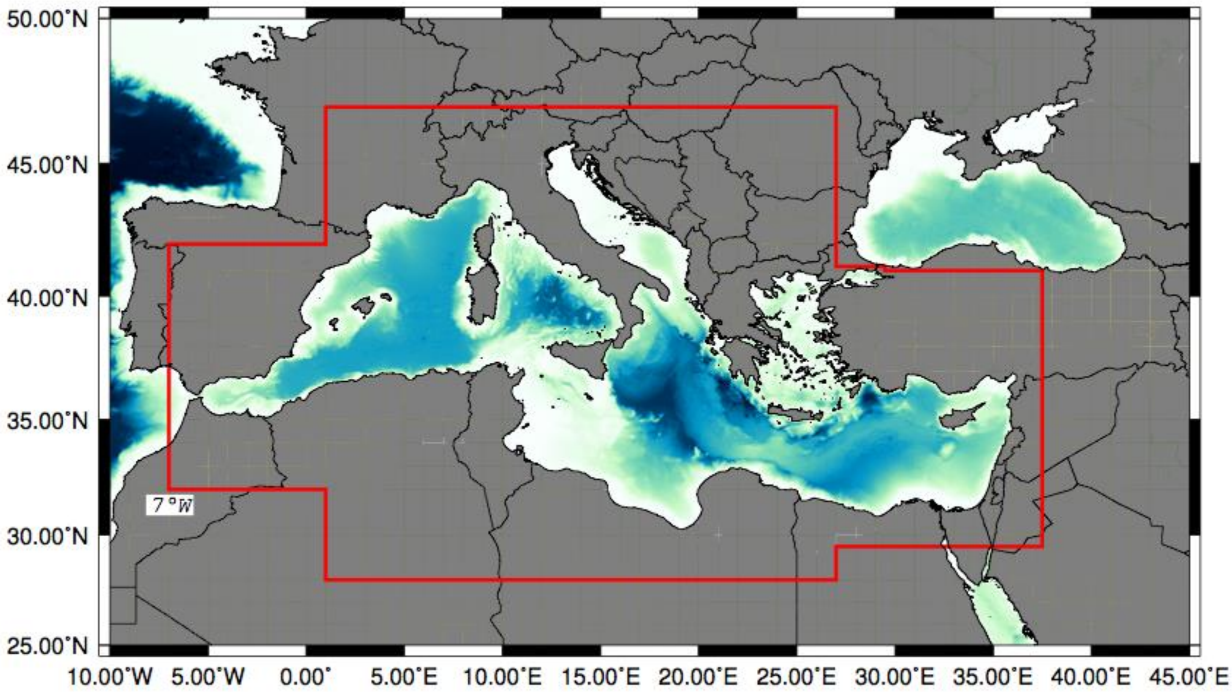


Figure 4 - Area monitored by CAT@INGV (All Mediterranean Sea from 100km West of Gibraltar to Marmara Sea).

The challenge for warning in the NEAMTWS region is to provide a rapid and robust tsunami forecast, within a few minutes after the earthquake origin time, even with a inhomogeneous coverage of seismometers (poor for northern Africa), and in the absence of deep-sea tsunami sensors.

As cTSP, providing tsunami warnings in the whole Mediterranean basin, CAT-INGV is about to complement, (and possibly replace in the future), the “decision matrix” used currently (last modified July 1st, 2015), with pre-calculated tsunami scenario databases, and with FTRT (Faster Than Real Time) tsunami simulations. The aim is to increase the accuracy of tsunami forecast by assimilating the largest possible amount of data in quasi real time, and performing simulations in a few minutes wall-clock time, possibly including the coastal inundation stage, all over the domain of interest.

This strategy of direct real-time computation, unfeasible a decade ago, is now possible because of the astonishing, recent increase of computational power and bandwidth evolution of modern GPUs. INGV, in collaboration with the EDANYA Group (University of Málaga), is developing and implementing a FTRT Tsunami Simulation approach for the Italian cTSP. Regardless of the tsunami simulation strategy, a major challenge within the complex tectonic setting of the Mediterranean basin, is the constraint of the earthquake parameters for offshore seismic events. To this end, the CAT-INGV is developing a novel approach that consents the inclusion of a-priori Probability Density Functions (PDF) of the earthquake mechanism in combination with that obtained from real-time earthquake information. The resulting PDF for earthquake parameters is thus passed along to the tsunami simulation module, and the (tsunami) forecast is provided as a PDF of the expected impact at each coastal location (Figure 4).

4.2.2 RIMES - Thailand

The Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) was presented by E.L. Lepiten who first gave an overview of the evolution of networks, arrangements and partnerships carried out since 2005 in Asia that deal with warning systems, in particular with tsunami. RIMES was established in 2009 and it is intergovernmental, namely Member States manage it. It is an end-to-end multi-hazard early warning system composed of 31 members and collaborating states in Asia and Africa (Figure 5):

- **12 Member States:** Cambodia, Comoros, Lao PDR, Maldives, Seychelles; Bangladesh, India, Mongolia, Papua New Guinea, Philippines, Sri Lanka, and Timor-Leste.
- **20 collaborating countries:** Armenia, Afghanistan, Bhutan, China, Indonesia, Kenya, Kyrgyzstan, Madagascar, Mauritius, Mozambique, Myanmar, Nepal, Pakistan, Somalia, Tanzania, Thailand, Vietnam, and Yemen; Russia and Uzbekistan have signed Memorandum of Understanding.
- **India as RIMES Council Chair, Maldives as Secretariat**

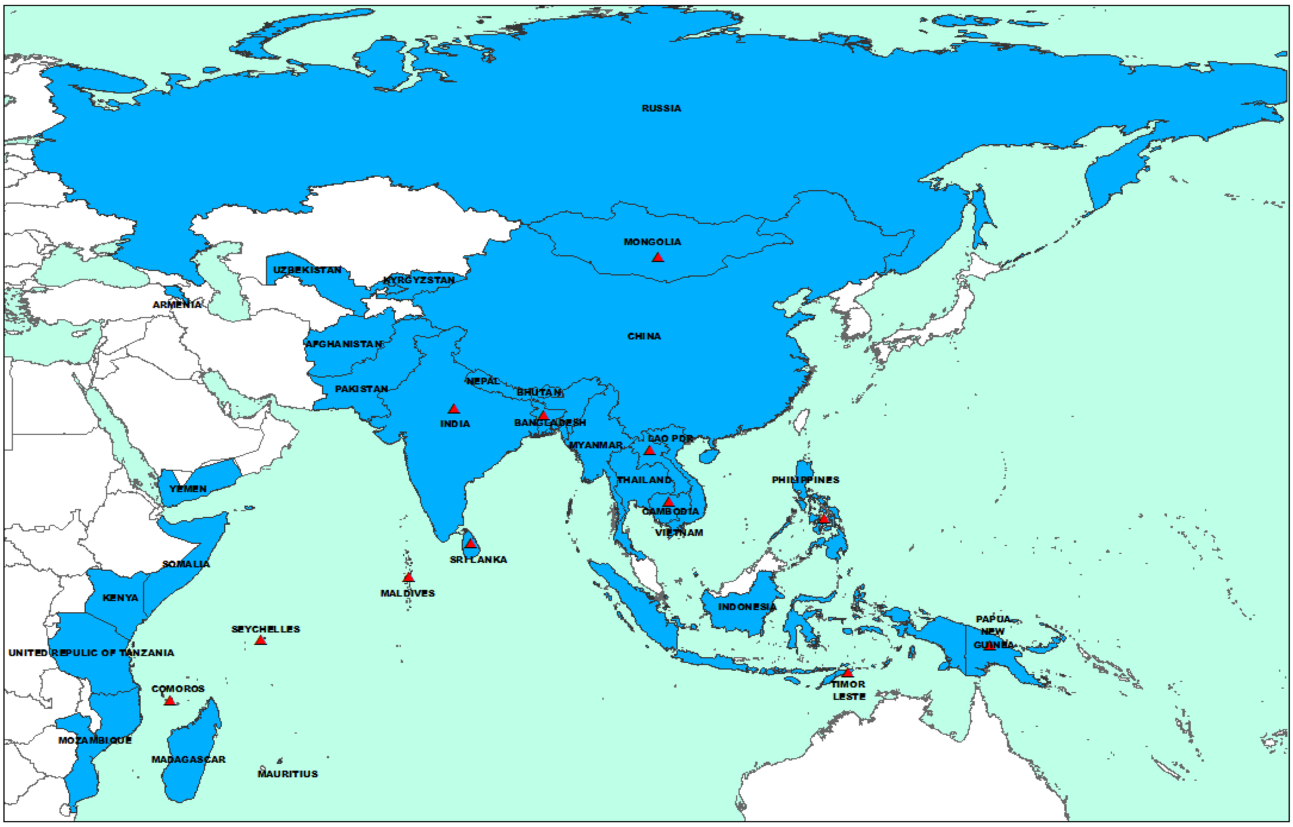


Figure 5 - RIMES Member States

The objectives range from enhancing early warning capabilities to providing regional tsunami and hydro-meteorological risk information respectively within the UNESCO/IOC framework and the WMO framework. RIMES deals with all stages of early warnings from the observation and risk assessment to mitigation programs at the community level. It is worth noting that RIMES does not provide information to users but exclusively to regional centres. During the presentation, the responsibilities of the Member States were highlighted (e.g. exchanging data, ensuring maintenance of monitoring systems, etc.).

At an operational level, RIMES provides both early warning earthquake information and bulletins (for earthquakes and tsunamis) to members and collaborative countries. Notifications are sent via email, sms and fax. Moreover, it assists and builds the capacity of member's countries earthquake centers. A number of tools are used to acquire and exchange data in real-time and to assess risk levels. In particular two tools were mentioned: PRECISE and INSPIRE. While PRECISE is a near real-time tsunami forecasting system, INSPIRE is a tsunami risk assessment tool. Examples of tsunami forecasts, arrival times and amplitude maps were shown, along with bulletin types (Figure 6).

At the end of the presentation, observation and gaps were touched upon and some of the issues that emerged here were also raised during the discussion on the second day of the workshop. In particular, attention was drawn to two aspects:

1. The need for more training and practice as far tsunami watch standers are concerned,
2. The manual input of data into the device which might lead to mistakes. Other issues raised concerned the small number of staff and economic constraints of some of the member States who have been developing free applications in-house.

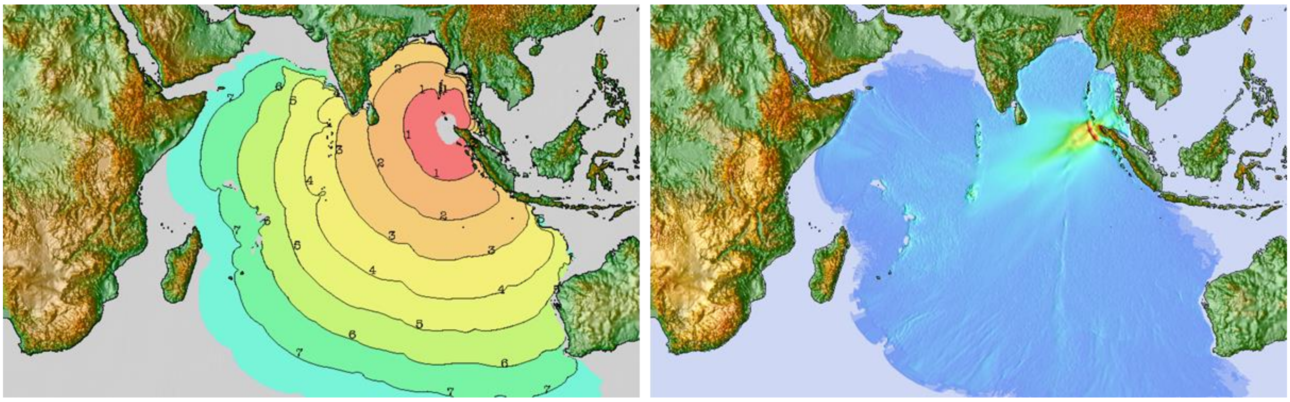


Figure 6 – Distribution of Tsunami Arrival Time & Maximum Wave Amplitude

4.2.3 KOERI - Turkey

A detailed overview of KOERI's National Earthquake Monitoring Center (NEMC) was given by O. Necmioglu who first presented the status of the Intergovernmental Coordination Group of the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and connected areas (ICG/NEAMTWS). In this context, KOERI provides a Tsunami Warning System to the Eastern Mediterranean, Aegean and Black Seas since 1 July 2012 as a Candidate Tsunami Service Provider (CTSP). CTSP-TR is under continuous testing due to its operational status (Figure 7).

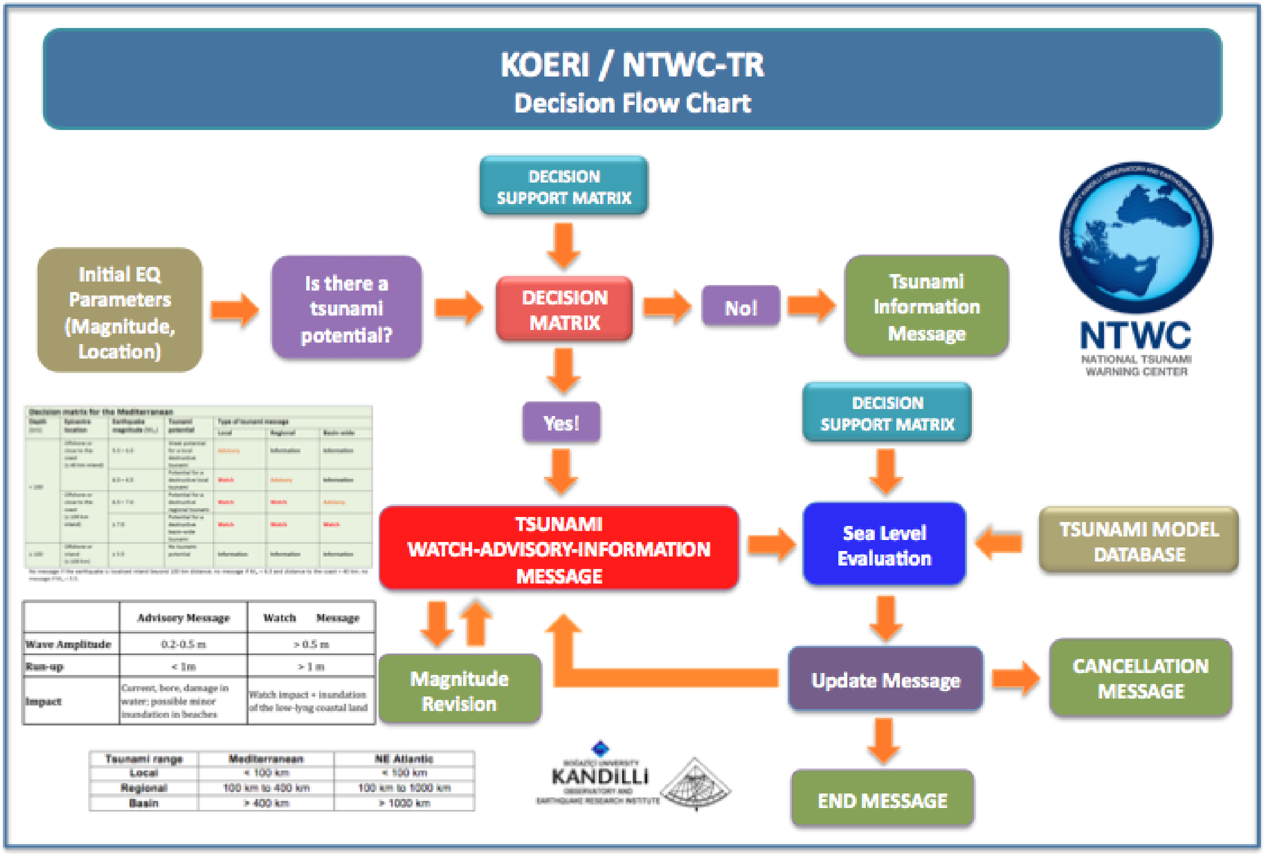


Figure 7 - Concepts of Operations – Decision Support System in KOERI

The daily operational set-up was explained highlighting the number of officers involved per day and night shifts and their duties. Overall, 3 duty officers per day shift and 2 per night shift are available and a test of the operational system is performed on a daily basis. They are also involved in tsunami's communication and test exercises.

Duty officers perform a test of the operational system based on a pre-defined scenario using TAT (Tsunami Analysis Tool developed by JRC) and TsuComp (Tsunami Message Composer developed by KOERI). So far, 169 scenarios have been performed. The operational concept of the Decision Support System is that the National Tsunami Warning Centre –TR (NTWCs) is integrated into the operational National Earthquake Monitoring Center of KOERI which operates 302 seismic stations including 143 BB, 159 strong motion (covering the purpose of rapid response) and 7 short period sensors. The regional coverage includes 280 stations from foreign institutions through bilateral agreements. As was pointed out during the presentation, the seismic monitoring is the core of the system. The latter is primarily based on a decision matrix through which the potential for a tsunami in the Mediterranean Sea is assessed on the basis of depth, epicenter location and earthquake magnitude (*Figure 8*). The decision matrix concerns also the type of tsunami message to be delivered at a local, regional or basin-wide level. Sea level monitoring is carried out through 7 tide-gauge stations which transmit data via satellite to KOERI. It is worth considering that a collaborative agreement has been signed between the JRC and KOERI and MOD1 and MOD2 Tsunami

Scenario Databases and TAT are received by KOERI. Additionally, the presentation put emphasis on the EC-JRC Global Tsunami Informal Monitoring Service Project thanks to which 16 events were analyzed by KOERI.

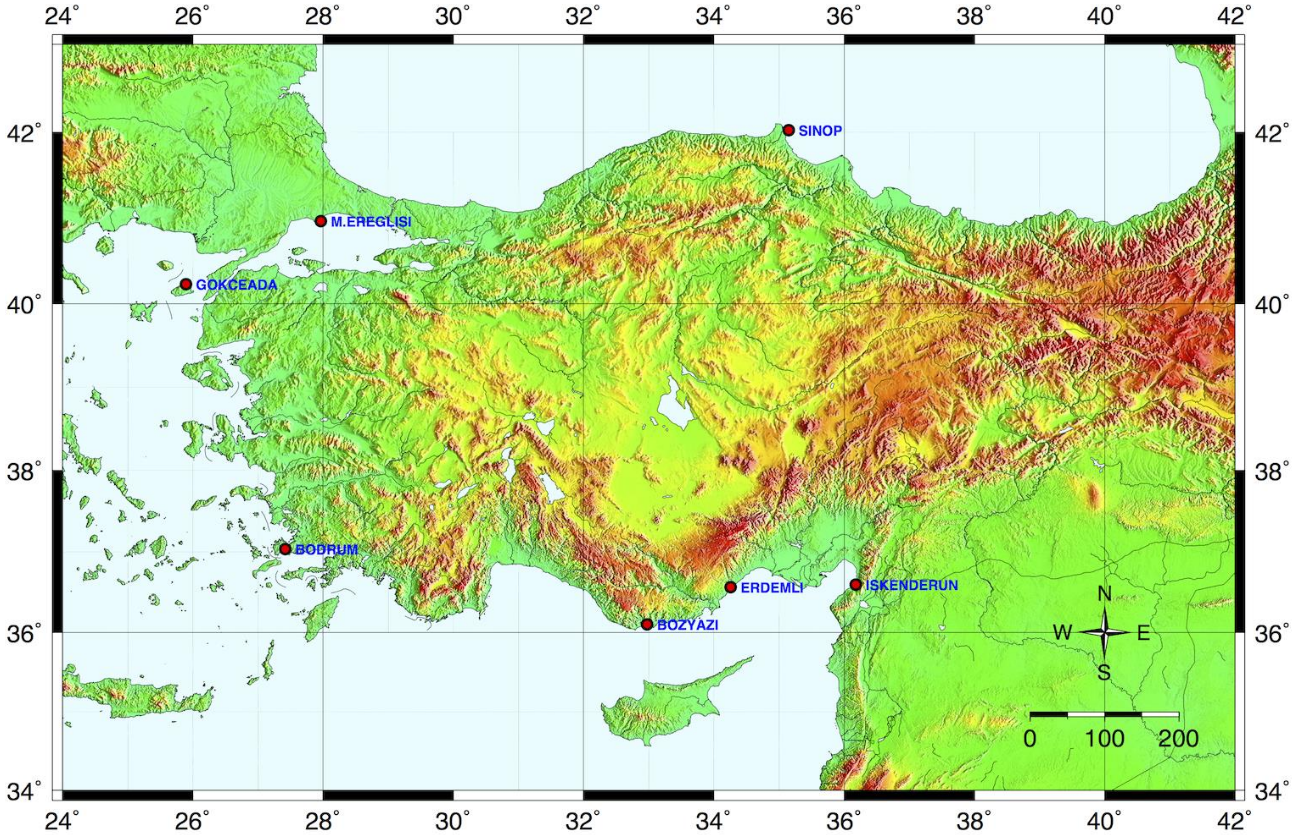


Figure 8 - Sea Level monitoring sensors. (*The maps and related information presented here do not necessarily reflect the views and position of the United Nations, UNESCO, IOC or any affiliated Member State).*

The presentation drew also attention to NEAMTWS Tsunami and Communication Test Exercises which took place from 2011 to 2014 with the involvement of NOA, CEA, IPMA; a brief presentation of the TsuComp programme was also outlined: this is a new in-house development for the creation of messages to be sent out. TsuComp is considered a backup solution to TAT, in case for any reason this would not be able to create the messages. The involvement in the TRIDEC FP7 project and a collaborative activity with TRIDEC Cloud based on previous partnership and commitments at the European scale were also highlighted.

4.2.4. NOA - Greece

The National Observatory of Athens (NOA), operational since 2012, was presented by M. Charalampakis. 17 Agencies from 12 Member States and 3 International Bodies receive TWMs from the observatory. The Standard Operational Procedures entail a wide range of activities: from earthquake detection to message dissemination for tsunamigenic events, from data analysis of sea levels to continuous monitoring of the networks operated by NOA. The network comprises of over 150 stations (80 of which are available in real time) with a GPS network of 20 stations with data to detect uplift and subsidence (Figure 9).

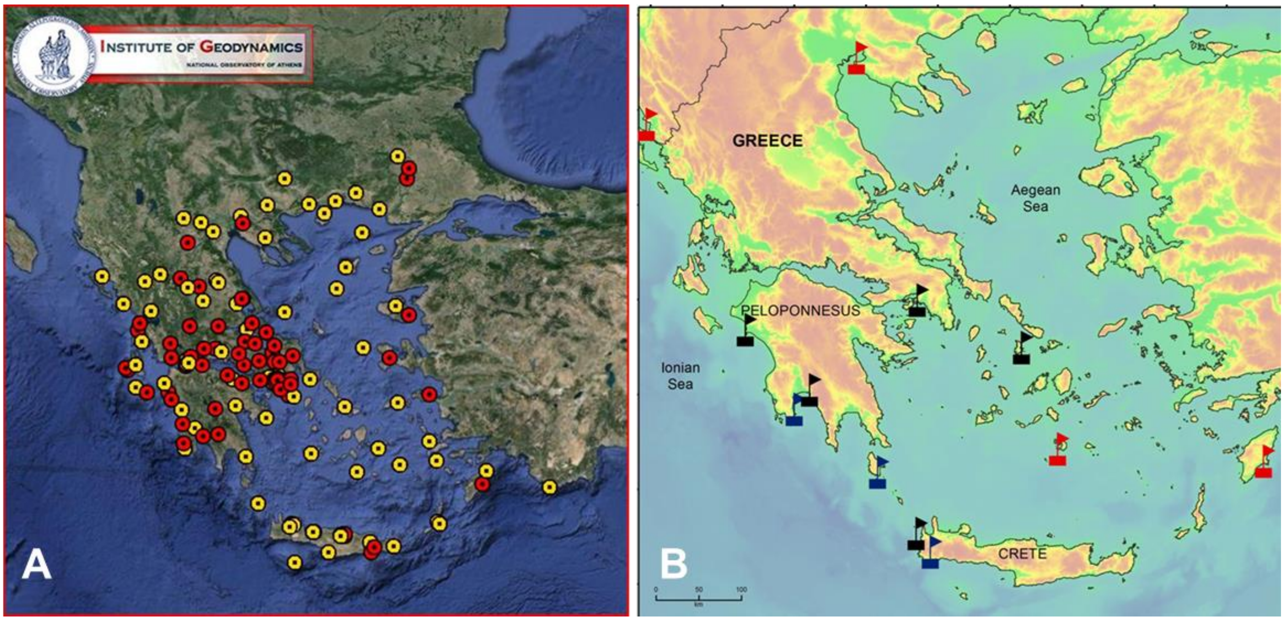


Figure 9 - Networks operated by NOA. A: Accelerometric network. B:Tide Gauge Network.

Moreover, a tide-gauge network of 12 stations is available in real-time to NOA- Hellenic National Tsunami Warning Center (NOA-HLNTWC). Tide- gauge stations – with microwave sensors – have been installed in the past two years in Santorini, Corfu, Rhodes and Thessaloniki (data is transmitted in real-time). In Koroni, Kithiria and Paleochora the stations are operated in cooperation with JRC (data is transmitted in real-time both to NOA-HLNTWC and JRC and each station has both pressure and microwave sensors). Training of duty officers is carried out on a regular basis.

The cooperation with JRC was emphasized. Likewise KOERI, MOD1 and MOD2 have been installed. The processing and the analysis have been implemented using TAT. Moreover, Tsunami Travel Time (TTT) software provided by NOAA (National Oceanic and Atmospheric Administration, USA), which allows the operator to estimate the arrival time, has been installed.

The dissemination of alert messages was described, pointing to the opportunity of sending simultaneously messages via email, fax and GTS. Greek Civil Protection is ultimately responsible for alerting the population. NOA-HLNTWC was also actively involved in the NEAMWAVE12 and NEAMWAVE14 exercises and in a Communication Test exercise held in October 2013 with the participation on 31 countries and 40 agencies.

National Tsunami Service Providers

4.2.5. SHOA – Chile

The Hydrographic and Oceanographic Service of the Navy (SHOA) is responsible for the National Tsunami Warning System (SNAM, Sistema Nacional de Alarma Maremotos) and represents the State of Chile in the International Tsunami Warning System in the Pacific.

Figure 10 – Mr. Zuniga presenting SNAM.

Chile's seismic history is of particular relevance here as the country has experienced some of the largest seismic events ever recorded in history This makes Chile different from other countries as far as the overall approach to decision support systems is concerned.

Mr. Zuniga explained in detail all the operational procedures of SHOA, focusing on the following stages (Figure 10): information reception, activation, evaluation, dissemination, monitoring and cancellation. In case of emergency, five minutes after the reception of information from the Seismological Center of the University of Chile (CSN) and from the Pacific Tsunami Warning Center (PTWC), SHOA has to establish the state of threat of the tsunami on the basis of near-field (intensity) and far-field (magnitude) data (Figure 11). Actions or activation depends on the size of the earthquake.

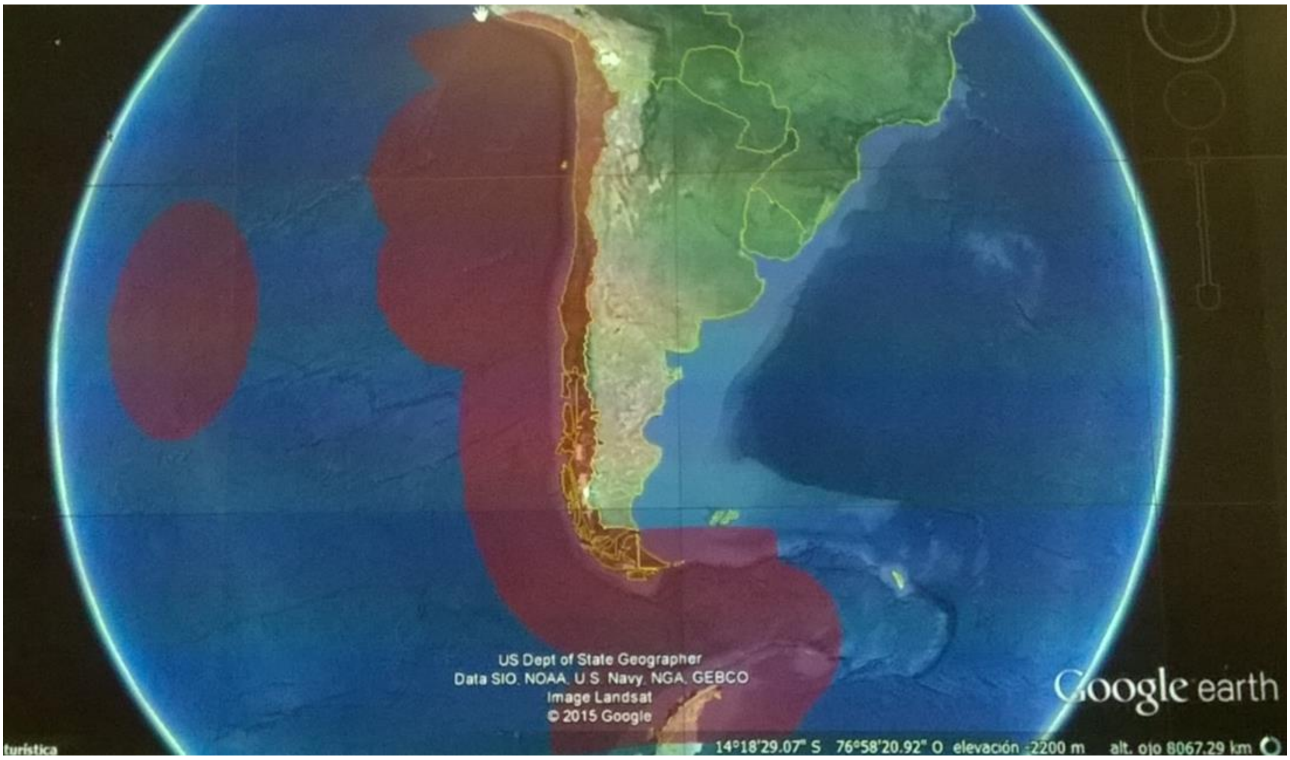


Figure 11 - The red area is considered as near field.

The "evaluation" phase and subsequent dissemination of the information consists of an evaluation of the magnitude. The determination of the magnitude leads to a special informative (5,0≤ M<6,5), an informative (6,5≤ M<7,0), an advisory (7,0≤ M<7,5), a watch (7,5≤ M<7,9) or a warning (M≥7,9) in the case of near field. Far field evaluations are carried out using PTWC tools and by differentiating between earthquakes within and out of the Pacific basin. During the presentation, attention was drawn to the timeframe as the first bulletin is issued (automatically) within the first 5 minutes of the earthquake. Dissemination of information to the population is done within 10 minutes. The country is divided by 21 hazard level blocks. The Tsunami forecasting activity is very fast, thanks to the 12.000 pre-calculated scenarios, In 3 seconds the system gives the results. Given the emphasis put on information and communication, questions were raised pertaining to the use and/or the exploitation of social media in case of emergencies. However, the use of social networks has not been fully exploited yet. Human resources are another important aspect which was highlighted: there are in fact 9 people who start the procedure in case of emergency. It was stressed that those are available any time.

There is a very strict protocol as far as cancellation is concerned. For this purpose, there is a check list which contains the following steps in order to issue a Cancellation to the Risk Management Office. It is required to have at least 3 tsunami periods with amplitude lower that 30 cm in each sea level stations of the national network, 40 in total (Figure 12).

This might be a long time, considering that tsunamis in certain Chilean bays has presented periods of 90 minutes; ii) also it is required a complete report from the Maritime Authority informing the normal sea level conditions along the whole coast; iii) Chilean DART buoys must be in normal state, without presence of tsunami waves, according its period; iv) once all those 4 conditions are achieved, the SHOA´s Director request the authorization for cancellation to the Director General of the Maritime Territory.

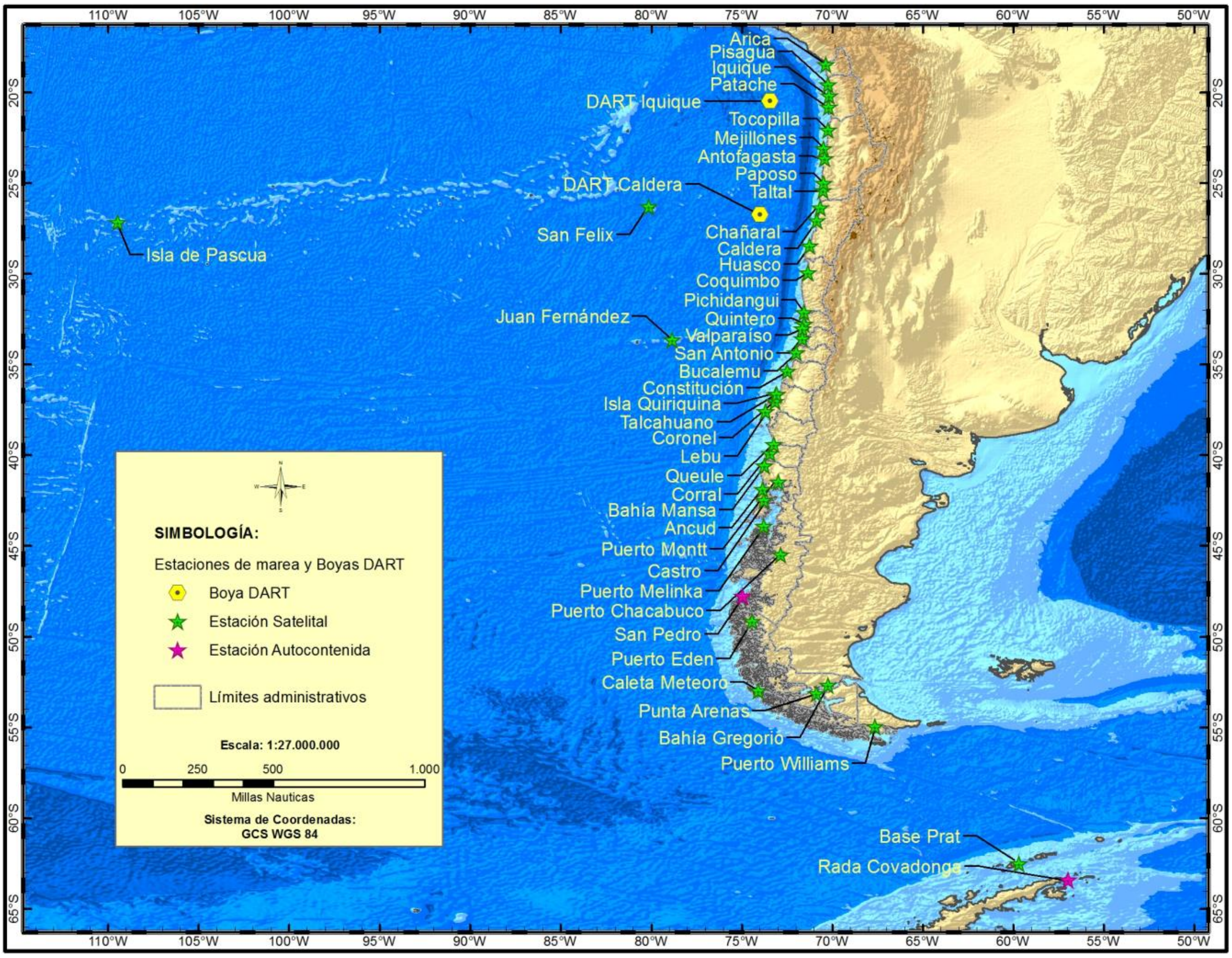


Figure 12 – Map of sensor network.

4.2.6. NEMA – Israel

Mr. A. Yahav (Figure 13Error! Reference source not found.) presented the National Emergency Management Authority (NEMA) starting from the approach to emergency management. While Chile's violent tectonic history makes it "unique", Israel's context is equally distinctive because of a number of emergency situations which complicate emergency management. Lessons learned from the past have shaped current approaches which aim to decrease disharmony at a national level between relevant institutions and organization. NEMA's goal is, in fact, preparing Israel's homeland to face emergencies in efficient ways by creating a "common language" (Figure 14). The presentation then turned to analyze what is needed to improve the system. First, there is the need to improve collaboration between Tsunami Warning Centers. This is an "open" issue that needs to be addressed along with clear guidelines for the media in case of emergency. At the moment, there is a national decision makers' team in charge of alerting the country in case of a tsunami and there is also a national plan for a tsunamis response but escape routes and safe zones have yet to be defined. The interest in tsunamis was triggered during an earthquake exercise in 2012. From that moment on, a group of experts has been working in order to develop procedures. The goals at a national level pertain to the definition of integrated procedures before, during and after a tsunami as well as the definition of communication strategies to alert the population near the coast and the analysis of escape routes. The current procedure entails the reception of the warning from the International Tsunami warning center through email, fax and GTS system.

Figure 13 – NEMA presentation.

The warning is sent to the scientific institutions and to the National Steering Committee for Earthquake preparedness. Information is processed at the seismology institute and at the National Steering Committee for Earthquake Preparedness.

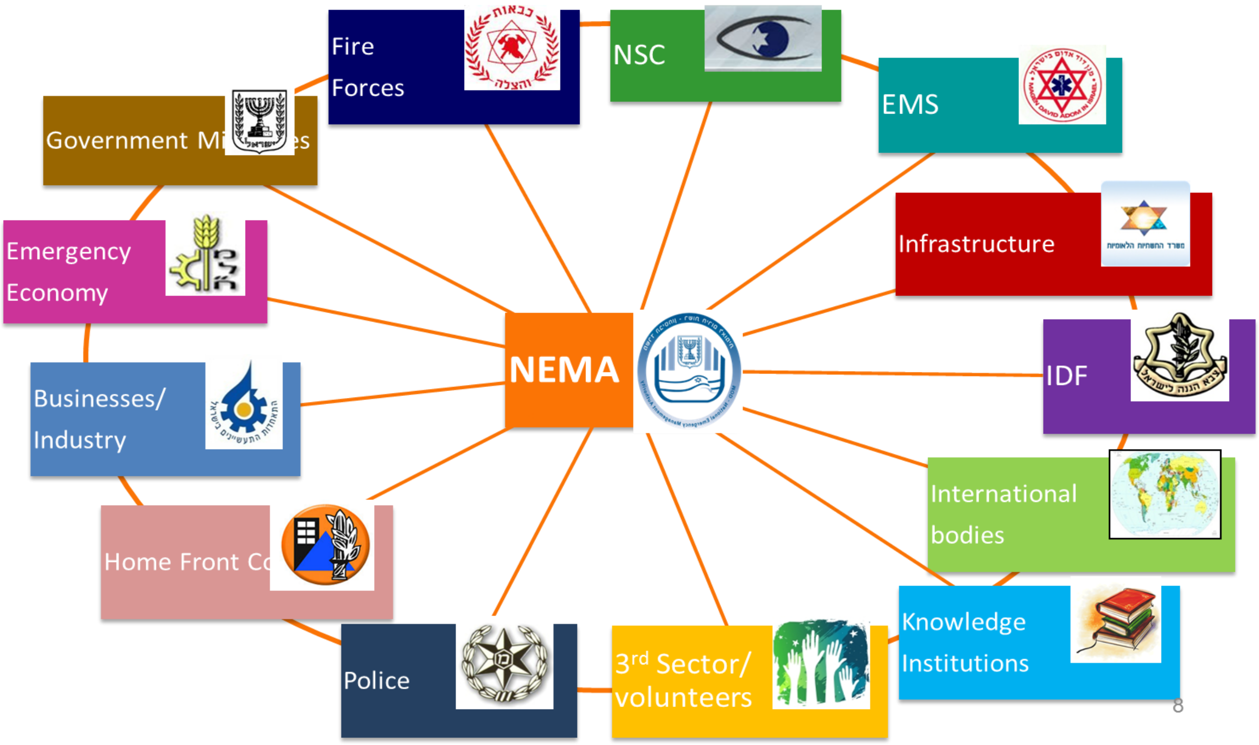


Figure 14 - NEMA institutional network

4.2.7. SINAMOT – Costa Rica

The National Tsunami Monitoring System (SINAMOT) was described by S. Chacon from the National University of Costa Rica. The presentation started with a short overview of tsunami history in the country, stressing that potential risk for tsunamis can come from distant sources, for instance from Colombia or Tonga (Figure 15). SINAMOT was established in 2014 and it is composed of 4 researchers from the National University and from the University of Costa Rica with a background in oceanography and maritime engineering.

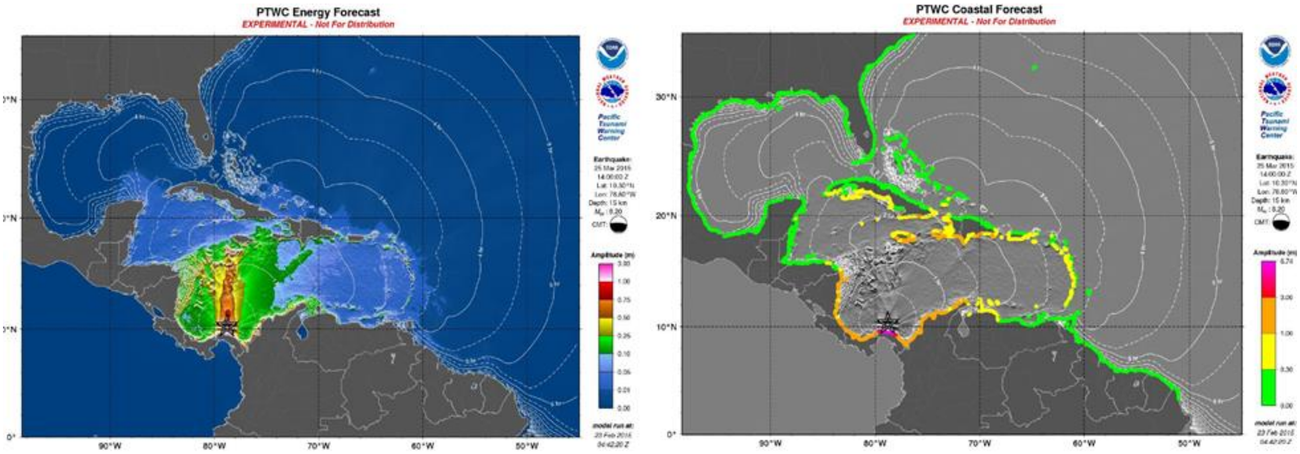


Figure 15 - Energy and Coastal forecast

Tsunami hazard assessment along with standard operating procedures and tsunami exercises are regularly carried out. The monitoring rooms are at the National University (backup also at theUniversity of Costa Rica). They use PTWC enhanced products for e.g. energy forecasting and wave height forecasting. Costal amplitude forecast are issued in support of the UNESCO/IOC Pacific Tsunami and Mitigation System and meant for authorities in each country of the system. National authorities will then determine the level of alert for each country and may issue more refined information. Additionally, tools to monitor the sea level in real time in tidal gauges and DART buoys tide tools and a historical tsunami database are used.

A network of researchers in Latin America was setup in order to share knowledge on tsunamis. They actively use Facebook, WhatsApp, Skype and RITLAC (Red de Investigadores en Tsunamis de Latinoamerica y el Caribe) which is a social network in Central America, South America, Caribbean and Mexico. While information shared in these platforms are not official as such, the role of social media and of networks of experts was stressed at the end of the presentation.

System Providers

4.2.8. TRIDEC Cloud – Germany

TRIDEC Cloud, as explained by M. Hammitzsch, is based on the experiences and the knowledge gained during the project TRIDEC, which was carried out from 2010 to 2013. Drawing on current trends in ICTs, TRIDEC Cloud aims to exploit the advantages of cloud computing to supply an operational system for early warning and fast response. The concept of cloud computing, or “the cloud” (Figure 16), was briefly described by pointing to the numerous benefits of a cloud applications (e.g. the delivery of on-demand computing resources, easily accessible with a local web browser or a smartphone app, etc.).

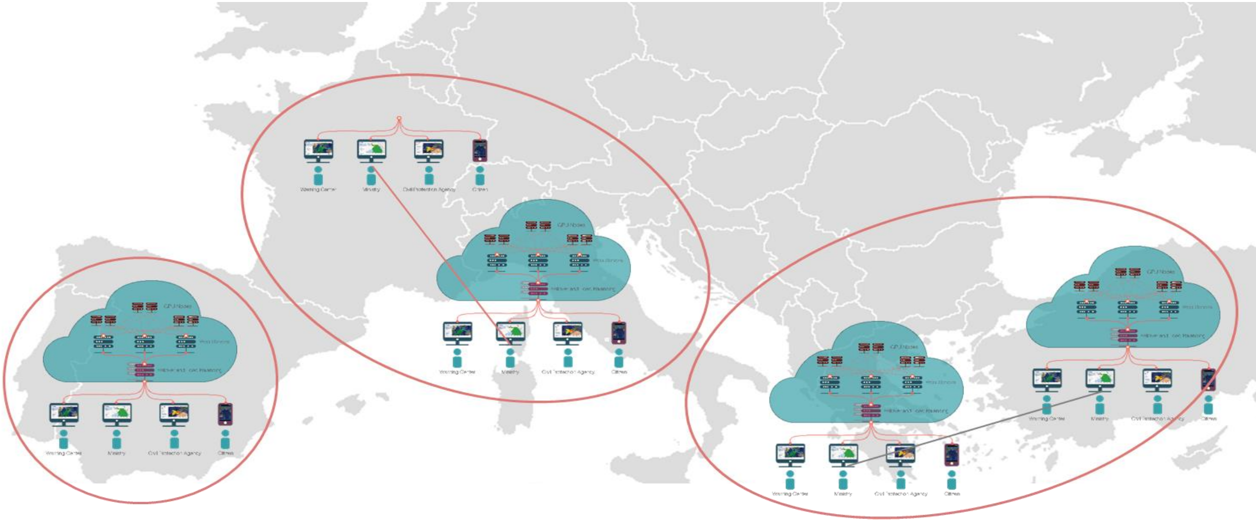


Figure 16 - Cloud computing diagram

The presentation then turned to analyze the features of the system. Pertaining to tsunami simulation, for instance, tsunami propagation calculations encompass tsunami travel times (TTT) and estimated time of arrivals (ETA), along with wave jets and estimated wave heights (EWH/SSH) and mareograms. For generating warning messages, tsunami forecast points (TFP) and tsunami forecast zones (CFZ) are processed. The generation of warning messages is done both with static and dynamic information (Figure 17). The message can be reviewed and then sent via email, fax, FTP/GTS, sms, cloud messages and shared maps. In particular, the use of cloud messages was described as it allows the integration of interactive and dynamic event and simulation data into text information. Moreover, recipients can interact dynamically with maps and diagrams.

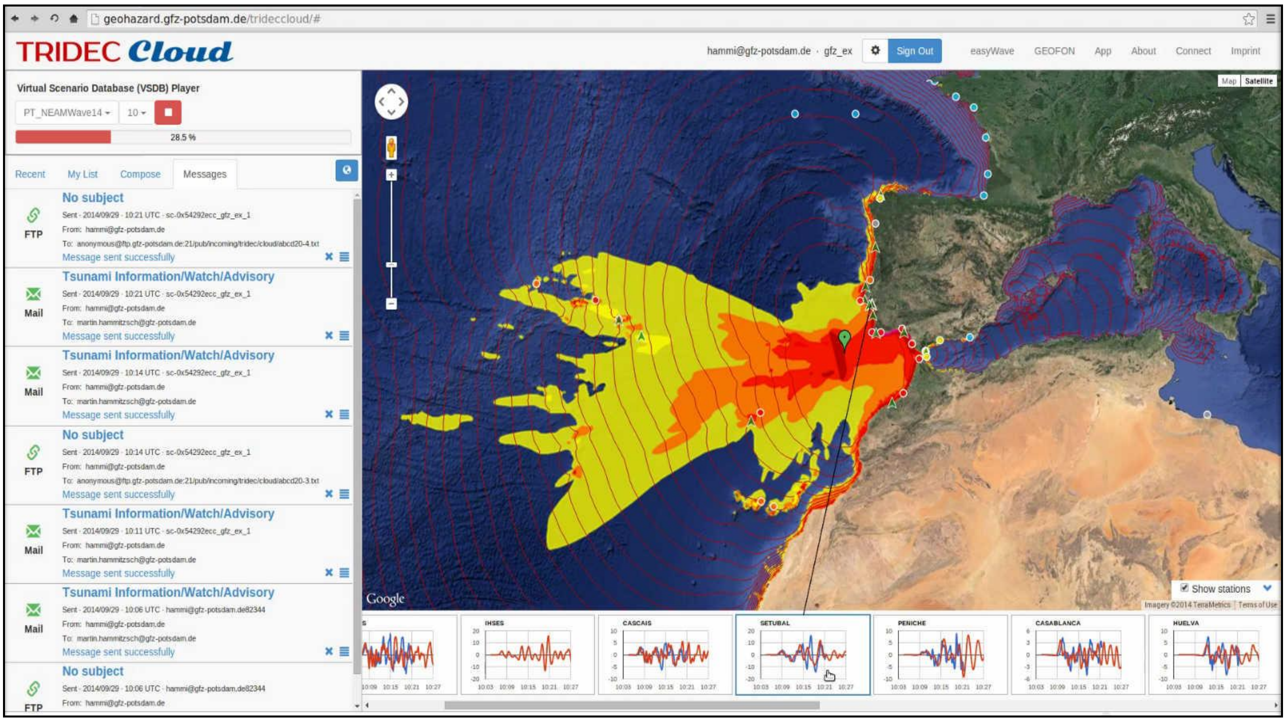


Figure 17 - Web based Graphical User Interface

In this context, TRIDEC cloud opens new prospects for early warnings, mitigation and fast response in case of natural hazards. It uses a combination of several complementary cloud-based services merged into a platform for web-mapping of hazard-specific geospatial data, GPUs (Computation with Graphics Processing

Units), sharing information, collaborating in distributed environments, monitoring real-events and training using virtual scenarios. For training purposes, virtual scenarios are playable with an acceleration to run prepared scenarios faster than in reality and new scenarios might be added at any time.

Maps and data can be shared with others (e.g. a list of close recipients or via social media) by using URL addresses. In order to interact with a shared map, recipients do not have to be TRIDEC cloud users. Automatically generated notifications are immediately delivered and it's easy to keep track of important changes. Preliminary warning messages with classification and information, e.g. on tsunami forecast points for the NEAM region and information on coastal forecast zones for the IO region are sent. Moreover, generated reports depict location map with simulation data and any other information can be integrated, if needed.

4.2.9 NOAA – USA

The activities of the National Oceanic and Atmospheric Administration (NOAA) were presented by V. Titov who focused on tsunami early warning and forecast starting from the challenges, in particular forecast speed and accuracy (Figure 18).

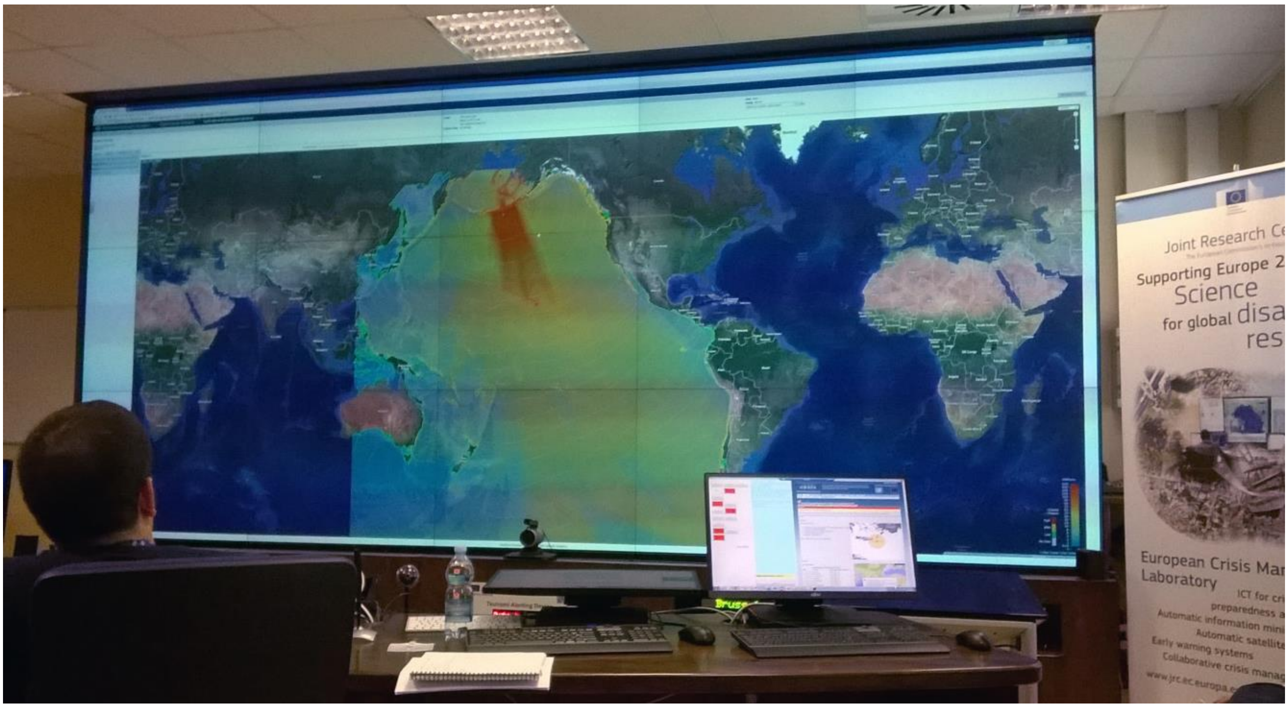


Figure 18 - Propagation of the 2011 Japan Tsunami showed during the presentation

Effective responses, in fact, rely on more timely and precise warnings and this is why a combination of measurement and modeling techniques is essential to provide reliable tsunami forecasts. At NOAA, seismic parameter estimates and tsunami measurements are used to sort through a Forecast Propagation database which is a collection of tsunami propagation model runs. These models, which have been precomputed, can be combined linearly to simulate earthquake scenarios in order to provide a fast forecast in case of emergency. During the presentation, the global propagation during the 2011 Japan Tsunami was shown.

Moreover, tsunami flooding forecast were described with an emphasis on what can be done today by using high-resolution flooding models for risk areas and can be done in the near future. Some improvements in forecast timing are expected during next future. The NOAA method for Tsunami Flooding Forecast considers 4 different actions which lead to an accurate and fast forecast:

- seismic event detection;
- Defining Basin- wide Tsunami Forecast;
- Receiving DART data;
- Running high-resolution flooding models.

In particular, the required time for receiving DART data will be reduced thanks to the integration of 4th generation DART buoys within the DART network. Furthermore, the models will become 10 times faster.

4. 2.10 JRC – EC

A. Annunziato presented the activities of JRC related to Tsunami monitoring and analysis.

The Tsunami Analysis Tool is the Decision Support System developed by JRC to analyse events and report about their behavior to the ERCC in Brussels. It has also been provided to several European or Mediterranean countries (Portugal, Turkey, Greece, Romania, Maroc, Spain) and it is also used by two participants in this workshop (Figure 19). The software runs on a Windows client but there is also a web version of it. It allows launching online calculations by specifying the initial conditions of the earthquake.

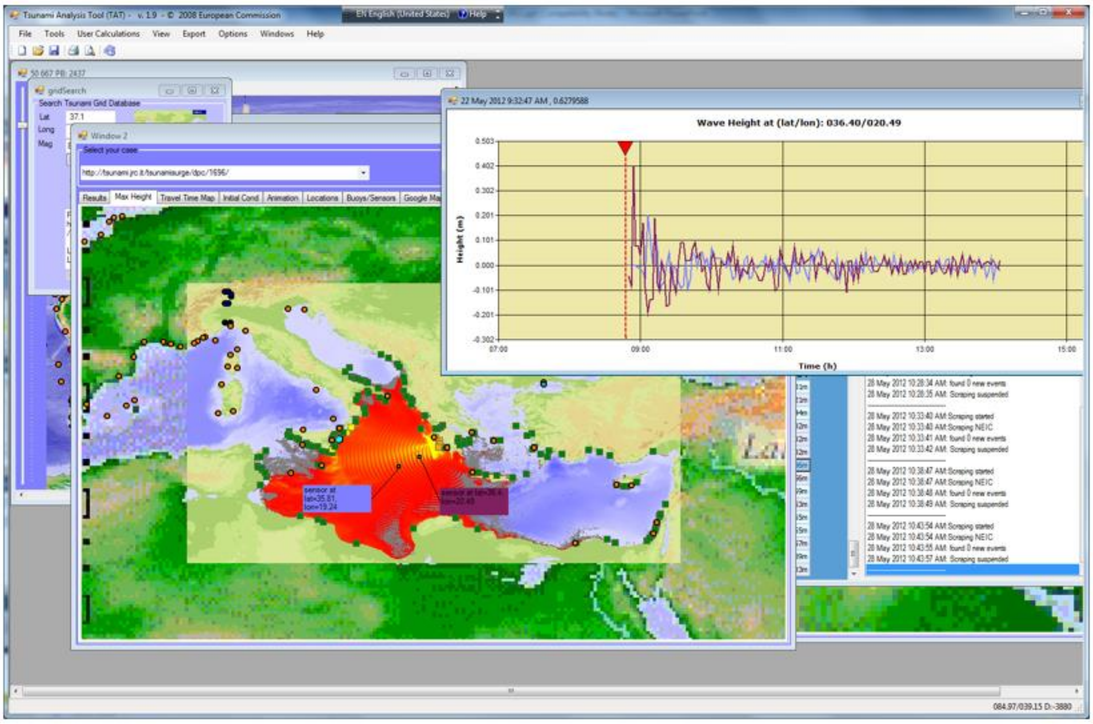


Figure 19 – An image of TAT showing **analysis and** comparison of **on line measured and calculated sea levels.**

A new mareograph device has been designed and developed at the **Joint Research Centre** of the European Commission (**JRC**) in order to facilitate the diffusion of this type of instrument in the Mediterranean Sea. The instrument has the characteristic to be cheap and very effective but its reliability, duration and quality need to be determined and qualified; therefore a pilot campaign is being organized in collaboration with **UNESCO/IOC**, responsible of the Tsunami Warning System development in the Mediterranean and North Atlantic area (**NEAMTWS**).

JRC is also involved in the development of “last mile devices”, i.e. Tsunami Alerting Device (TAD) of which one example has been installed in Setubal (Portugal) in 2011. Recently the device has been tested in connection with a sea level measurement, so that the alerting of the panel has been activated by the detection of a Tsunami wave at the measurement device (Figure 20). The measurement device was mounted on a Tsunami simulator that replicated the wave behaviour during a hypothetical event.

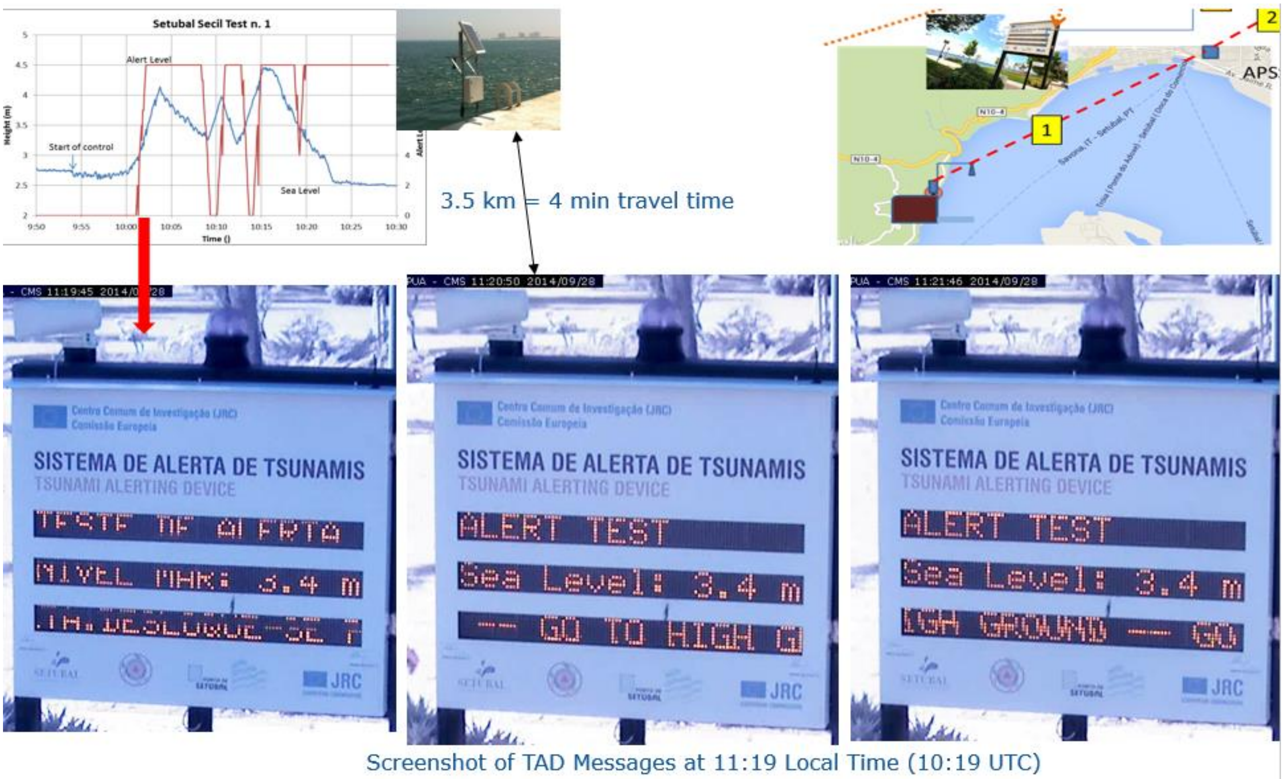


Figure 20 – An image of TAD in alert mode during the Last mile experiment. 30s after start of sea level rising alert is shown on the panel: 3.5-4 min to escape

Finally a training activity was performed in the period 2013-2014 and will be replicated in 2015-2016 consisting in the analysis by a number of organizations of every potential Tsunami event occurring worldwide caused by earthquakes of magnitude greater than Mw 7 (GTIMS).

4.2.11 Tsunami- HySEA – University of Malaga

HySEA is a GPU-based model for Tsunami Early Warning Systems presented by José M. González Vida. Based on the non-linear shallow water equations, tsunami-HySEA model, implements in the same code the three phases of an earthquake generated tsunami: generation, propagation and coastal inundation. At the same time it is implemented in nested meshes with different resolution and multi-GPU (Graphic Processing Unit) environment, which allows much faster than real time simulations (Figure 21). The initial sea surface deformation is computed using Okada seabed deformation model. Wave propagation is computed using nonlinear shallow water equations in spherical coordinates, where coastal inundation and run-up are suitable treated in the numerical algorithm.

$$
(1) \quad \begin{aligned}
h_t + (q_x)_x + (q_y)_y &= 0 \\
(q_x)_t + \left(\frac{q_x^2}{h} + \frac{g}{2}h^2\right)_x + \left(\frac{q_x q_y}{h}\right)_y &= ghH_x + S_x \\
(q_y)_t + \left(\frac{q_x q_y}{h}\right)_x + \left(\frac{q_y^2}{h} + \frac{g}{2}h^2\right)_y &= ghH_y + S_y
\end{aligned}
$$

Figure 21 - Shallow-water equations for tsunami modeling (Cartesian coordinates)

Generation, propagation and inundation phases are all integrated in a single code and computed coupled and synchronously when they occur at the same time. Inundation is modelled by allowing cells to dynamically change from dry to wet and reciprocally when water retreats from wetted areas. Special effort is made in preserving model well-balanced (i.e. capturing small perturbations to the steady state of the ocean at rest). The GPU model implementation allows faster than real time (FTRT) simulation for real large-scale problems. The large speed-ups obtained make HySEA code suitable for its use in Tsunami Early Warning Systems. The Italian TEWS at INGV (Rome)[1] has adopted HySEA GPU code for its National System. The model is verified by hindcasting the wave behavior in several benchmark problems (Figure 22). The interest of using higher order methods, analysing numerical schemes from first order up to order five, in the context of TEWS, is also addressed. Tsunami codes do not usually use higher than second order methods. It is demonstrated that this should idea should be revised[2].

A synthetic example was reported to demonstrate the HySEA effectiveness. Four hours of real time simulation is computed in 110" using 8 Titan Black GPUs. The example was run considering the parameters reported below.

- Mesh resolution: 30 arc-sec (Eastern Mediterranean Basin -more than 7.5 million cells-).
- Wall clock time to be simulated: 8 hours.
- Saving time step: 15 seconds.
- Okada parameters:
    - Epicenter longitude: 22.3°
    - Epicenter latitude: 35.7°
    - Epicenter depth: 16.33km
    - Fault length: 100.0km
    - Fault width: 50.0km
    - Strike: 313.0°
    - Dip: 35.0°
    - Rake: 90.0°
    - Slip: 8.4m

[1] See 4.2.1
[2] For more information see: http://riuma.uma.es/xmlui/handle/10630/7489#sthash.lDbu0FQ4.dpuf

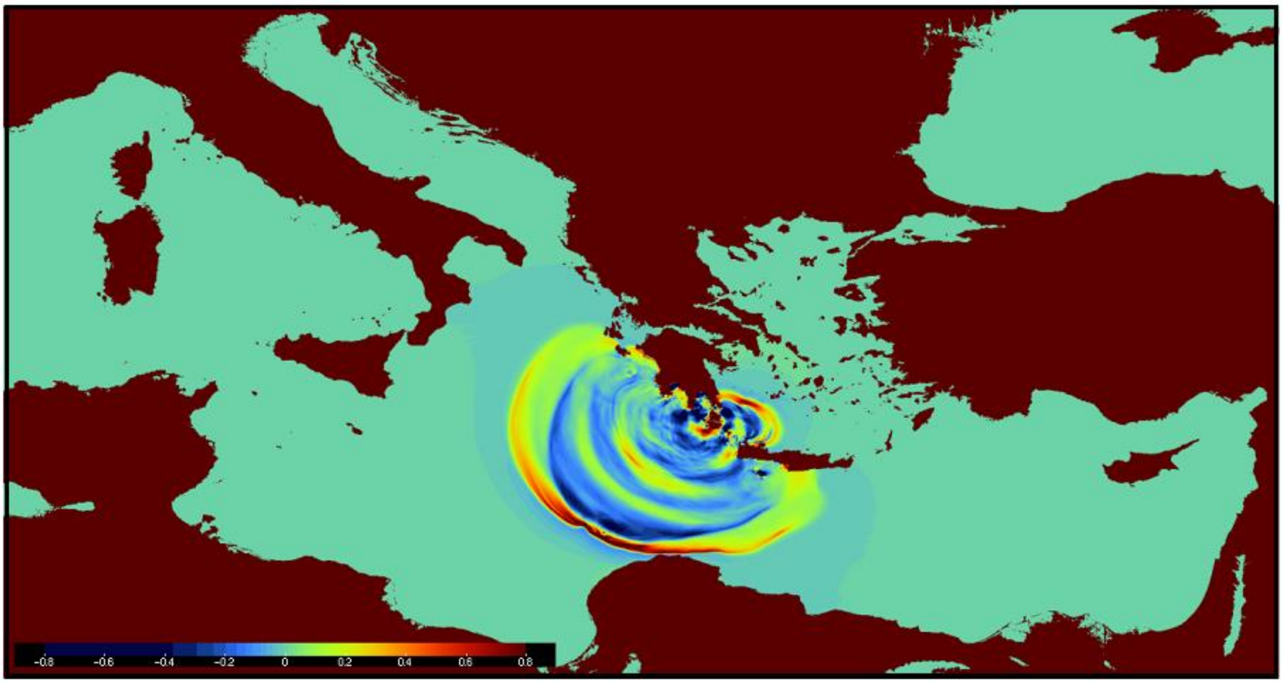


Figure 22 - Tsunami propagation simulation

5 Demonstration Cases

5.1 Working mode

JRC organized the demonstration as live analysis by the various teams. The cases were prepared by JRC personnel by selecting 2 or 3 potential Tsunami events specific of each DSS provider area of analysis. The cases were codified in XML files of the type used by USGS (RSS feeds) and the address, containing the cases definition was given to the demonstrators several days in advance: until the demonstration the XML files contained just one minor event. A driver programme was set-up so that at the moment of the demonstration the XML file was populated with the case to analyse: the case was therefore completely unknown to the demonstrators who could just choose one numeric option (1-2 or maybe 3 in one case), corresponding to a case to be run. At the same time, in the TDSS web page (http://webcritech.jrc.ec.europa.eu/tdss) in addition to the links to the XML files, also a corresponding equivalent GDACS page was published; the GDACS page contained exactly the same information that would be present in a GDACS report few min after an event and an automatic calculation would have been run. All the results of the automatic calculations are available for consultation and download.

In some case the systems were ready to accept automatically the case and therefore started to react accordingly; in other cases the data of the case were provided manually to the system.

This “surprise” method provided to be a useful method in order to provide the operators with a case that they should be able to analyse following their standard procedures but it was “new” enough to pose some pressure and emotivism into the exercise. The fact that many eyes were behind the operators was considered probably not realistic: in fact in an initial proposal for the workshop JRC has thought to provide the operators a dedicated isolated room and not in front of all the other participants. In reality some of the workshop participants indicated that during a real event the monitoring room is not, unfortunately, a calm quiet room but many people enter inside and participate to the activities, thus the situation was not very different from the normal one.

Those were the cases that have been prepared and that were chosen by the various demonstrators:

Group	Case	Mode	Notes
RIMES	Mw 8.2 Sumatra case	Remote analysis	Run 30th June with
KOERI	Mw 7.7 East Aegean Sea	Live Remote analysis	Run with TAT and TsuComp
NOA	Mw 7.8 South of Crete	Live Analysis	Run with TAT
TRIDEC	Mw 7.5 Off-shore Algeria	Live Analysis	Run on web browser
UMA	Mw 7.5 Off-shore Algeria	Live Calculation	Run remotely in Malaga
NOAA	Mw 8.4 Off-shore Japan	Live Analysis	Run on web browser
SHOA	Mw 8.2 Off-shore Chile	Case Presentation	Run off-line before the workshop

Table 1 – List of events

As indicated a web page in GDACS was present for each of the cases and were classified as:

Case	Overall Alert	Earthquake	Tsunami	Max Est. Height/Location
Mw 8.2 Sumatra case	RED	RED	RED	**3.9** m in Melingge, Indonesia
Mw 7.7 East Aegean Sea	ORANGE	ORANGE	GREEN	**0.2** m in Gure, Turkey
Mw 7.8 South of Crete	ORANGE	ORANGE	ORANGE	**1.2** m in Arkasa, Greece
Mw 7.5 Off-shore Algeria	RED	RED	GREEN	**0.9** m in Douar Mendil, Algeria
Mw 8.4 Off-shore Japan	ORANGE	ORANGE	ORANGE	**2.9** m in Fundai, Japan
Mw 8.2 Off-shore Chile	xx	xx	Xx	xx

Table 2 – Alert classification

Details about all the cases and related Tsunami and Earthquake estimations can be found below.

Mw 8.2 Sumatra Case: http://www.gdacs.org/Tsunamis/report.aspx?eventid=1058872&eventtype=EQ

Mw 7.7 East Aegean Sea: http://www.gdacs.org/Tsunamis/report.aspx?eventid=1058514&eventtype=EQ

Mw 7.8 South of Crete: http://www.gdacs.org/Tsunamis/report.aspx?eventid=1058538&eventtype=EQ

Mw 8.4 Off-shore Japan: http://www.gdacs.org/Tsunamis/report.aspx?eventid=1058540&eventtype=EQ

Mw 7.5 Off-shore Algeria: http://www.gdacs.org/Tsunamis/report.aspx?eventid=1058541&eventtype=EQ

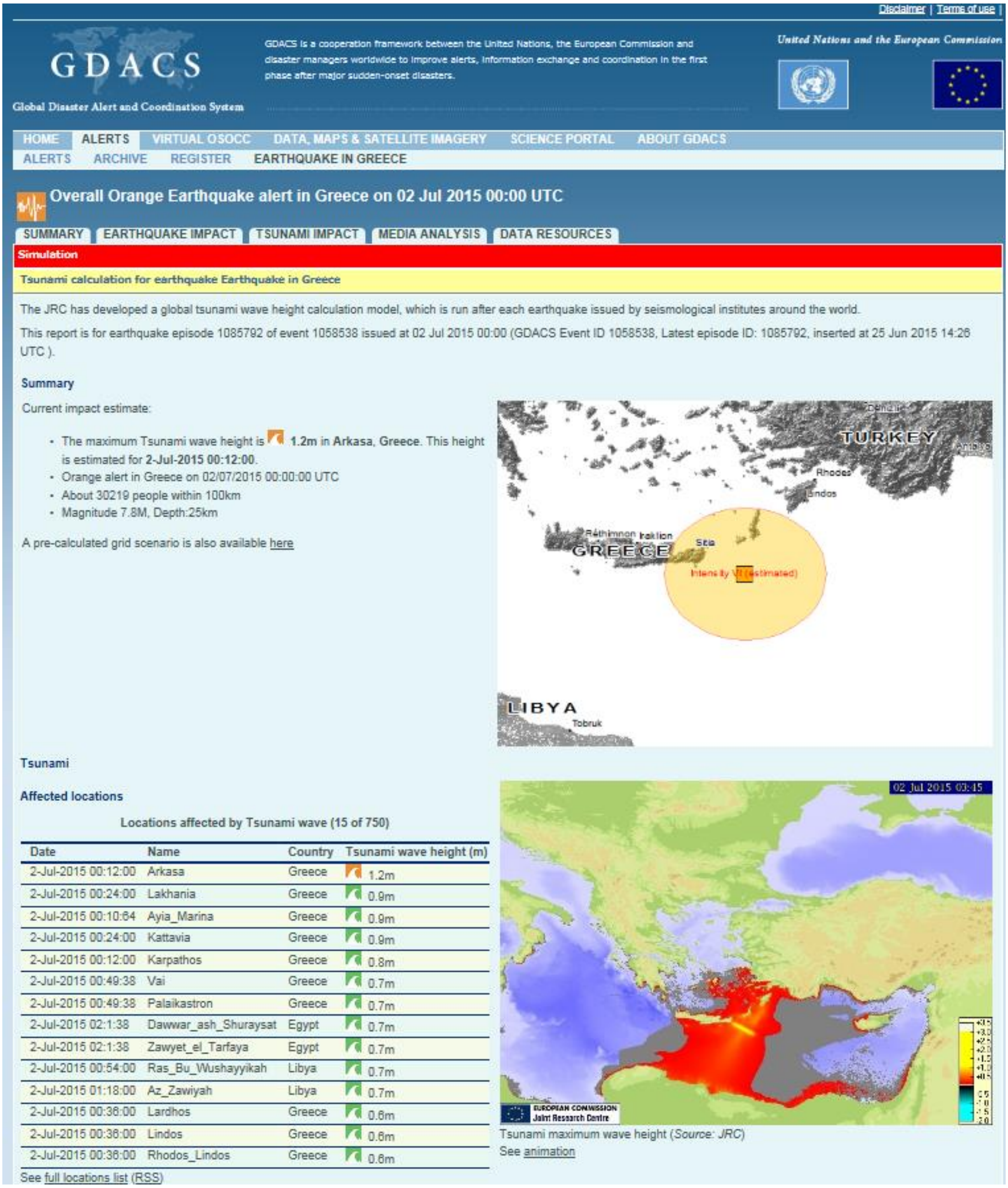
The GDACS response to those events would have been the following:

- As the event is notified to GDACS system (about 3-5 min after), the alert level is estimated for both the Earthquake impact and the Tsunami impact. The first is calculated taking into account the population density, the country vulnerability and the magnitude. The Tsunami impact is estimated using the global Tsunami scenario database developed by JRC, that includes 132000 scenarios worldwide; the alert level is calculated using the maximum height present in the scenario calculation that has initial conditions closer to the event ones (height larger than 3 m red alert, between 1 and 3 m Orange alert, below 1m Green alert). The overall alert level is the most severe among the two.
- If the overall alert level is Orange or Red notification is sent to the registered users via SMS and email
- After sending out the alerts a new online calculation is performed using the conditions of the current event and using fault mechanisms present in a dedicated database. Once the calculation is completed (between 20 min and 45 min depending on the magnitude which influences the calculation resolution), the alert level obtained by this calculation replaces the one obtained by the

scenario database: if the overall alert level is more severe than the one previously established a new notification is sent to the users

- The same procedure applies to all the following estimations of the same event (new magnitude established, new position, new depth or new provider) but no notification is sent out if the alert level is not more severe that the previous one.

An example of the response page in GDACS is shown below for the Mw 7.8 East of Crete



Date	Name	Country	Tsunami wave height (m)
2-Jul-2015 00:12:00	Arkasa	Greece	1.2m
2-Jul-2015 00:24:00	Lakhania	Greece	0.9m
2-Jul-2015 00:10:64	Ayia_Marina	Greece	0.9m
2-Jul-2015 00:24:00	Kattavia	Greece	0.9m
2-Jul-2015 00:12:00	Karpathos	Greece	0.8m
2-Jul-2015 00:49:38	Vai	Greece	0.7m
2-Jul-2015 00:49:38	Palaikastron	Greece	0.7m
2-Jul-2015 02:1:38	Dawwar_ash_Shuraysat	Egypt	0.7m
2-Jul-2015 02:1:38	Zawyet_el_Tarfaya	Egypt	0.7m
2-Jul-2015 00:54:00	Ras_Bu_Wushayyikah	Libya	0.7m
2-Jul-2015 01:18:00	Az_Zawiyah	Libya	0.7m
2-Jul-2015 00:36:00	Lardhos	Greece	0.6m
2-Jul-2015 00:36:00	Lindos	Greece	0.6m
2-Jul-2015 00:36:00	Rhodos_Lindos	Greece	0.6m

Figure 23 - *Web page that would be present in GDACS few min after the Crete event*

5.2 RIMES Demonstration (Started 29 June 2015 7:10 UTC)

Due to the impossibility to have an online live demonstration of RIMES during the workshop an agreement with JRC was obtained in order to run a demonstration case off-line beforehand the workshop with the same characteristics of the demonstrations run during the workshop. For this reason it was agreed that between 7:00 and 8:00 UTC JRC would have included a sample case in the distribution RSS file. RIMES staff was asked to choose among the following events (unknown to them) that were prepared:

1. Nicobar Island Event
2. Sumatra Event

On request to choose between 1 and 2 RIMES selected, without knowing any detail of the case or the event area, n. 2. The case was therefore the following:

```
Event Date: Mon, 29 Jun 2015 07:10:54 GMT
Location: NW Sumatra TEST TEST TEST
Latitude: 4.6040
Longitude: 94.3741
Magnitude: 8.6 Mw
Depth: 20 km
```

RIMES Staff reacted by performing similar actions that are normally performed in an event like this and in particular:

- Issued a Flash Report
- Issued a SMS report
- Launched an analysis calculation with the system PRECISE

Events timeline

Event	7:10:54	Notification time 0
Launched Analysis	??	??
SMS report	7:17:48	06:54
Email notification: Bulletin n.1	7:20:20	09:26
Analysis completed	7:43	32:06
Bulletin n. 2	7:58	47:06

Table 3 – Event and notifications

5.2.1 Flash Report

1. EMAIL AND SMS STATUS - AUTOMATIC , AT ABOUT 7:17:48 UTC

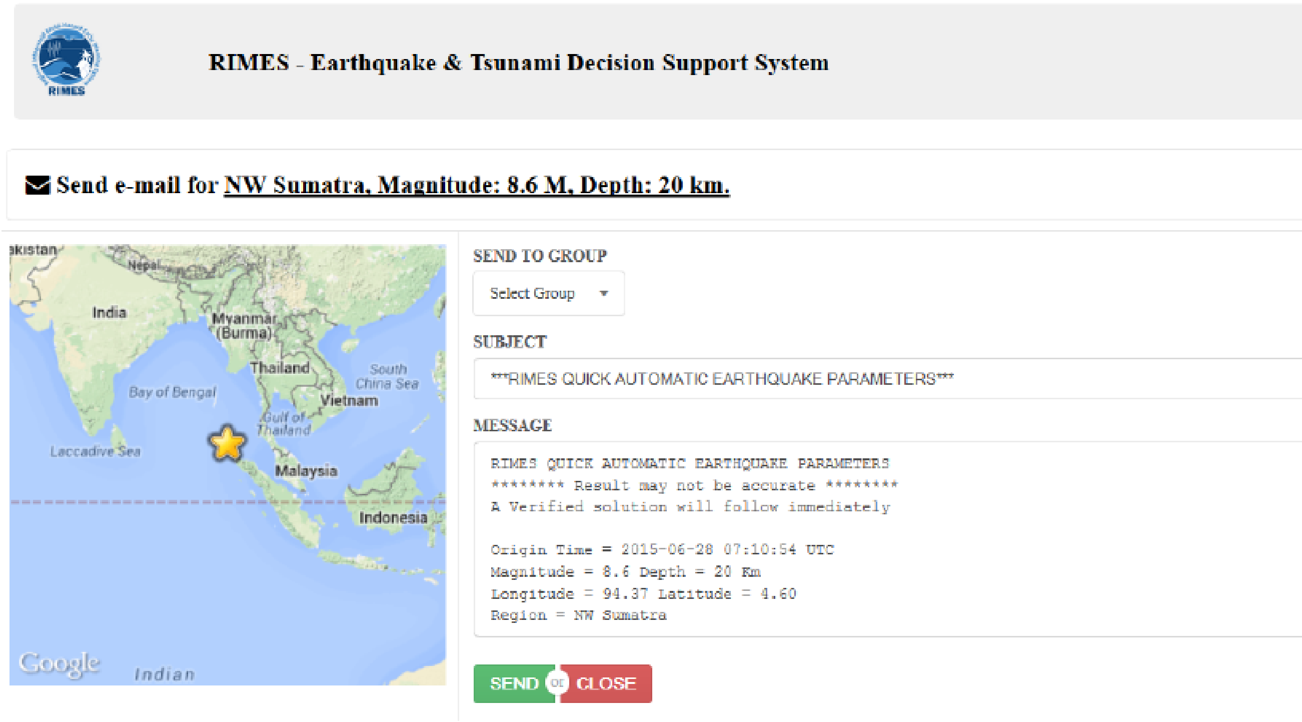


Figure 24 – E-mail automatic

The above figure shows the screenshot of the issue of the email. The content of the email is

RIMES QUICK AUTOMATIC EARTHQUAKE PARAMETERS
******** Result may not be accurate ******** A Verified solution will follow immediately

Origin Time = 2015-06-**28** 07:10:54 UTC
Magnitude = 8.6 Depth = 20 Km
Longitude = 94.37 Latitude = 4.60
Region = NW Sumatra

Message sent by RIMES Automatic Alerting

The email was sent out at 7:17:48; the date indicated was 28 instead of 29 as it was inserted manually into the analysis system. In the following all the 28 should be intended as 29/6.

5.2.2 SMS

A SMS was sent out with the following content

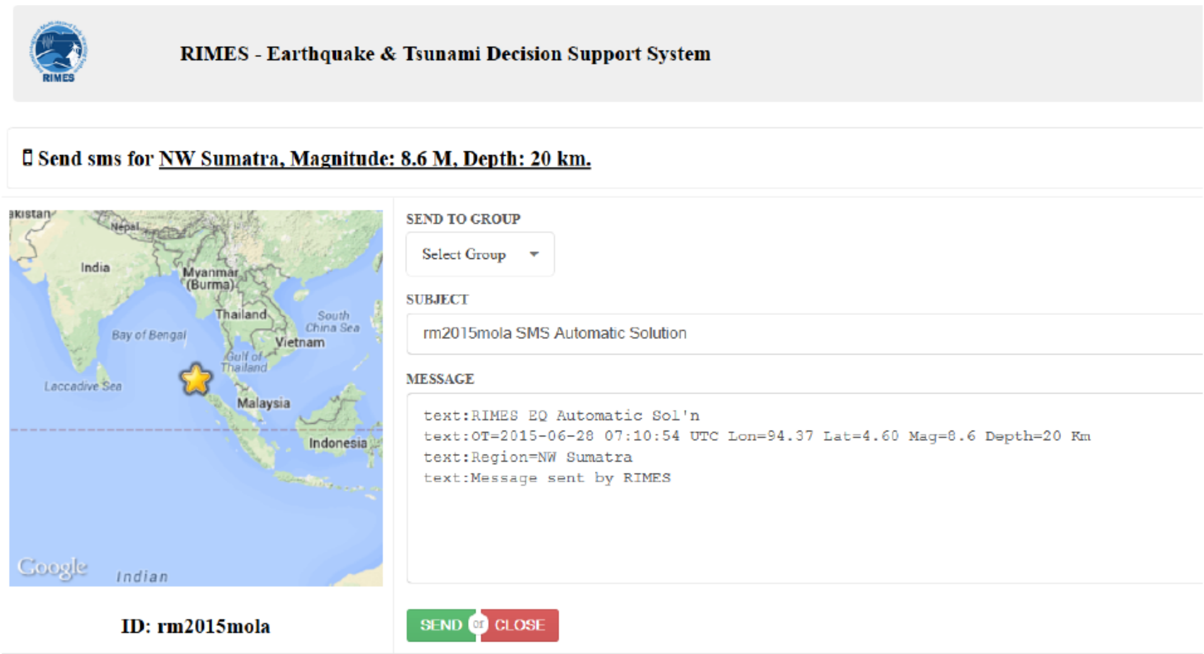


Figure 25 – SMS automatic

5.2.3 Report bulletin

As a result of the analysis a Tsunami bulletin was issued at 7:41 and containing Tsunami height and indication of treat.

- TSUNAMI BULLETIN -1

```
TEST TEST
TEST TEST
RIMES-20150504-0741-001 (TYPE I)
------------------------------------------------------------------------------
TSUNAMI BULLETIN NUMBER 1
REGIONAL INTEGRATED MULTI-HAZARD EARLY WARNING SYSTEM (RIMES)
issued at 0720 UTC Monday 28 June 2015
------------------------------------------------------------------------------

. . . EARTHQUAKE INFORMATION BULLETIN . . .

1. EARTHQUAKE INFORMATION
RIMES has detected an earthquake with the following preliminary information:

Magnitude:          8.6M |
Depth:              20km
Date:               28 June 2015
Origin Time:        07:10:54 UTC
Latitude:           4.604N
Longitude:          94.3741E
Location:           NW Sumatra

2. EVALUATION
RIMES is evaluating this earthquake to determine if a tsunami has been
generated.

Further information on this event will be available at:
http://www.rimes.int/earthquake/tsunami_bulletin/

3. ADVICE
This bulletin is being issued as advice. Only national/state/local authorities
and disaster management officers have the authority to make decisions regarding
the official threat and warning status in their coastal areas and any action to
be taken in response.
```

Figure 26 – Tsunami bullettin 1

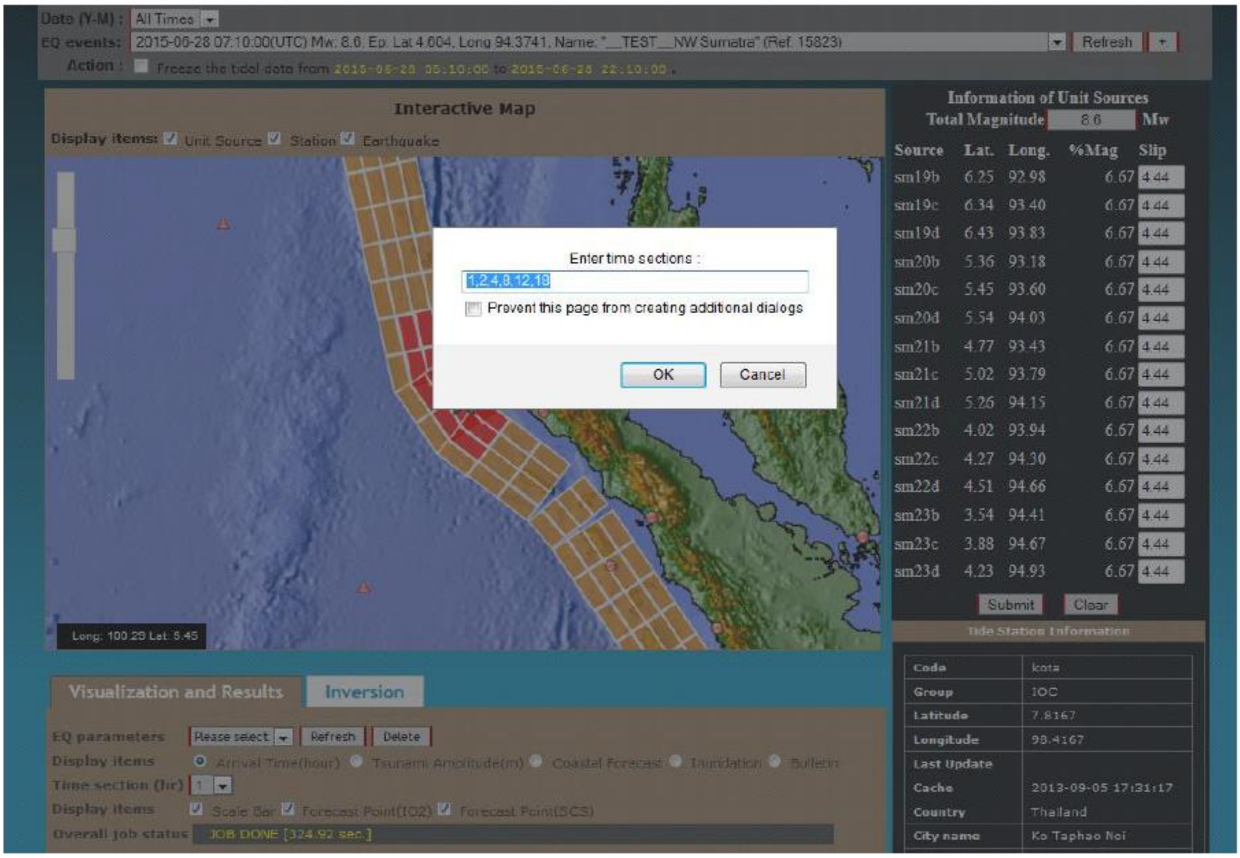


Figure 27 – This forecast simulation take time depending on the number of time section

Appendix to RIMES demonstration – Bulletin n. 2

TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST
TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST TEST
TEST TEST TEST TEST RIMES-20150629-0911-002 (TYPE II)

--

TSUNAMI BULLETIN NUMBER 2
REGIONAL INTEGRATED MULTI-HAZARD EARLY WARNING SYSTEM
(RIMES) Issued at 0758 UTC Monday 29 June 2015

--

. . . POTENTIAL TSUNAMI THREAT IN THE INDIAN OCEAN . . .

1. EARTHQUAKE INFORMATION
RIMES has detected an earthquake with the following details:

Magnitude:	8.6 M
Depth:	20 km
Date:	28 June 2015
Origin Time:	0710 UTC
Latitude:	4.6N
Longitude:	94.37E
Location:	NW Sumatra

2. EVALUATION
Earthquakes of this size are capable of generating tsunamis. However, so far, there is no confirmation about the triggering of a tsunami.

An investigation is under way to determine if a tsunami has been triggered. RIMES will monitor sea level gauges and report if any tsunami wave activity has occurred.

Based on pre-run model scenarios, the zones listed below are POTENTIALLY UNDER THREAT.

3. TSUNAMI THREAT FOR THE INDIAN OCEAN
The list below shows the forecast arrival time of the first wave estimated to exceed 0.5m amplitude at the beach in each zone, and the amplitude of the maximum wave predicted for the zone. Zones where the estimated wave amplitudes are less than 0.5m at the beach are not shown.

The list is grouped by country (alphabetic order) and ordered according to the earliest estimated times of arrival at the beach.
Please be aware that actual wave arrival times may differ from those below, 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.

The threat is deemed to have passed two hours after the forecast time for last exceedance of the 0.5m threat threshold for a zone. As local conditions can cause a wide variation on tsunami wave action, CANCELLATION of national warnings and ALL CLEAR determination must be made by national/ state/ local authorities.

BRITISH INDIAN OCEAN TERRITORY

Salomon Islands	043Z	28	Jun 2015	2.33m	Threat
Speakers Bank	044Z	28	Jun 2015	2.82m	Threat
Point Marianne	045Z	28	Jun 2015	2.28m	Threat
Diego Garcia	049Z	28	Jun 2015	1.90m	Threat

Morsby Island	053Z	28	Jun 2015	3.16m	Threat
Wight Bank	100Z	28	Jun 2015	1.36m	Threat
Three Brothers	106Z	28	Jun 2015	1.72m	Threat
Danger Island	109Z	28	Jun 2015	2.55m	Threat
INDIA					
Vetapalem	000Z	28	Jun 2015	1.26m	Threat
Dandugopala Puram	003Z	28	Jun 2015	1.37m	Threat
Uvari	014Z	28	Jun 2015	1.37m	Threat
Kadiapattanam	049Z	28	Jun 2015	0.78m	Threat
Little Nicobar Island North	713Z	28	Jun 2015	2.08m	Threat
Casuarina Bay Great Nicobar Island W	716Z	28	Jun 2015	3.00m	Threat
West Little Nicobar	716Z	28	Jun 2015	2.02m	Threat
Pryce Channel	718Z	28	Jun 2015	4.14m	Threat
Great Nicobar Island South	720Z	28	Jun 2015	3.97m	Threat
Indira Point	720Z	28	Jun 2015	3.59m	Threat
Galathea Bay	721Z	28	Jun 2015	2.91m	Threat
Saint George Channel	721Z	28	Jun 2015	3.17m	Threat
Nanjappa Bay	722Z	28	Jun 2015	3.49m	Threat
Anderson Bay	723Z	28	Jun 2015	2.57m	Threat
Mero Island	723Z	28	Jun 2015	1.71m	Threat
TB3	723Z	28	Jun 2015	5.15m	Threat
Campbell Bay	727Z	28	Jun 2015	2.20m	Threat
Pigeon Islands	728Z	28	Jun 2015	2.21m	Threat
Oal-Kolo-Kwak Katchall	730Z	28	Jun 2015	2.14m	Threat
West Bay Katchall	730Z	28	Jun 2015	1.12m	Threat
West Teressa	733Z	28	Jun 2015	1.94m	Threat
Kola- rue Terassa	734Z	28	Jun 2015	1.61m	Threat
North Katchall	737Z	28	Jun 2015	2.06m	Threat
Sombrio Point	737Z	28	Jun 2015	2.42m	Threat
Treis Island	737Z	28	Jun 2015	1.77m	Threat
East Little Nicobar	738Z	28	Jun 2015	2.36m	Threat
South Katchall	738Z	28	Jun 2015	2.89m	Threat
Chaura Island	739Z	28	Jun 2015	1.84m	Threat
Cape Connaught	740Z	28	Jun 2015	1.69m	Threat
Batti Malv Island	741Z	28	Jun 2015	1.18m	Threat
Kondul Island	741Z	28	Jun 2015	4.35m	Threat
Mount Deoban	741Z	28	Jun 2015	3.49m	Threat
West Noncowry	741Z	28	Jun 2015	2.90m	Threat
East Katchall	743Z	28	Jun 2015	3.35m	Threat
West Kamatra	744Z	28	Jun 2015	3.12m	Threat
Trinkat Island	745Z	28	Jun 2015	1.29m	Threat
Bompoka Island	747Z	28	Jun 2015	1.81m	Threat
Kemois Bay Car Nicobar	750Z	28	Jun 2015	2.12m	Threat
Tillanchong Island West	751Z	28	Jun 2015	1.22m	Threat
East Teressa	752Z	28	Jun 2015	2.76m	Threat
Tillanchong Island South	752Z	28	Jun 2015	0.70m	Threat
West Car Nicobar	752Z	28	Jun 2015	2.36m	Threat
North Kamorta	756Z	28	Jun 2015	2.37m	Threat
North Car Nicobar	757Z	28	Jun 2015	1.61m	Threat
Ekiti Bay Little Andaman South	804Z	28	Jun 2015	1.89m	Threat
South Bay Little Andaman	806Z	28	Jun 2015	1.89m	Threat
South Little Andaman	808Z	28	Jun 2015	1.98m	Threat
Little Andaman West	809Z	28	Jun 2015	1.75m	Threat
……	…	…	…	…	…
Vevaru	024Z	28	Jun 2015	1.31m	Threat
Wilifuri	026Z	28	Jun 2015	1.54m	Threat
Humada	034Z	28	Jun 2015	1.36m	Threat
Furadu	036Z	28	Jun 2015	0.67m	Threat
Magudu	041Z	28	Jun 2015	1.24m	Threat
Hithaadhoo (Baa Atoll)	042Z	28	Jun 2015	0.69m	Threat

Pulau Tapah North East	738Z	28	Jun 2015	2.27m	Threat
Silingar	739Z	28	Jun 2015	2.57m	Threat
Ballasetas	740Z	28	Jun 2015	1.76m	Threat
Calang (North West sumatra)	740Z	28	Jun 2015	7.62m	Threat
Oleelheue (Northern Sumatra)	740Z	28	Jun 2015	5.09m	Threat
Kotabaru	746Z	28	Jun 2015	1.38m	Threat
Leunghh	746Z	28	Jun 2015	3.22m	Threat
Bali	747Z	28	Jun 2015	1.86m	Threat
Meulaboh	747Z	28	Jun 2015	5.59m	Threat
Sikandang	751Z	28	Jun 2015	4.18m	Threat
Sinabang-baai South East	751Z	28	Jun 2015	1.51m	Threat
Alasa	752Z	28	Jun 2015	2.07m	Threat
Tapakktuan	755Z	28	Jun 2015	2.55m	Threat
Hilihoja	756Z	28	Jun 2015	0.52m	Threat
Susoh	756Z	28	Jun 2015	2.58m	Threat
Tanjongbunga	756Z	28	Jun 2015	2.61m	Threat
PulauTuangku	758Z	28	Jun 2015	2.65m	Threat
Sirombu	759Z	28	Jun 2015	1.86m	Threat
Pulau Bangkaru	800Z	28	Jun 2015	1.62m	Threat
Pulau Tuangku South	800Z	28	Jun 2015	1.53m	Threat
Culeegle	801Z	28	Jun 2015	2.38m	Threat
Meuko	801Z	28	Jun 2015	2.24m	Threat
Suaqbakong	801Z	28	Jun 2015	2.46m	Threat
Jeunieb	804Z	28	Jun 2015	2.81m	Threat
Bireuen	805Z	28	Jun 2015	2.80m	Threat
Jangka	805Z	28	Jun 2015	2.81m	Threat
Pulau Tanahbala West	805Z	28	Jun 2015	1.62m	Threat
Pulau Udjung Batu	805Z	28	Jun 2015	2.22m	Threat
Djamboerpapeuen	809Z	28	Jun 2015	1.96m	Threat
Pulau Tuangku West	809Z	28	Jun 2015	3.38m	Threat
Banyak Islands	810Z	28	Jun 2015	2.01m	Threat
Pulau Sipika	812Z	28	Jun 2015	1.16m	Threat
Pulau Tanahmasa	812Z	28	Jun 2015	1.08m	Threat
Sibabau	814Z	28	Jun 2015	1.16m	Threat
Lhokseumawe	815Z	28	Jun 2015	2.47m	Threat
Teluk Semawe	815Z	28	Jun 2015	2.47m	Threat
Sumatera Utara	817Z	28	Jun 2015	1.67m	Threat
Madat	831Z	28	Jun 2015	1.58m	Threat
Beleratsok	837Z	28	Jun 2015	0.91m	Threat
Langsar Bay	942Z	28	Jun 2015	1.34m	Threat
Manyak Payed	942Z	28	Jun 2015	1.34m	Threat
INTERNATIONAL					
BPR_INT	718Z	28	Jun 2015	8.83m	Threat
BPR_INT	722Z	28	Jun 2015	5.52m	Threat
BPR_INT	729Z	28	Jun 2015	4.16m	Threat
BPR_INT	736Z	28	Jun 2015	4.20m	Threat
BPR_INT	738Z	28	Jun 2015	6.04m	Threat
BPR_INT	809Z	28	Jun 2015	5.07m	Threat
MALAYSIA					
Kampung Genting	105Z	28	Jun 2015	1.22m	Threat
Kampung Perlis	105Z	28	Jun 2015	1.22m	Threat
Pulau Betong	105Z	28	Jun 2015	1.22m	Threat
MALDIVES					

Pulau Tapah North East	738Z	28	Jun 2015	2.27m
Silingar	739Z	28	Jun 2015	2.57m
Ballasetas	740Z	28	Jun 2015	1.76m
Calang (North West sumatra)	740Z	28	Jun 2015	7.62m
Oleelheue (Northern Sumatra)	740Z	28	Jun 2015	5.09m

Kotabaru	746Z	28	Jun 2015	1.38m	
Leunghh	746Z	28	Jun 2015	3.22m	
Bali	747Z	28	Jun 2015	1.86m	
Meulaboh	747Z	28	Jun 2015	5.59m	
Sikandang	751Z	28	Jun 2015	4.18m	
Sinabang-baai South East	751Z	28	Jun 2015	1.51m	
Alasa	752Z	28	Jun 2015	2.07m	
Tapakktuan	755Z	28	Jun 2015	2.55m	
Hilihoja	756Z	28	Jun 2015	0.52m	
Susoh	756Z	28	Jun 2015	2.58m	
Tanjongbunga	756Z	28	Jun 2015	2.61m	
PulauTuangku	758Z	28	Jun 2015	2.65m	
Sirombu	759Z	28	Jun 2015	1.86m	
Pulau Bangkaru	800Z	28	Jun 2015	1.62m	
Pulau Tuangku South	800Z	28	Jun 2015	1.53m	
Culeegle	801Z	28	Jun 2015	2.38m	
Meuko	801Z	28	Jun 2015	2.24m	
Suaqbakong	801Z	28	Jun 2015	2.46m	
Jeunieb	804Z	28	Jun 2015	2.81m	
Bireuen	805Z	28	Jun 2015	2.80m	
Jangka	805Z	28	Jun 2015	2.81m	
Pulau Tanahbala West	805Z	28	Jun 2015	1.62m	
Pulau Udjung Batu	805Z	28	Jun 2015	2.22m	
Djamboerpapeuen	809Z	28	Jun 2015	1.96m	
Pulau Tuangku West	809Z	28	Jun 2015	3.38m	
Banyak Islands	810Z	28	Jun 2015	2.01m	
Pulau Sipika	812Z	28	Jun 2015	1.16m	
Pulau Tanahmasa	812Z	28	Jun 2015	1.08m	
MYANMAR					
Great Western Torres Island South	908Z	28	Jun 2015	1.29m	Threat
Macleod island	910Z	28	Jun 2015	1.62m	Threat
Zadetkyi Kyun West	910Z	28	Jun 2015	1.46m	Threat
Christie Island	912Z	28	Jun 2015	1.65m	Threat
Eliza Island	945Z	28	Jun 2015	1.27m	Threat
SOMALIA					
Gaalkacyo North East	432Z	28	Jun 2015	1.24m	Threat
Hobyo South	438Z	28	Jun 2015	1.27m	Threat
Gaba Uein	440Z	28	Jun 2015	1.15m	Threat
Assaley	449Z	28	Jun 2015	1.24m	Threat
Kismayo	516Z	28	Jun 2015	1.11m	Threat
SRILANKA					
Kalmunai	855Z	28	Jun 2015	1.54m	Threat
Yala Wela	855Z	28	Jun 2015	2.53m	Threat
Ambalam	856Z	28	Jun 2015	3.08m	Threat
Komari	856Z	28	Jun 2015	2.22m	Threat
Batticaloa	858Z	28	Jun 2015	1.56m	Threat
Okanda	900Z	28	Jun 2015	2.47m	Threat
Pottuvil	900Z	28	Jun 2015	2.68m	Threat
Pirappaiyadimadu	903Z	28	Jun 2015	1.73m	Threat
Yala National Park	903Z	28	Jun 2015	2.15m	Threat
Anaitivu	904Z	28	Jun 2015	1.87m	Threat
Matara	909Z	28	Jun 2015	1.33m	Threat
Tangalla	909Z	28	Jun 2015	1.99m	Threat
Welligama	913Z	28	Jun 2015	1.03m	Threat

Bundala	915Z	28	Jun 2015	1.94m	Threat
Hambantota	917Z	28	Jun 2015	1.77m	Threat
Mullaittivu	917Z	28	Jun 2015	2.20m	Threat
Galle	920Z	28	Jun 2015	2.51m	Threat
Putukkudiyirippu	920Z	28	Jun 2015	1.95m	Threat
Unawatuna Beach Galle	920Z	28	Jun 2015	2.10m	Threat
Chundikkulam	928Z	28	Jun 2015	1.36m	Threat
Kosgoda	930Z	28	Jun 2015	1.30m	Threat
Telwatta Ganga	930Z	28	Jun 2015	1.14m	Threat
Ambalangoda	931Z	28	Jun 2015	1.31m	Threat
Benota	934Z	28	Jun 2015	1.26m	Threat
Point Pedro	934Z	28	Jun 2015	1.22m	Threat
Beruwala	935Z	28	Jun 2015	1.37m	Threat
Beruwala Bay	935Z	28	Jun 2015	1.37m	Threat
Kanakasanturai	939Z	28	Jun 2015	1.36m	Threat
Wadduwa	939Z	28	Jun 2015	2.14m	Threat
Katunayake	946Z	28	Jun 2015	1.44m	Threat
Colombo North	947Z	28	Jun 2015	1.51m	Threat
Colombo South	950Z	28	Jun 2015	1.33m	Threat
THAILAND					
Langkawi	031Z	28	Jun 2015	1.17m	Threat
Ko Tarurao	034Z	28	Jun 2015	1.45m	Threat
Ko Payang	838Z	28	Jun 2015	1.50m	Threat
Ko Similan	842Z	28	Jun 2015	1.62m	Threat
Ko Racha Yai	845Z	28	Jun 2015	1.38m	Threat
Ko Similan North	846Z	28	Jun 2015	1.84m	Threat
Ko Similan South	846Z	28	Jun 2015	1.36m	Threat
Ko Born	855Z	28	Jun 2015	1.91m	Threat
Ko Taphao Noi	900Z	28	Jun 2015	1.52m	Threat
Pa Tong	903Z	28	Jun 2015	1.80m	Threat
Kammala	907Z	28	Jun 2015	1.87m	Threat
Ko Surin Tai	907Z	28	Jun 2015	1.52m	Threat
Choeng Thale	912Z	28	Jun 2015	3.12m	Threat
Choeng Thale North West	912Z	28	Jun 2015	3.12m	Threat
Thalang West Coast	912Z	28	Jun 2015	3.12m	Threat
Ban Thai Muang	914Z	28	Jun 2015	2.52m	Threat
Ban Muang Mai	915Z	28	Jun 2015	1.83m	Threat
Lam Kaen	916Z	28	Jun 2015	1.91m	Threat
Ban Bang Niang	927Z	28	Jun 2015	3.55m	Threat
Khukkhak	928Z	28	Jun 2015	1.55m	Threat
Bang Muang	931Z	28	Jun 2015	1.73m	Threat
Ko Ra Wi	935Z	28	Jun 2015	1.22m	Threat

4. ADVICE

This bulletin is being issued as advice. Only national/ state/ local authorities and disaster management officers have the authority to make decisions regarding the official threat and warning status in their coastal areas and any action to be taken in response.

5. UPDATES

Additional bulletins will be issued by RIMES for this event as more information becomes available.

RTSPs may issue additional information at:

RTSP AUSTRALIA: http://reg.bom.gov.au/tsunami/rtsp/

RTSP INDIA: http://www.tsunami.incois.gov.in/ITEWS

RTSP INDONESIA: http://rtsp.bmkg.go.id

In case of conflicting information from RTSPs or the IAS (PTWC, JMA), the more conservative information should be used for safety.

6. CONTACT INFORMATION

REGIONAL INTEGRATED MULTI-HAZARD EARLY WARNING SYSTEM (RIMES) Address: Outreach Building, AIT Campus, Pathumthani 12120 Thailand Tel.: +662-516-5905 to 07
Fax: +662-516-5908 to 09 Email: tsunami@rimes.int
Website: www.rimes.int

END OF BULLETIN

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5.3 KOERI Demonstration (Started at 13:47 UTC)

KOERI demonstration was performed using the JRC software **TAT**, currently the official Decision Support Tool for KOERI and **TsuComp**, a novel in-house software developed by KOERI that is currently used as backup system, should TAT have any performance problem. The demonstration was performed remotely by M. Comoglu and C. Ozer Sozdinler located in KOERI and connected via two VNC instances with JRC and a phone call[3].

Two cases were ready for KOERI; the one that was chosen was the following:

Date of the event: **2 July 2015 13:47 UTC**

Location: **East Aegean Sea**

Lat/Lon: **38.83/26.27**

Magnitude: **7.7 Mw**

Depth: **20 km**

TAT and TsuComp were setup in order to scrape a feed, located at JRC that was activated exactly at the time of the event. Both TAT and TsuComp correctly scraped the event even if for some reason TsuComp could not recognize the date format and therefore it was necessary to input manually the date; this is not a major issue because in a real case the system would continuously scrape the feeds and therefore eventual discrepancy with the current feed would be identified immediately and thus corrected. The two software have been used independently, on two different computers, in the same room.

The time of scraping depends on the frequency of scraping of the case; in the case of TAT this time interval was set at 5 min but it is also possible to force the scraping on request of the operation (should he know that an important event is going on).

A first message was produced with TsuComp at 13:56 (+9 min)

Date	Event		Time difference
02 Jul 2015 13:47	Mw 7.7 in Aegean Sea		-
02 Jul 2015 13:56	First Message by Tsucomp		+ 9 min
02 Jul 2015 13:58	First Message by TAT		+ 11 min
02 Jul 2015 14:06	Cancellation Message by Tsucomp		+ 19 min
02 Jul 2015 14:06	Cancellation Message by TAT		+ 19 min
02 Jul 2015 14:09	Start of editing of TAT Report		+ 21 min
02 Jul 2015 14:13	TsuComp report created		+ 26 min
02 Jul 2015 14:15	End of editing of TAT Report		+ 28 min

Table 4 – Messages per event

[3] It should be noted that the day before the workshop a test with the Hangup+ software (Microsoft) was tried because skype was not working; during the experiment instead skype was tried with bad results and therefore the audio was actuated using a normal phone, amplified in the Meeting room. As **Lessons Learnt** for future workshop it is important not to deviate, during an event, by the solutions tested during the event preparation

Both systems used the same method for the estimation of the event: i.e. Decision Matrix and TTT (Tsunami Travel Time by NOAA) for the first message and scenario grid calculation (JRC mod 2.0) for the creation of the report and for comparing with sea levels. The grid case that was selected is

W:\Disk2\MAG_775\P0265^P0390^0775\

Corresponding to a magnitude 7.75 Mw, Latitude 39 and longitude 25.6.

As the case was analysed using the UNESCO NEATMWS Decision matrix, that for Magnitude larger than 7 consider a Tsunami Watch for the whole Basin. However as KOERI limits the basin to the East Mediterranean Regions, it includes in TAT all the countries defined as Forecast points. In the case of TsuComp not all the countries are included. This was due to an error in the configuration of the TsuComp and was corrected afterwards.

Countries included in TAT message:

```
... TSUNAMI WATCH ...
THIS                        ALERT                            APPLIES                              TO
ALBANIA...CROATIA...CYPRUS...EGYPT...GREECE...ISRAEL...ITALY...LEBANON...LIBYA...MALTA...
MONTENEGRO...PALESTINIAN AUTHORITY...SYRIA...TRNC...TUNISIA...TURKEY
```

Countries included in TsuComp message:

```
... TSUNAMI WATCH ...
THIS  ALERT  APPLIES  TO  ALBANIA  ...  CROATIA  ...  CYPRUS  ...  GREECE  ...  ISRAEL  ...  LEBANON  ...
MONTENEGRO ... PALESTINIAN AUTHORITY ... TUNISIA ... TURKEY ... TURKISH REPUBLIC OF NORTHERN CYPRUS
```

More in detail about the locations: the first and the last 5 locations for Turkey

TAT

```
TURKEY-IZMIR_ALACATI      38.25N  26.39E  1401Z  02 JUL WATCH
TURKEY-IZMIR_ALIAGA       38.83N  26.94E  1401Z  02 JUL WATCH
TURKEY-BALIKESIR_AYVALIK  39.31N  26.69E  1423Z  02 JUL WATCH
TURKEY-IZMIR_MENTES_(M)   38.43N  26.72E  1435Z  02 JUL WATCH
TURKEY-AYDIN_KUSADASI     37.87N  27.26E  1439Z  02 JUL WATCH
...
TURKEY-MERSIN_BOZYAZI_(M) 36.10N  32.94E  1613Z  02 JUL WATCH
TURKEY-MERSIN_TASUCU_(M)  36.28N  33.84E  1636Z  02 JUL WATCH
TURKEY-MERSIN_ERDEMLI_(M) 36.56N  34.26E  1643Z  02 JUL WATCH
TURKEY-ADANA_YUMURTALIK   36.77N  35.78E  1730Z  02 JUL WATCH
TURKEY-HATAY_ISKENDERUN_(M36.59N  36.18E  1737Z  02 JUL WATCH
```

TsuComp

```
TURKEY - IZMIR ALIAGA           38.8340  26.9370  1418Z 02 JUL  WATCH
TURKEY - IZMIR ALACATI          38.2534  26.3866  1438Z 02 JUL  WATCH
TURKEY - IZMIR MENTES (M)       38.4276  26.7167  1447Z 02 JUL  WATCH
TURKEY - CANAKKALE BOZCAADA     39.8356  26.0770  1454Z 02 JUL  WATCH
TURKEY - AYDIN KUSADASI         37.8698  27.2601  1454Z 02 JUL  WATCH
...
TURKEY - MERSIN BOZYAZI (M)     36.0962  32.9403  1624Z 02 JUL  WATCH
TURKEY - MERSIN TASUCU (M)      36.2815  33.8360  1655Z 02 JUL  WATCH
TURKEY - MERSIN ERDEMLI (M)     36.5634  34.2550  1656Z 02 JUL  WATCH
TURKEY - HATAY ISKENDERUN (M)   36.5933  36.1802  1751Z 02 JUL  WATCH
TURKEY - ADANA YUMURTALIK       36.9140  35.9803  1759Z 02 JUL  WATCH
```

Although both TAT and TsuComp used TTT to calculate the travel time, they differ for the closest locations to the epicentre (for example 14:01 in Aliaga for TAT and 14:18 at the same location for TsuComp. The reason is that TAT uses TTT by defining width and length of the source while TsuComp uses TTT with a point source. For the closer locations of course this causes important differences while for the farer locations the differences are reduced (i.e. for Porec, Croatia, the difference is 2 min). It would also be important to check if the resolution adopted for these calculations is the same. This problem will disappear when TsuComp produces the message based on the pre-calculated scenario database.

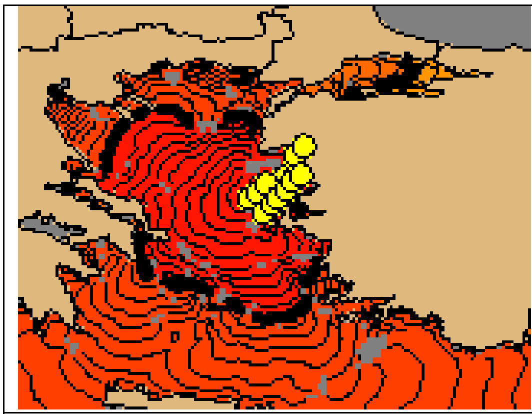	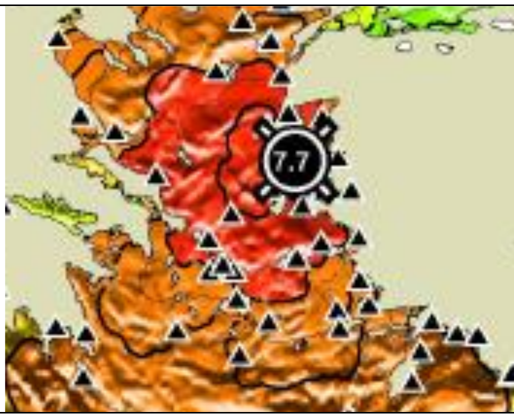
TTT calculation in TAT	TTT calculation in TsuComp

Figure 28 – TTT calculation in TAT and TsuComp

Both systems created an automatic analysis report containing the initial conditions and some maps and a list of locations. The TAT report is created in Word format and this facilitates further editing; it contains a limited number of locations and includes a sea level verification, used to declare the cancellation message. The TsuComp report has been created very quickly, it is in PDF format, easy to send by email; although the label of the locations indicates only the ones with height above 0.3 m in reality all the available quantities are included, also with few cm of height.

In terms of performance it should be noted that TAT has demonstrated some problems in the analysis of the case and it was necessary to repeat one of the operation as the programme was stuck. It is not clear if this was due to a lack of memory (2 instances of TAT were running because it was used the same computer on which the regular operational TAT was run. KOERI will upgrade the internal memory to 16 GB but this issue needs further investigation). TsuComp demonstrated to be easier to use with less windows open. It should be noted that the case did not foresee the comparison of measured and calculated quantities which in reality opens many other operational issues.

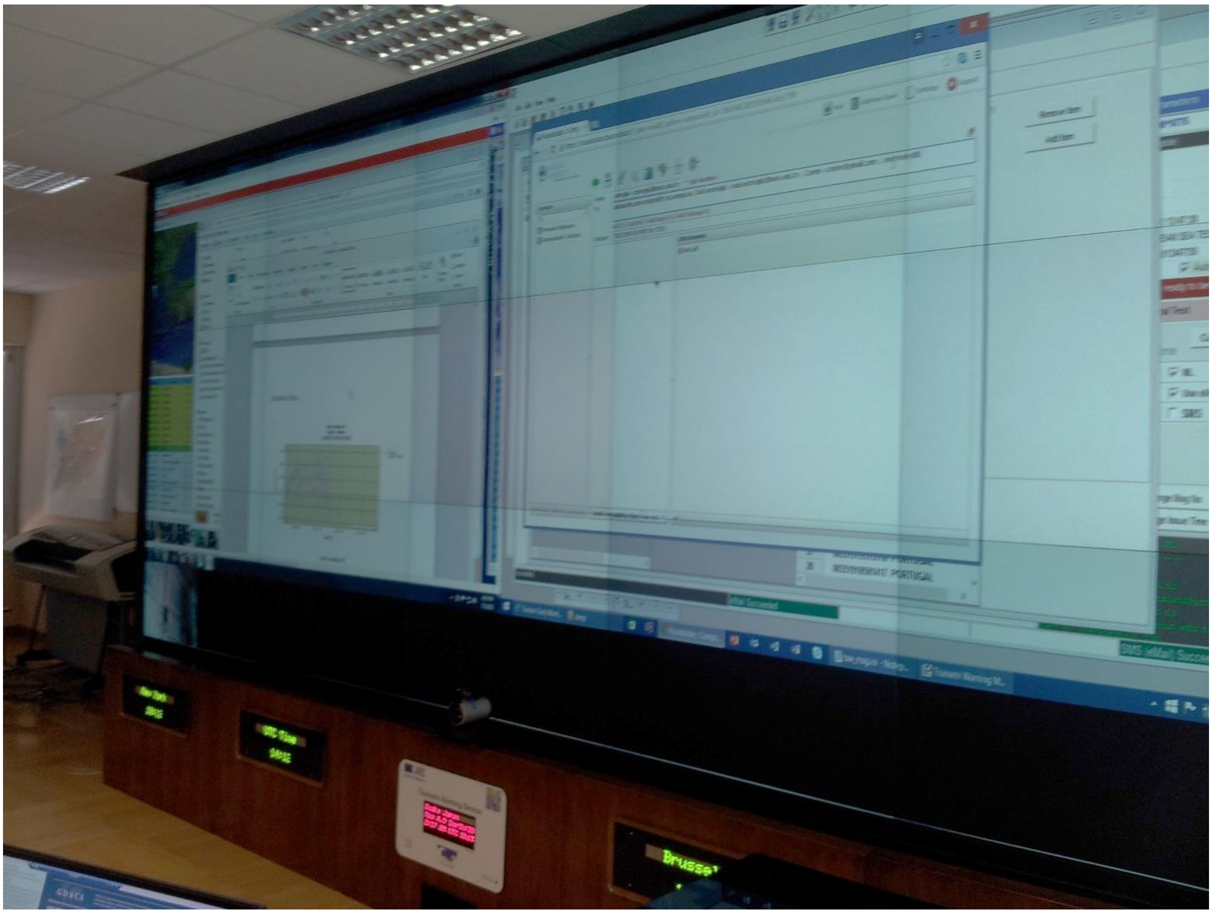

Figure 29 - ***The video wall was used to visualize both VNC connections with KOERI: left side TAT DSS and right side TsuComp. The image was taken during the creation of the reports***

5.4 Conclusions

The demonstration was very positive. Although the case was unknown to the KOERI operators both were able to identify the location, estimate the possible consequences, issue messages according to the NEAMTWS rules, understand that no Tsunami was generated, send out the cancellation message and issue an analysis report. The first message was issued within 9 min with TsuComp and 11 min with TAT.

Appendix to KOERI demonstration: TAT Messages 1 and 2

```
TSUNAMI MESSAGE NUMBER 001
NEAM  KOERI TSUNAMI SERVICE PROVIDER
```

ISSUED AT 1358Z 02 JUL 2015

THIS ALERT APPLIES TO ALL COUNTRIES AND INSTITUTIONS SUBSCRIBED TO THE SERVICES OF KOERI CTSP IN ITS MONITORING AREA.

... TSUNAMI WATCH ...
THIS ALERT APPLIES TO ALBANIA...CROATIA...CYPRUS...EGYPT...GREECE...ISRAEL...ITALY...LEBANON...LIBYA...MALTA... MONTENEGRO...PALESTINIAN AUTHORITY...SYRIA...TRNC...TUNISIA...TURKEY

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 - 1347 UTC THU JUL 2 2015
COORDINATES - 38.83 NORTH 26.27 EAST
DEPTH - 20.0 KM
LOCATION - EAST AEGEAN SEA TEST TEST TEST
MAGNITUDE - 7.7

EVALUATION OF TSUNAMI WATCH
IT IS NOT KNOWN THAT A TSUNAMI WAS GENERATED. THIS MESSAGE 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 GREATER THAN 0.5M AND/OR CAUSE A TSUNAMI RUN-UP GREATER 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.

ESTIMATED INITIAL TSUNAMI WAVE ARRIVAL TIMES AT FORECAST POINTS WITHIN THE MONITORING 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		LEVEL
ALBANIA-DURRES	41.30N	19.46E	1728Z	02 JUL	WATCH
CROATIA-DUBROVNIK	42.64N	18.10E	1731Z	02 JUL	WATCH
CROATIA-PALAGRUZA	42.39N	16.26E	1752Z	02 JUL	WATCH
CROATIA-VELA_LUKA	42.96N	16.70E	1805Z	02 JUL	WATCH
CROATIA-ZIRJE	43.63N	15.69E	1847Z	02 JUL	WATCH
CROATIA-SPLIT	43.50N	16.44E	1924Z	02 JUL	WATCH
CROATIA-VELI_RAT-(DUGI_OTO	44.15N	14.82E	1928Z	02 JUL	WATCH
CROATIA-MALI_LOSINJ	44.54N	14.43E	2020Z	02 JUL	WATCH
CROATIA-PULA	44.85N	15.82E	2127Z	02 JUL	WATCH
CROATIA-POREC	45.22N	13.58E	2145Z	02 JUL	WATCH
CROATIA-RIJEKA	45.34N	14.37E	2254Z	02 JUL	WATCH
CYPRUS-PAPHOS	34.76N	32.41E	1606Z	02 JUL	WATCH
CYPRUS-ZYGHI	34.73N	33.34E	1621Z	02 JUL	WATCH
EGYPT-ALEXANDRIA	31.27N	29.94E	1628Z	02 JUL	WATCH
EGYPT-PORT_SAID	31.31N	32.36E	1732Z	02 JUL	WATCH
GREECE-CHIOS_VOLLISOS	38.47N	25.92E	1359Z	02 JUL	WATCH
GREECE-LESVOS_SIGRI	39.21N	25.84E	1400Z	02 JUL	WATCH
GREECE-LESVOS_MITILINI	39.10N	26.57E	1401Z	02 JUL	WATCH
GREECE-KALOGEROI	38.15N	25.29E	1408Z	02 JUL	WATCH
GREECE-LESVOS_MOLIVOS	39.37N	26.17E	1414Z	02 JUL	WATCH
GREECE-SAMOS_KARLOVASI	37.80N	26.68E	1419Z	02 JUL	WATCH
GREECE-ANDROS	37.84N	24.94E	1421Z	02 JUL	WATCH
GREECE-IKARIA_AGIOS_KIRIKO	37.61N	26.30E	1421Z	02 JUL	WATCH
GREECE-MIKONOS_CHORA	37.45N	25.32E	1428Z	02 JUL	WATCH
GREECE-EVIA_KIMI	38.62N	24.13E	1430Z	02 JUL	WATCH
GREECE-TINOS	37.53N	25.16E	1432Z	02 JUL	WATCH
GREECE-SIROS_ERMOUPOLI	37.44N	24.95E	1438Z	02 JUL	WATCH
GREECE-LIMNOS_MIRINA	39.87N	25.05E	1440Z	02 JUL	WATCH
GREECE-KALIMNOS_PANORMOS	36.97N	26.93E	1446Z	02 JUL	WATCH
GREECE-SKIATHOS	39.16N	23.49E	1447Z	02 JUL	WATCH
GREECE-AMORGOS_KATAPOLA	36.83N	25.86E	1448Z	02 JUL	WATCH
GREECE-NAXOS_CHORA	37.11N	25.37E	1454Z	02 JUL	WATCH

GREECE-KOS KEFALOS	36.74N	26.98E	1458Z	02	JUL	WATCH
GREECE-SANTORINI_ORMOS FIR	36.42N	25.42E	1503Z	02	JUL	WATCH
GREECE-SAMOTHRAKI	40.48N	25.47E	1506Z	02	JUL	WATCH
GREECE-KARPATHOS_MESOCHORI	35.64N	27.10E	1510Z	02	JUL	WATCH
GREECE-MILOS_ADAMAS	36.72N	24.45E	1513Z	02	JUL	WATCH
GREECE-MONEMVASIA	36.68N	23.04E	1515Z	02	JUL	WATCH
GREECE-VOLOS	39.35N	22.95E	1518Z	02	JUL	WATCH
GREECE-RHODOS_LINDOS	36.09N	28.09E	1525Z	02	JUL	WATCH
GREECE-SITEIA	35.23N	26.11E	1525Z	02	JUL	WATCH
GREECE-KITHERA_KAPSALI	36.14N	23.00E	1526Z	02	JUL	WATCH
GREECE-AGIOS_NIKOLAOS	35.21N	25.72E	1526Z	02	JUL	WATCH
GREECE-RHODOS_TOWN	36.46N	28.21E	1528Z	02	JUL	WATCH
GREECE-RETHIMNON	35.38N	24.47E	1529Z	02	JUL	WATCH
GREECE-GITHEION	36.77N	22.57E	1536Z	02	JUL	WATCH
GREECE-IERAPETRA	35.01N	25.74E	1536Z	02	JUL	WATCH
GREECE-THASSOS	40.78N	24.71E	1537Z	02	JUL	WATCH
GREECE-KATERINI	40.26N	22.60E	1542Z	02	JUL	WATCH
GREECE-CHORA_SFAKION	35.20N	24.13E	1542Z	02	JUL	WATCH
GREECE-KASTELORIZO_MEGISTI	36.15N	29.59E	1544Z	02	JUL	WATCH
GREECE-GAVDOS_KARAVE	34.85N	24.12E	1547Z	02	JUL	WATCH
GREECE-KIPARISSIA	37.26N	21.66E	1555Z	02	JUL	WATCH
GREECE-KATAKOLO	37.64N	21.32E	1559Z	02	JUL	WATCH
GREECE-ZAKINTHOS	37.78N	20.91E	1605Z	02	JUL	WATCH
GREECE-CEPHALONNIA_ARGOSTO	38.19N	20.49E	1606Z	02	JUL	WATCH
GREECE-CHANIA	35.53N	24.02E	1606Z	02	JUL	WATCH
GREECE-KERKIRA_PELEKAS	39.59N	19.81E	1626Z	02	JUL	WATCH
GREECE-IGOUMENITSA	39.51N	20.22E	1651Z	02	JUL	WATCH
GREECE-PATRA	38.25N	21.73E	1655Z	02	JUL	WATCH
ISRAEL-HAIFA	32.80N	34.94E	1646Z	02	JUL	WATCH
ISRAEL-NAHARIYA	33.01N	35.07E	1647Z	02	JUL	WATCH
ISRAEL-HADERA	32.46N	34.87E	1649Z	02	JUL	WATCH
ISRAEL-TEL_AVIV	32.08N	34.75E	1659Z	02	JUL	WATCH
ISRAEL-ASHDOD	31.81N	34.63E	1659Z	02	JUL	WATCH
ISRAEL-ASHKELON	31.69N	34.55E	1701Z	02	JUL	WATCH
ITALY-SIDERNO	38.27N	16.30E	1633Z	02	JUL	WATCH
ITALY-CROTONE	39.08N	17.13E	1635Z	02	JUL	WATCH
ITALY-CATANZARO	38.83N	16.63E	1636Z	02	JUL	WATCH
ITALY-CATANIA	37.50N	15.09E	1639Z	02	JUL	WATCH
ITALY-SIRACUSA	37.22N	15.23E	1639Z	02	JUL	WATCH
ITALY-REGGIO_CALABRIA	38.12N	15.65E	1641Z	02	JUL	WATCH
ITALY-MESSINA	38.20N	15.56E	1643Z	02	JUL	WATCH
ITALY-POLICORO_LIDO	40.19N	16.72E	1649Z	02	JUL	WATCH
ITALY-GALLIPOLI	40.05N	17.97E	1650Z	02	JUL	WATCH
ITALY-LAGHI_DI_SIBARI	39.73N	16.52E	1650Z	02	JUL	WATCH
ITALY-OTRANTO	40.15N	18.50E	1653Z	02	JUL	WATCH
ITALY-TARANTO	40.48N	17.22E	1659Z	02	JUL	WATCH
ITALY-BRINDISI	40.66N	18.00E	1714Z	02	JUL	WATCH
ITALY-BARI	41.14N	16.87E	1734Z	02	JUL	WATCH
ITALY-GELA	37.06N	14.23E	1743Z	02	JUL	WATCH
ITALY-PORTO_EMPODECLE	37.29N	13.53E	1748Z	02	JUL	WATCH
ITALY-LAMPEDUSA	35.50N	12.60E	1749Z	02	JUL	WATCH
ITALY-BARLETTA	41.33N	16.30E	1805Z	02	JUL	WATCH
ITALY-TERMOLI	42.00N	15.01E	1854Z	02	JUL	WATCH
ITALY-ORTONA	42.36N	14.41E	1911Z	02	JUL	WATCH
ITALY-SAN_BENEDETTO_DEL_TR	42.96N	13.89E	1928Z	02	JUL	WATCH
ITALY-ANCONA	43.62N	13.51E	2012Z	02	JUL	WATCH
ITALY-CESENATICO	44.18N	12.42E	2136Z	02	JUL	WATCH
ITALY-RAVENNA	44.49N	12.28E	2154Z	02	JUL	WATCH
ITALY-CHIOGGIA	45.21N	12.30E	2224Z	02	JUL	WATCH
ITALY-TRIESTE	45.65N	13.76E	2242Z	02	JUL	WATCH
ITALY-VENEZIA	45.42N	12.43E	2248Z	02	JUL	WATCH
LEBANON-BEIRUT	33.90N	35.45E	1639Z	02	JUL	WATCH
LEBANON-SIDON	33.57N	35.36E	1641Z	02	JUL	WATCH
LEBANON-TYRE	33.29N	35.18E	1642Z	02	JUL	WATCH
LEBANON-TRIPOLI	34.47N	35.81E	1645Z	02	JUL	WATCH
LEBANON-QLAIAAT	34.58N	35.98E	1653Z	02	JUL	WATCH
LIBYA-TUBRUQ	32.08N	24.03E	1621Z	02	JUL	WATCH
LIBYA-DERNA	32.79N	22.65E	1629Z	02	JUL	WATCH
LIBYA-BENGHAZI	32.13N	20.02E	1642Z	02	JUL	WATCH
LIBYA-TRIPOLI	32.96N	13.24E	1752Z	02	JUL	WATCH
MALTA-VALLETTA	35.90N	14.53E	1714Z	02	JUL	WATCH
MONTENEGRO-BAR	42.09N	19.07E	1737Z	02	JUL	WATCH

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PALESTINIAN AUTHORITY-GAZA31.54N  34.42E  1704Z  02 JUL WATCH
SYRIA-TARTUS               34.91N  35.86E  1646Z  02 JUL WATCH
SYRIA-BANIYAS              35.19N  35.95E  1650Z  02 JUL WATCH
SYRIA-JABLEH               35.36N  35.92E  1653Z  02 JUL WATCH
SYRIA-LATAKIA              35.54N  35.75E  1654Z  02 JUL WATCH
TRNC-GIRNE_(M)             35.34N  33.33E  1616Z  02 JUL WATCH
TRNC-GAZIMAGUSA_(M)        35.12N  33.95E  1641Z  02 JUL WATCH
TUNISIA-NABEUL             36.44N  10.75E  1843Z  02 JUL WATCH
TUNISIA-TUNIS              36.88N  10.37E  1848Z  02 JUL WATCH
TUNISIA-MONASTIR           35.79N  10.86E  1853Z  02 JUL WATCH
TUNISIA-SOUSSE             35.83N  10.67E  1901Z  02 JUL WATCH
TUNISIA-GABES              33.93N  10.13E  2105Z  02 JUL WATCH
TURKEY-IZMIR_ALACATI       38.25N  26.39E  1401Z  02 JUL WATCH
TURKEY-IZMIR_ALIAGA        38.83N  26.94E  1401Z  02 JUL WATCH
TURKEY-BALIKESIR_AYVALIK   39.31N  26.69E  1423Z  02 JUL WATCH
TURKEY-IZMIR_MENTES_(M)    38.43N  26.72E  1435Z  02 JUL WATCH
TURKEY-AYDIN_KUSADASI      37.87N  27.26E  1439Z  02 JUL WATCH
TURKEY-CANAKKALE_BOZCAADA  39.84N  26.08E  1447Z  02 JUL WATCH
TURKEY-AYDIN_DIDIM         37.35N  27.28E  1505Z  02 JUL WATCH
TURKEY-CANAKKALE_GOKCEADA_40.23N  25.89E  1508Z  02 JUL WATCH
TURKEY-MUGLA_BODRUM_(M)    37.03N  27.42E  1515Z  02 JUL WATCH
TURKEY-IZMIR_ALSANCAK      38.44N  27.14E  1532Z  02 JUL WATCH
TURKEY-MUGLA_AKSAZ_(M)     36.84N  28.40E  1533Z  02 JUL WATCH
TURKEY-EDIRNE_ENEZ         40.71N  26.05E  1534Z  02 JUL WATCH
TURKEY-MUGLA_DALAMAN       36.69N  28.78E  1534Z  02 JUL WATCH
TURKEY-ANTALYA_FINIKE      36.29N  30.15E  1542Z  02 JUL WATCH
TURKEY-ANTALYA_KAS         36.20N  29.64E  1544Z  02 JUL WATCH
TURKEY-MUGLA_FETHIYE       36.66N  29.11E  1547Z  02 JUL WATCH
TURKEY-ANTALYA_(M)         36.83N  30.61E  1557Z  02 JUL WATCH
TURKEY-ANTALYA_ALANYA      36.55N  31.98E  1559Z  02 JUL WATCH
TURKEY-MERSIN_BOZYAZI_(M)  36.10N  32.94E  1613Z  02 JUL WATCH
TURKEY-MERSIN_TASUCU_(M)   36.28N  33.84E  1636Z  02 JUL WATCH
TURKEY-MERSIN_ERDEMLI_(M)  36.56N  34.26E  1643Z  02 JUL WATCH
TURKEY-ADANA_YUMURTALIK    36.77N  35.78E  1730Z  02 JUL WATCH
TURKEY-HATAY_ISKENDERUN_(M36.59N  36.18E  1737Z  02 JUL WATCH
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SUPPLEMENT MESSAGES WILL BE ISSUED AS SOON AS NEW DATA AND EVALUATION ALLOWS. THE TSUNAMI ALERT WILL REMAIN IN EFFECT UNTIL AN END OF ALERT IS BROADCAST

END OF TSUNAMI MESSAGE NUMBER 001

TSUNAMI MESSAGE NUMBER 002
NEAM KOERI TSUNAMI SERVICE PROVIDER
ISSUED AT 1406Z 02 JUL 2015

THIS ALERT APPLIES TO ALL COUNTRIES AND INSTITUTIONS SUBSCRIBED TO THE SERVICES OF KOERI CTSP IN ITS MONITORING AREA.

... TSUNAMI WATCH CANCELLATION ...
THIS ALERT APPLIES TO ALBANIA...CROATIA...CYPRUS...EGYPT...GREECE...ISRAEL...ITALY...LEBANON...LIBYA...MALTA... MONTENEGRO...PALESTINIAN AUTHORITY...SYRIA...TRNC...TUNISIA...TURKEY

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 - 1347 UTC THU JUL 2 2015
COORDINATES - 38.83 NORTH 26.27 EAST
DEPTH - 20.0 KM
LOCATION - EAST AEGEAN SEA TEST TEST TEST
MAGNITUDE - 7.7

EVALUATION OF TSUNAMI WATCH
SEA LEVEL READINGS INDICATE THAT NO TSUNAMI WAS GENERATED. THE TSUNAMI ALERT IS CANCELLED. HOWEVER, EARTHQUAKES OF THIS SIZE CAN GENERATE SMALL TSUNAMIS THAT CAUSE LOCAL

CHANGES IN CURRENTS AND RESONANCE IN HARBOURS. AUTHORITIES SHOULD BE AWARE OF THIS POSSIBILITY AND TAKE APPROPRIATE ACTION.
THIS WILL BE THE FINAL MESSAGE ISSUED FOR THIS EVENT UNLESS ADDITIONAL INFORMATION BECOMES AVAILABLE.

END OF TSUNAMI MESSAGE NUMBER 002

Appendix to KOERI demonstration: TsuComp Messages 1 and 2

TSUNAMI EXERCISE MESSAGE NUMBER 001
NEAM KOERI CANDIDATE TSUNAMI SERVICE PROVIDER
ISSUED AT 1356Z 02 JUL 2015

THIS ALERT IS ADDRESSED TO ALL COUNTRIES AND INSTITUTIONS SUBSCRIBED TO THE SERVICES OF KOERI CTSP IN ITS MONITORING AREA.

... TSUNAMI WATCH ...
THIS ALERT APPLIES TO ALBANIA ... CROATIA ... CYPRUS ... GREECE ... ISRAEL ... LEBANON ... MONTENEGRO ... PALESTINIAN AUTHORITY ... TUNISIA ... TURKEY ... TURKISH REPUBLIC OF NORTHERN CYPRUS

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 - 1347Z 02 JUL 2015
COORDINATES - 38.83 NORTH 26.27 EAST
DEPTH - 20.00 KM
LOCATION - EAST AEGEAN SEA TEST TEST TEST
MAGNITUDE - 7.7

EVALUATION OF TSUNAMI WATCH
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 GREATER THAN 0.5M AND/OR CAUSE A TSUNAMI RUN-UP GREATER 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.

ESTIMATED INITIAL TSUNAMI WAVE ARRIVAL TIMES AT FORECAST POINTS WITHIN THE MONITORING 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	LEVEL
ALBANIA - DURRES	41.3015	19.4554	1743Z 02 JUL	WATCH
CROATIA - DUBROVNIK	42.6400	18.1000	1741Z 02 JUL	WATCH
CROATIA - PALAGRUZA	42.3900	16.2600	1759Z 02 JUL	WATCH
CROATIA - VELA LUKA	42.9600	16.7000	1826Z 02 JUL	WATCH
CROATIA - ZIRJE	43.6300	15.6900	1850Z 02 JUL	WATCH
CROATIA - VELI RAT (DUGI OTOK)	44.1500	14.8200	1938Z 02 JUL	WATCH
CROATIA - SPLIT	43.5000	16.4400	1945Z 02 JUL	WATCH
CROATIA - MALI LOSINJ	44.5400	14.4300	2024Z 02 JUL	WATCH
CROATIA - POREC	45.2200	13.5800	2147Z 02 JUL	WATCH
CROATIA - PULA	44.8500	15.8200	2205Z 02 JUL	WATCH
CROATIA - RIJEKA	45.3400	14.3700	2255Z 02 JUL	WATCH
CYPRUS - PAPHOS	34.7551	32.4088	1620Z 02 JUL	WATCH
CYPRUS - ZYGHI	34.7271	33.3384	1633Z 02 JUL	WATCH
GREECE - LESVOS SIGRI	39.2080	25.8370	1407Z 02 JUL	WATCH
GREECE - CHIOS VOLLISOS	38.4660	25.9170	1411Z 02 JUL	WATCH
GREECE - KALOGEROI	38.1540	25.2870	1419Z 02 JUL	WATCH
GREECE - LESVOS MITILINI	39.1010	26.5690	1421Z 02 JUL	WATCH
GREECE - LESVOS MOLIVOS	39.3670	26.1680	1424Z 02 JUL	WATCH
GREECE - ANDROS	37.8410	24.9430	1432Z 02 JUL	WATCH
GREECE - SAMOS KARLOVASI	37.7980	26.6760	1438Z 02 JUL	WATCH
GREECE - MIKONOS CHORA	37.4470	25.3240	1441Z 02 JUL	WATCH
GREECE - IKARIA AGIOS KIRIKOS	37.6110	26.2990	1443Z 02 JUL	WATCH
GREECE - TINOS	37.5340	25.1570	1443Z 02 JUL	WATCH
GREECE - EVIA KIMI	38.6170	24.1280	1444Z 02 JUL	WATCH
GREECE - LIMNOS MIRINA	39.8710	25.0540	1446Z 02 JUL	WATCH

GREECE - SIROS ERMOUPOLI	37.4370	24.9480	1452Z	02	JUL	WATCH
GREECE - SKIATHOS	39.1600	23.4900	1458Z	02	JUL	WATCH
GREECE - KALIMNOS PANORMOS	36.9710	26.9280	1502Z	02	JUL	WATCH
GREECE - NAXOS CHORA	37.1070	25.3670	1506Z	02	JUL	WATCH
GREECE - SAMOTHRAKI	40.4770	25.4670	1510Z	02	JUL	WATCH
GREECE - KOS KEFALOS	36.7420	26.9770	1511Z	02	JUL	WATCH
GREECE - AMORGOS KATAPOLA	36.8280	25.8610	1512Z	02	JUL	WATCH
GREECE - SANTORINI ORMOS FIRON	36.4170	25.4220	1516Z	02	JUL	WATCH
GREECE - MONEMVASIA	36.6800	23.0440	1525Z	02	JUL	WATCH
GREECE - VOLOS	39.3520	22.9460	1532Z	02	JUL	WATCH
GREECE - KARPATHOS MESOCHORI	35.6350	27.0950	1532Z	02	JUL	WATCH
GREECE - THASSOS	40.7820	24.7060	1535Z	02	JUL	WATCH
GREECE - SITEIA	35.2320	26.1050	1537Z	02	JUL	WATCH
GREECE - RHODOS TOWN	36.4560	28.2140	1539Z	02	JUL	WATCH
GREECE - AGIOS NIKOLAOS	35.2070	25.7240	1540Z	02	JUL	WATCH
GREECE - RETHIMNON	35.3780	24.4720	1540Z	02	JUL	WATCH
GREECE - KITHERA KAPSALI	36.1380	22.9990	1540Z	02	JUL	WATCH
GREECE - RHODOS LINDOS	36.0870	28.0890	1540Z	02	JUL	WATCH
GREECE - CHANIA	35.5250	24.0180	1544Z	02	JUL	WATCH
GREECE - GITHEION	36.7650	22.5720	1546Z	02	JUL	WATCH
GREECE - KATERINI	40.2600	22.5990	1549Z	02	JUL	WATCH
GREECE - IERAPETRA	35.0090	25.7430	1550Z	02	JUL	WATCH
GREECE - CHORA SFAKION	35.1960	24.1320	1550Z	02	JUL	WATCH
GREECE - MILOS ADAMAS	36.7220	24.4460	1553Z	02	JUL	WATCH
GREECE - GAVDOS KARAVE	34.8460	24.1200	1556Z	02	JUL	WATCH
GREECE - KASTELORIZO MEGISTI	36.1530	29.5940	1606Z	02	JUL	WATCH
GREECE - KIPARISSIA	37.2580	21.6550	1606Z	02	JUL	WATCH
GREECE - KATAKOLO	37.6440	21.3230	1609Z	02	JUL	WATCH
GREECE - ZAKINTHOS	37.7830	20.9100	1612Z	02	JUL	WATCH
GREECE - KERKIRA PELEKAS	39.5850	19.8120	1633Z	02	JUL	WATCH
GREECE - CEPHALONNIA ARGOSTOLI	38.1930	20.4850	1638Z	02	JUL	WATCH
GREECE - IGOUMENITSA	39.5060	20.2190	1655Z	02	JUL	WATCH
GREECE - PATRA	38.2530	21.7270	1703Z	02	JUL	WATCH
ISRAEL - HAIFA	32.7972	34.9430	1659Z	02	JUL	WATCH
ISRAEL - NAHARIYA	33.0091	35.0654	1700Z	02	JUL	WATCH
ISRAEL - HADERA	32.4649	34.8705	1705Z	02	JUL	WATCH
ISRAEL - TEL AVIV	32.0810	34.7528	1712Z	02	JUL	WATCH
ISRAEL - ASHDOD	31.8129	34.6256	1716Z	02	JUL	WATCH
ISRAEL - ASHKELON	31.6922	34.5509	1719Z	02	JUL	WATCH
LEBANON - BEIRUT	33.9024	35.4498	1652Z	02	JUL	WATCH
LEBANON - TYRE	33.2857	35.1767	1655Z	02	JUL	WATCH
LEBANON - SIDON	33.5655	35.3558	1656Z	02	JUL	WATCH
LEBANON - TRIPOLI	34.4706	35.8109	1704Z	02	JUL	WATCH
LEBANON - QLAIAAT	34.5819	35.9849	1710Z	02	JUL	WATCH
MONTENEGRO - BAR	42.0889	19.0689	1747Z	02	JUL	WATCH
PALESTINIAN AUTHORITY - GAZA	31.5399	34.4204	1722Z	02	JUL	WATCH
TUNISIA - NABEUL	36.4406	10.7517	1852Z	02	JUL	WATCH
TUNISIA - TUNIS	36.8831	10.3701	1853Z	02	JUL	WATCH
TUNISIA - MONASTIR	35.7863	10.8550	1857Z	02	JUL	WATCH
TUNISIA - SOUSSE	35.8298	10.6728	1906Z	02	JUL	WATCH
TUNISIA - GABES	33.9292	10.1309	2115Z	02	JUL	WATCH
TURKEY - IZMIR ALIAGA	38.8340	26.9370	1418Z	02	JUL	WATCH
TURKEY - IZMIR ALACATI	38.2534	26.3866	1438Z	02	JUL	WATCH
TURKEY - IZMIR MENTES (M)	38.4276	26.7167	1447Z	02	JUL	WATCH
TURKEY - CANAKKALE BOZCAADA	39.8356	26.0770	1454Z	02	JUL	WATCH
TURKEY - AYDIN KUSADASI	37.8698	27.2601	1454Z	02	JUL	WATCH
TURKEY - CANAKKALE GOKCEADA (M)	40.2316	25.8938	1510Z	02	JUL	WATCH
TURKEY - AYDIN DIDIM	37.3491	27.2755	1527Z	02	JUL	WATCH
TURKEY - BALIKESIR AYVALIK	39.3145	26.6879	1529Z	02	JUL	WATCH
TURKEY - MUGLA BODRUM (M)	37.0323	27.4235	1533Z	02	JUL	WATCH
TURKEY - EDIRNE ENEZ	40.7056	26.0530	1536Z	02	JUL	WATCH
TURKEY - IZMIR ALSANCAK	38.4427	27.1430	1546Z	02	JUL	WATCH
TURKEY - MUGLA DALAMAN	36.6894	28.7791	1548Z	02	JUL	WATCH
TURKEY - MUGLA FETHIYE	36.6564	29.1104	1607Z	02	JUL	WATCH
TURKEY - ANTALYA KAS	36.1965	29.6425	1607Z	02	JUL	WATCH
TURKEY - ANTALYA (M)	36.8304	30.6087	1610Z	02	JUL	WATCH
TURKEY - MUGLA AKSAZ (M)	36.8372	28.3977	1610Z	02	JUL	WATCH
TURKEY - ANTALYA FINIKE	36.2945	30.1534	1611Z	02	JUL	WATCH
TURKEY - ANTALYA ALANYA	36.5454	31.9832	1612Z	02	JUL	WATCH
TURKEY - MERSIN BOZYAZI (M)	36.0962	32.9403	1624Z	02	JUL	WATCH
TURKEY - MERSIN TASUCU (M)	36.2815	33.8360	1655Z	02	JUL	WATCH
TURKEY - MERSIN ERDEMLI (M)	36.5634	34.2550	1656Z	02	JUL	WATCH

TURKEY - HATAY ISKENDERUN (M)	36.5933	36.1802	1751Z 02 JUL	WATCH
TURKEY - ADANA YUMURTALIK	36.9140	35.9803	1759Z 02 JUL	WATCH
TURKISH REPUBLIC OF NORTHERN CYP	35.3406	33.3338	1632Z 02 JUL	WATCH
TURKISH REPUBLIC OF NORTHERN CYP	35.1232	33.9495	1656Z 02 JUL	WATCH

SUPPLEMENT MESSAGES WILL BE ISSUED AS SOON AS NEW DATA AND EVALUATION ALLOWS. THE TSUNAMI ALERT WILL REMAIN IN EFFECT UNTIL AN END OF ALERT IS BROADCAST.

END OF TSUNAMI EXERCISE MESSAGE NUMBER 001

TSUNAMI EXERCISE MESSAGE NUMBER 002
NEAM KOERI CANDIDATE TSUNAMI SERVICE PROVIDER
ISSUED AT 1406Z 02 JUL 2015

THIS ALERT IS ADDRESSED TO ALL COUNTRIES AND INSTITUTIONS SUBSCRIBED TO THE SERVICES OF KOERI CTSP IN ITS MONITORING AREA.

... TSUNAMI WATCH CANCELLATION ...
THIS ALERT APPLIES TO ALBANIA...CROATIA...CYPRUS...GREECE...ISRAEL...LEBANON...MONTENEGRO...PALESTINIAN AUTHORITY...TUNISIA...TURKEY...TURKISH REPUBLIC OF NORTHERN CYPRUS...

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 - 1347Z 02 JUL 2015
COORDINATES - 38.83 NORTH 26.27 EAST
DEPTH - 20.00 KM
LOCATION - EAST AEGEAN SEA TEST TEST TEST
MAGNITUDE - 7.7

EVALUATION OF TSUNAMI WATCH
SEA LEVEL READINGS INDICATE THAT NO TSUNAMI WAS GENERATED. THE TSUNAMI ALERT IS CANCELLED. HOWEVER, EARTHQUAKES OF THIS SIZE CAN GENERATE SMALL TSUNAMIS THAT CAUSE LOCAL CHANGES IN CURRENTS AND RESONANCE IN HARBOURS. AUTHORITIES SHOULD BE AWARE OF THIS POSSIBILITY AND TAKE APPROPRIATE ACTION.
THIS WILL BE THE FINAL MESSAGE ISSUED FOR THIS EVENT UNLESS ADDITIONAL INFORMATION BECOMES AVAILABLE.

END OF TSUNAMI EXERCISE MESSAGE NUMBER 002

Appendix B1: KOERI Report with TAT

Lat/lon/mag: 39/26.5/7.75

Initial Conditions

This calculation has been performed using SWAN and the JRC computing system. These results are corresponding to the tsunami scenario calculated at the nearest location.

W:\Disk2\MAG_775\P0265^P0390^07
75\

Response:

Status Calc

Epicenter

Latitude:	**39.00**	
Longitude:	**26.50**	
Magnitude:	**7.75**	
Depth:	**5.00**	(km, Top of fault)
Water Depth:	**74**	(m)
Event Date:	**02 Jul 2015 13:47:30**	

Fault Geometry

Displacement:	3	(m)
Width:	34	(km)
Lenght:	136	(km)
Strike:	45	(deg - North=0)
Dip:	89	(deg)
Rake:	188	(deg)

Calculation Window

Lon Min:	-6	(deg)
Lon Min:	42.5	(deg)
Lon Min:	30	(deg)
Lon Min:	47.5	(deg)
Bathymetry:	**2**	(min)

Execution Server:

List of first 120 affected coastal Locations

The list below represents the list of the first 120 affected locations along the coasts of event region.

02 Jul 2015 13:47	Greece	Leptopodha	**0.1**	38.60	25.95
02 Jul 2015 13:47	Greece	Kardhamila	**0.1**	38.56	26.11
02 Jul 2015 14:00	Greece	Parakoila	**0.1**	39.16	26.15
02 Jul 2015 14:18	Greece	Polikhnitos	**0.1**	39.10	26.16
02 Jul 2015 13:47	Greece	Vrisa	**0.1**	39.02	26.20
02 Jul 2015 13:59	Greece	Mandamadhos	**0.1**	39.35	26.37
02 Jul 2015 13:47	Greece	Mistegna	**0.1**	39.23	26.46
02 Jul 2015 14:47	Greece	Loutra Termis	**0.2**	39.18	26.51
02 Jul 2015 14:47	Greece	Lesvos Mitilini	**0.2**	39.10	26.56
02 Jul 2015 13:58	Turkey	Kucukkuyu	**0.1**	39.55	26.60
02 Jul 2015 14:44	Greece	Kratipos	**0.1**	39.05	26.61
02 Jul 2015 13:47	Turkey	Balikesir Ayvalik	**0.1**	39.32	26.68
02 Jul 2015 14:45	Turkey	Kucukkoy	**0.2**	39.27	26.70
02 Jul 2015 14:45	Turkey	Altinova	**0.2**	39.22	26.74
02 Jul 2015 13:55	Turkey	Altinoluk	**0.1**	39.56	26.74
02 Jul 2015 13:50	Turkey	Armutova	**0.1**	39.40	26.80
02 Jul 2015 14:22	Turkey	Bademli	**0.2**	39.04	26.82
02 Jul 2015 14:23	Turkey	Dikili	**0.3**	39.07	26.88
02 Jul 2015 13:47	Turkey	Gure	**0.2**	39.58	26.90
02 Jul 2015 13:47	Turkey	Burhaniye	**0.2**	39.52	26.94
02 Jul 2015 13:47	Turkey	Akcay	**0.2**	39.57	26.95
02 Jul 2015 14:00	Greece	Kalloni	**0.1**	39.20	26.20
02 Jul 2015 13:47	Greece	Palaiokipos	**0.1**	39.07	26.47
02 Jul 2015 14:08	Turkey	Kozlu	**0.1**	39.50	26.41
02 Jul 2015 14:03	Turkey	Karaburun	**0.2**	38.67	26.46
02 Jul 2015 19:34	Greece	Melanios	**0.1**	38.55	25.84
02 Jul 2015 14:06	Turkey	Behramkale	**0.1**	39.48	26.34
02 Jul 2015 14:05	Greece	Mesotopos	**0.2**	39.10	26.00
02 Jul 2015 14:09	Greece	Aryennos	**0.1**	39.38	26.26
02 Jul 2015 14:05	Greece	Eresos	**0.1**	39.14	25.92
02 Jul 2015 14:17	Turkey	Yenifoca	**0.1**	38.75	26.84
02 Jul 2015 14:20	Turkey	Kozbeyli	**0.2**	38.74	26.90
02 Jul 2015 14:13	Turkey	Bergos	**0.1**	39.48	26.26
02 Jul 2015 14:00	Turkey	Kucukbahce	**0.1**	38.57	26.36
02 Jul 2015 14:11	Turkey	Foca	**0.2**	38.67	26.74
02 Jul 2015 14:35	Turkey	Izmir Aliaga	**0.1**	38.84	26.94
02 Jul 2015 14:39	Turkey	Kosedere	**0.1**	38.56	26.58
02 Jul 2015 14:56	Turkey	Candarli	**0.1**	38.94	26.94
02 Jul 2015 14:42	Turkey	Zeytindag	**0.2**	38.94	27.05
02 Jul 2015 14:41	Turkey	Yenisakran	**0.2**	38.88	27.06
02 Jul 2015 15:40	Turkey	Izmir Mentes (m)	**0.1**	38.44	26.72
02 Jul 2015 18:42	Turkey	Ciftlik Koyu Ciftlikkoy	**0.1**	38.30	26.27
02 Jul 2015 19:40	Turkey	Cesme	**0.1**	38.34	26.32
02 Jul 2015 18:00	Greece	Vrondadhos	**0.1**	38.41	26.14
02 Jul 2015 14:29	Turkey	Geren	**0.1**	38.61	26.85

02 Jul 2015 18:00	Greece	Khios	**0.1**	38.37	26.14
02 Jul 2015 17:54	Turkey	Balikliova	**0.1**	38.42	26.60
02 Jul 2015 15:33	Turkey	Urla	**0.1**	38.37	26.77
02 Jul 2015 14:50	Greece	Linaria	**0.1**	38.84	24.55
02 Jul 2015 14:50	Greece	Skiros	**0.1**	38.91	24.58
02 Jul 2015 18:08	Turkey	Ozbek	**0.1**	38.34	26.69
02 Jul 2015 15:34	Turkey	Guzelbahce	**0.1**	38.37	26.87
02 Jul 2015 19:02	Turkey	Asaginarlidere	**0.1**	38.40	27.00
02 Jul 2015 18:04	Turkey	Guzelcamli	**0.2**	37.72	27.23
02 Jul 2015 18:04	Turkey	Davutlar	**0.2**	37.75	27.25
02 Jul 2015 15:33	Greece	Panormos	**0.1**	37.62	25.02
02 Jul 2015 18:08	Turkey	Aydin Kusadasi	**0.2**	37.87	27.26
02 Jul 2015 19:40	Turkey	Narlica	**0.1**	38.36	26.45
02 Jul 2015 18:16	Greece	Samos	**0.1**	37.76	26.96
02 Jul 2015 18:20	Turkey	Ozdere	**0.2**	38.00	27.11
02 Jul 2015 18:22	Turkey	Gumuldur	**0.2**	38.07	26.99
02 Jul 2015 18:18	Greece	Kokkarion	**0.1**	37.78	26.89
02 Jul 2015 18:22	Turkey	Doganbey	**0.2**	38.05	26.89
02 Jul 2015 18:50	Greece	Katarraktis	**0.1**	38.26	26.10
02 Jul 2015 16:56	Greece	Skandalion	**0.1**	39.79	25.33
02 Jul 2015 19:04	Turkey	Balcova	**0.2**	38.40	27.10
02 Jul 2015 19:08	Turkey	Izmir Alsancak	**0.2**	38.45	27.15
02 Jul 2015 18:28	Greece	Neon Karlovasion	**0.1**	37.80	26.70
02 Jul 2015 18:42	Turkey	Izmir Alacati	**0.1**	38.24	26.39
02 Jul 2015 18:28	Greece	Samos_Karlovasi	**0.1**	37.80	26.68
02 Jul 2015 18:40	Turkey	Zeytineli	**0.1**	38.19	26.48
02 Jul 2015 18:24	Turkey	Seferihisar	**0.1**	38.16	26.81
02 Jul 2015 18:24	Turkey	Demirci	**0.1**	38.20	26.70
02 Jul 2015 18:32	Greece	Kallithea	**0.1**	37.75	26.58
02 Jul 2015 18:36	Greece	Marathokambos	**0.1**	37.70	26.69
02 Jul 2015 18:38	Greece	Therma	**0.1**	37.69	26.31
02 Jul 2015 18:44	Greece	Pyrjion	**0.1**	38.18	26.03
02 Jul 2015 18:30	Greece	Evdilos	**0.1**	37.64	26.16
02 Jul 2015 19:40	Turkey	Alacati	**0.1**	38.31	26.37
02 Jul 2015 19:04	Greece	Mesta	**0.1**	38.30	25.93
02 Jul 2015 19:36	Greece	Sidherounda	**0.1**	38.43	25.95
02 Jul 2015 19:34	Greece	Anavatos	**0.1**	38.38	25.99
02 Jul 2015 19:20	Greece	Kalogeroi	**0.1**	38.15	25.29
02 Jul 2015 15:34	Turkey	Tuzculu	**0.1**	38.54	26.89
02 Jul 2015 19:36	Greece	Chios_Vollisos	**0.1**	38.47	25.92
02 Jul 2015 19:36	Greece	Volissos	**0.1**	38.47	25.92
02 Jul 2015 19:16	Greece	Psara	**0.1**	38.55	25.55

Images

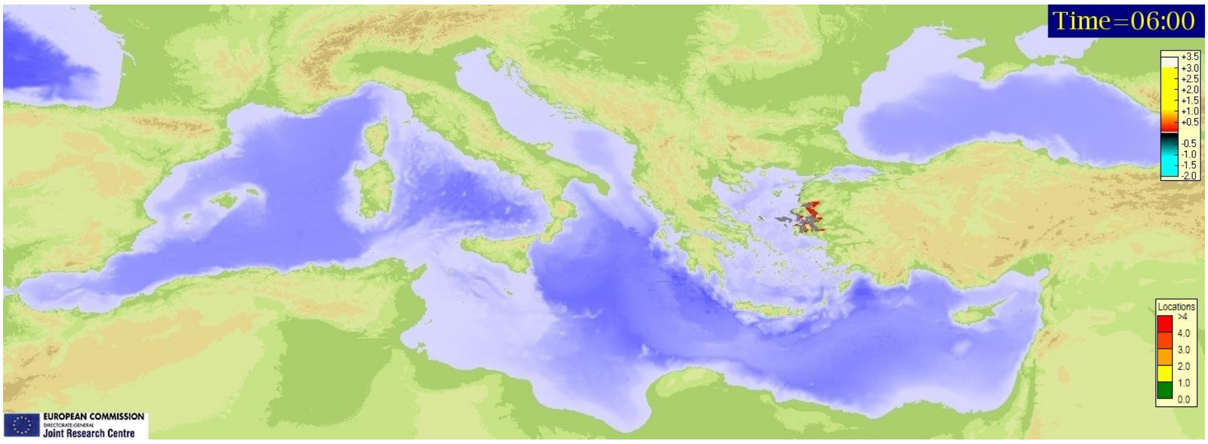


Fig. 1 - Distribution of Maximum Height

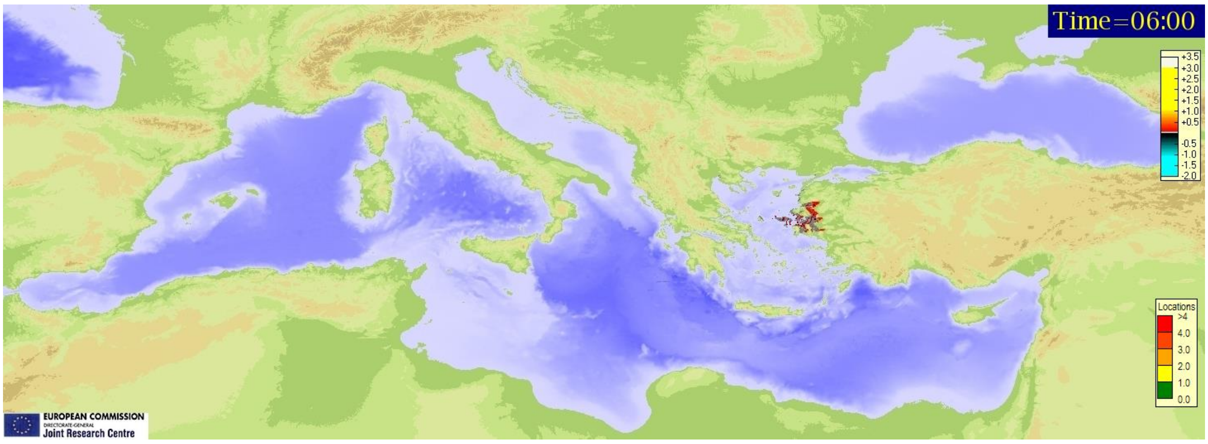


Fig. 2 - Travel Time calculated by wave propagation

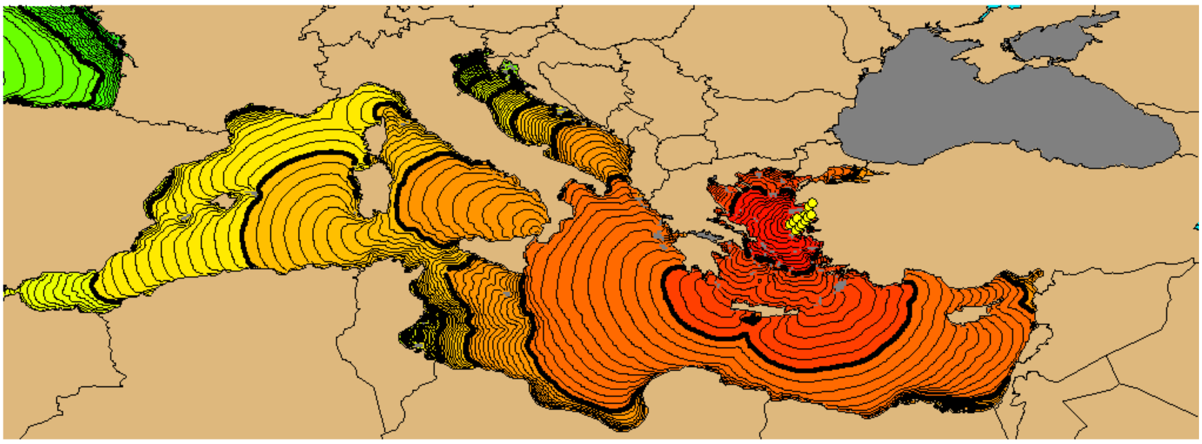
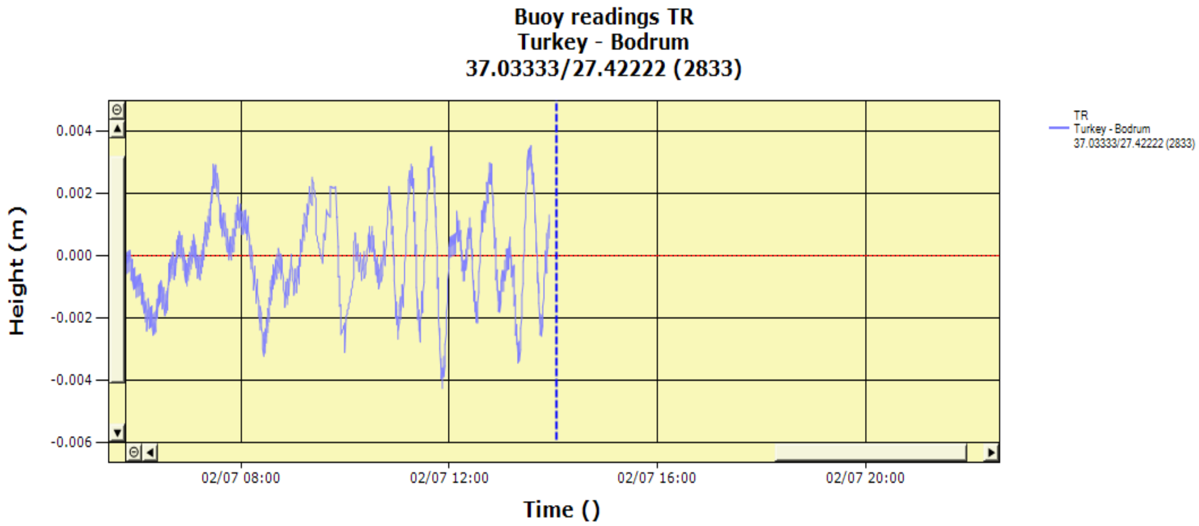


Fig 3 – Tsunami Travel Time calculated by TTT

Situation Plots



Buoy readings TR
Turkey - Bodrum
37.03333/27.42222 (2833)

Appendix B2: KOERI Report with TsuComp

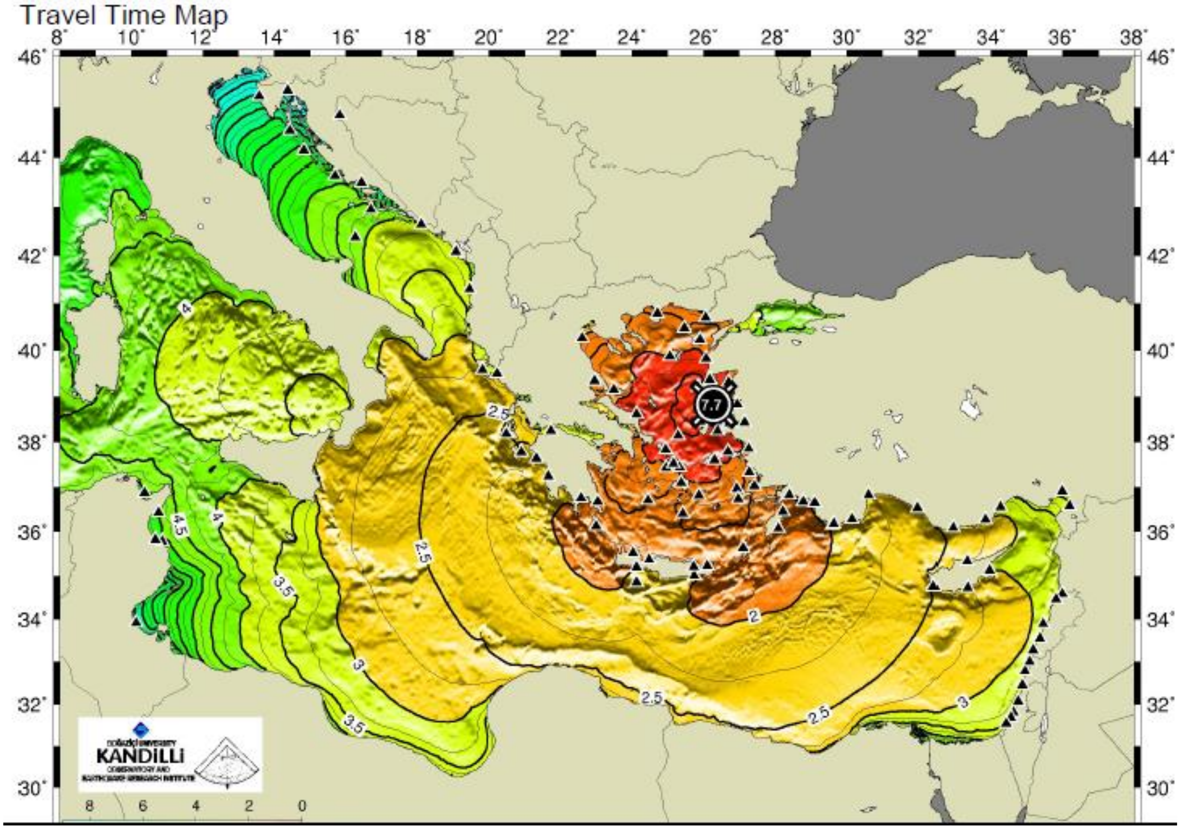
2015.07.02 13:47:30 EAST AEGEAN SEA TEST TEST TEST (Lat/Lon/Mag: 38.83/26.27/7.7)

Model Information

Parameter	Value
Latitude (deg)	39.00
Longitude (deg)	26.50
Depth (km)	5
Magnitude	7.75
Width (km)	33.92
Lenght (km)	135.68
Height (km)	2.57
Strike (deg)	45
Dip (deg)	89
Rake (deg)	188

Maximum Heights Map

Travel Time Map



Locations (max height >= 0.3 m)

country	place	MaxHei	ArrTime	tMaxHei	lon	lat
Greece	Leptopodha	0.12	00:00	00:00	25.954170	38.595833
Greece	Kardhamila	0.10	00:00	00:00	26.112503	38.562500
Greece	Parakoila	0.07	00:00	00:13	26.154167	39.162498
Greece	Polikhnitos	0.07	00:00	00:31	26.162502	39.104164
Greece	Vrisa	0.11	00:00	00:00	26.204170	39.020832
Greece	Plomarion	0.05	00:00	06:00	26.362503	38.970833
Greece	Mandamadhos	0.11	00:00	00:12	26.370834	39.345833
Greece	Mistegna	0.12	00:00	00:00	26.462502	39.229164
Greece	Loutra Termis	0.21	00:00	01:00	26.512501	39.179165
Greece	Lesvos Mitilini	0.21	00:00	01:00	26.562500	39.104164
Turkey	Kucukkuyu	0.11	00:00	00:11	26.595837	39.545834
Greece	Kratipos	0.12	00:00	00:57	26.612503	39.045834
Turkey	Balikesir Ayvalik	0.12	00:00	00:00	26.679169	39.320831
Turkey	Kucukkoy	0.15	00:00	00:58	26.695835	39.270832
Turkey	Altinova	0.15	00:00	00:58	26.737503	39.220833
Turkey	Altinoluk	0.13	00:00	00:08	26.737503	39.562500
Turkey	Armutova	0.14	00:00	00:03	26.804169	39.395832
Turkey	Bademli	0.23	00:00	00:35	26.820835	39.037498
Turkey	Dikili	0.26	00:00	00:36	26.879169	39.070831
Turkey	Gure	0.21	00:00	00:00	26.895836	39.579166
Turkey	Burhaniye	0.21	00:00	00:00	26.937504	39.520832
Turkey	Akcay	0.21	00:00	00:00	26.945835	39.570831
Greece	Kalloni	0.07	00:00	00:13	26.204170	39.204166
Greece	Palaiokipos	0.06	00:00	00:00	26.470837	39.070831
Turkey	Kozlu	0.10	00:03	00:21	26.412502	39.504166
Turkey	Karaburun	0.20	00:04	00:16	26.462502	38.670834
Greece	Melanios	0.08	00:04	05:47	25.837502	38.554165
Turkey	Behramkale	0.09	00:05	00:19	26.337502	39.479164
Greece	Mesotopos	0.19	00:09	00:18	25.995834	39.104164
Greece	Aryennos	0.07	00:10	00:22	26.262501	39.379166
Greece	Eresos	0.09	00:11	00:18	25.920834	39.137501
Turkey	Yenifoca	0.14	00:11	00:30	26.837502	38.754166
Turkey	Kozbeyli	0.19	00:11	00:33	26.895836	38.737499
Turkey	Bergos	0.07	00:12	00:26	26.262501	39.479164
Turkey	Kucukbahce	0.10	00:12	00:13	26.362503	38.570831
Turkey	Foca	0.21	00:12	00:24	26.737503	38.670834
Turkey	Izmir Aliaga	0.13	00:12	00:48	26.937504	38.837502
Turkey	Kosedere	0.10	00:15	00:52	26.579170	38.562500
Greece	Lesvos Sigri	0.05	00:15	06:00	25.845837	39.204166
Turkey	Candarli	0.11	00:16	01:09	26.937504	38.937500
Turkey	Zeytindag	0.17	00:21	00:55	27.045834	38.937500
Turkey	Yenisakran	0.20	00:22	00:54	27.062504	38.879166
Greece	Lesvos Molivos	0.05	00:24	00:26	26.167999	39.367001
Greece	Mithymna	0.05	00:24	00:26	26.187500	39.379166
Turkey	Izmir Mentes (m)	0.09	00:29	01:53	26.720837	38.437500
Turkey	Ciftlik Koyu Ciftlikkoy	0.13	00:29	04:55	26.270836	38.295834
Turkey	Cesme	0.08	00:29	05:53	26.320835	38.337502
Greece	Vrondadhos	0.06	00:35	04:13	26.137501	38.412498
Turkey	Geren	0.12	00:37	00:42	26.854168	38.612499
Greece	Khios	0.06	00:37	04:13	26.137501	38.370834

country	place	MaxHei	ArrTime	tMaxHei	lon	lat
Turkey	Balikliova	0.08	00:39	04:07	26.604168	38.420834
Turkey	Urla	0.09	00:40	01:46	26.770836	38.370834
Greece	Linaria	0.05	00:41	02:19	24.529167	38.845833
Greece	Linaria	0.08	00:41	01:03	24.545834	38.837502
Greece	Skiros	0.08	00:41	01:03	24.579170	38.912498
Turkey	Ozbek	0.12	00:43	04:21	26.687504	38.337502
Turkey	Guzelbahce	0.06	00:43	01:47	26.870834	38.370834
Turkey	Asaginarlidere	0.13	00:50	05:15	27.004169	38.404167
Greece	Evia Kimi	0.05	01:37	01:38	24.129169	38.620834
Turkey	Guzelcamli	0.20	01:41	04:17	27.229168	37.720833
Turkey	Davutlar	0.19	01:43	04:17	27.254169	37.754166
Greece	Panormos	0.07	01:44	01:46	25.020836	37.620834
Turkey	Aydin Kusadasi	0.19	01:45	04:21	27.262501	37.870834
Turkey	Narlica	0.07	01:49	05:53	26.454170	38.362499
Greece	Samos	0.14	01:51	04:29	26.962502	37.762501
Turkey	Ozdere	0.19	01:54	04:33	27.112503	38.004166
Turkey	Gumuldur	0.16	01:56	04:35	26.987503	38.070831
Greece	Kokkarion	0.13	02:00	04:31	26.887501	37.779167
Turkey	Doganbey	0.15	02:00	04:35	26.887501	38.045834
Greece	Katarraktis	0.12	02:03	05:03	26.104168	38.262501
Greece	Skandalion	0.06	02:04	03:09	25.329170	39.787498
Turkey	Balcova	0.15	02:05	05:17	27.095837	38.404167
Turkey	Izmir Alsancak	0.15	02:05	05:21	27.145836	38.445831
Greece	Neon Karlovasion	0.12	02:06	04:41	26.695835	37.795834
Turkey	Izmir Alacati	0.13	02:09	04:55	26.387501	38.237499
Greece	Samos Karlovasi	0.12	02:10	04:41	26.676001	37.798000
Turkey	Zeytineli	0.13	02:10	04:53	26.479168	38.187500
Turkey	Seferihisar	0.14	02:11	04:37	26.812504	38.162498
Turkey	Demirci	0.14	02:12	04:37	26.704170	38.204166
Greece	Kallithea	0.11	02:24	04:45	26.579170	37.745834
Greece	Marathokambos	0.11	02:25	04:49	26.687504	37.704166
Greece	Therma	0.12	02:27	04:51	26.312500	37.687500
Greece	Pyrjion	0.11	02:34	04:57	26.029167	38.179165
Greece	Evdilos	0.09	02:41	04:43	26.162502	37.637501
Turkey	Alacati	0.08	03:43	05:53	26.370834	38.312500
Greece	Mesta	0.08	04:07	05:17	25.929169	38.295834
Greece	Sidherounda	0.08	04:21	05:49	25.954170	38.429165
Greece	Anavatos	0.08	04:21	05:47	25.987503	38.379166
Greece	Kalogeroi	0.07	04:23	05:33	25.287001	38.153999
Greece	Peraia	0.05	04:31	04:35	22.929169	40.512501
Greece	Thessaloniki	0.05	04:31	04:35	22.945835	40.620834
Turkey	Tuzculu	0.06	04:33	01:47	26.887501	38.537498
Greece	Ayia Trias	0.05	04:35	04:35	22.845837	40.512501
Greece	Chios Vollisos	0.08	04:37	05:49	25.917000	38.466000
Greece	Volissos	0.08	04:37	05:49	25.920834	38.470833
Greece	Psara	0.07	04:37	05:29	25.554169	38.554165
Turkey	Bozyani	0.06	01:33	05:27	32.987503	36.095833
Cyprus	Akrotiri	0.06	01:34	05:21	32.979168	34.562500
Libya	Bardiyah	0.09	01:36	02:56	25.087502	31.779167
Libya	Qaryat Maqrun	0.07	01:43	05:35	23.837502	32.137497
Israel	Ashdod	0.06	01:45	04:51	34.629169	31.804165
Israel	Netanya	0.07	01:45	04:47	34.845837	32.337502

... other 7 pages of locations ... until this page

country	place	MaxHei	ArrTime	tMaxHei	lon	lat
Italy	Marina di Nicotera	0.05	04:37	04:37	15.929169	38.545834
Italy	Salve	0.05	04:41	05:25	18.279169	39.829166
Italy	Leuca	0.05	04:41	05:25	18.354168	39.795834
Italy	San Gregorio	0.05	04:43	05:21	15.654167	38.054165
Greece	Merichas	0.06	04:49	04:49	24.387501	37.387501
Greece	Loutra	0.06	04:49	04:49	24.429169	37.445831
Greece	Dhriopis	0.06	04:49	04:49	24.454170	37.379166
Greece	Panormos	0.07	04:49	04:53	25.020836	37.620834
Libya	Qaryat az Zurayqi	0.06	04:51	05:09	14.895834	32.445831
Italy	Marina di Strongoli	0.05	04:53	05:03	17.112501	39.245834
Italy	Fasana	0.05	04:53	05:03	17.120834	39.237499
Greece	Ormos Panormos	0.07	04:53	04:53	25.087502	37.654167
Greece	Asos	0.05	04:55	04:55	20.537502	38.370834
Greece	Fiskardhon	0.05	04:55	04:55	20.537502	38.462502
Greece	Tinos	0.06	04:55	04:55	25.154167	37.537498
Greece	Ano Chorion	0.05	04:57	05:01	19.504168	39.779167
Greece	Palaiokastritsa	0.05	04:57	04:57	19.695835	39.670834
Greece	Levkas	0.06	04:57	05:53	20.695835	38.837502
Greece	Preveza	0.06	04:57	05:53	20.754168	38.954166
Greece	Serifos	0.05	05:01	05:01	24.479168	37.120834
Italy	Torre Melissa	0.05	05:03	05:03	17.112501	39.304165
Italy	Ciro Marina	0.05	05:03	05:03	17.129168	39.362499
Greece	Nissakion	0.08	05:05	05:47	19.945835	39.754166
Albania	Butrint	0.08	05:05	05:47	19.995834	39.737499
Libya	Bani Hasan	0.06	05:11	05:43	14.129168	32.720833
Italy	Montegiordano Marina	0.05	05:17	05:19	16.604168	40.037498
Italy	Rocca Imperiale	0.05	05:17	05:19	16.612501	40.087502
Italy	San Pietro	0.05	05:17	05:19	16.662502	40.129166
Italy	San Pietro	0.06	05:19	05:21	17.670835	40.304165
Italy	Specchiarica	0.06	05:19	05:21	17.712502	40.304165
Italy	Torre Colimena	0.06	05:19	05:21	17.745834	40.295834
Libya	Al Hanshir	0.06	05:23	05:23	13.245834	32.912498
Libya	Bu al Ashhar	0.06	05:23	05:23	13.320835	32.895832
Libya	Ed Dachla	0.06	05:23	05:23	13.395834	32.895832
Italy	Otranto	0.05	05:29	05:29	18.487501	40.154167
Italy	Taranto	0.05	05:31	05:31	17.237501	40.462502
Italy	Talsano	0.05	05:31	05:31	17.270834	40.387501
Libya	Abyar as Sababil	0.05	05:33	05:41	13.454168	32.854164
Greece	Kastrosikia	0.06	05:33	05:39	20.620834	39.104164
Greece	Arkhangelos	0.06	05:33	05:39	20.679169	39.070831
Albania	Sarande	0.09	05:37	05:41	20.004168	39.870834
Greece	Gavrion	0.05	05:37	05:55	24.737503	37.879166
Greece	Kalivarion	0.05	05:41	05:55	24.737503	37.987499
Turkey	Izmir Alacati	0.05	05:51	05:53	26.387501	38.237499
Greece	Katarraktis	0.05	05:53	05:53	26.104168	38.262501
Turkey	Ciftlik Koyu Ciftlikkoy	0.05	05:53	05:53	26.270836	38.295834

5.5 NOA Demonstration (Started at 14:24 UTC)

NOA demonstration was performed using the JRC software **TAT**, currently the official Decision Support Tool for NOA. The demonstration was performed using an exact copy of the folder present at NOA, replicated at JRC.

Two cases were ready for NOA; the one that was chosen was the following:

Date of the event: 2 July 2015 14:24 UTC
Location: South of Crete
Lat/Lon: 34.8038/27.0027
Magnitude: 7.8 Mw
Depth: 25 km

TAT was setup in order to scrape a feed, located at JRC, that was activated exactly at the time of the event. TAT correctly scraped the event at 14:26:30 (+2min) as a visiting source feed interval is 5 min.

The time of scraping depends on the frequency of scraping of the case; in the case of TAT this time interval was set at 5 min but it is also possible to force the scraping on request of the operation (should he know that an important event is going on).

A first report was produced with TAT at 14:28 (+4 min):

Date	**Event**	**Time difference**
02 Jul 2015 14:24	Mw 7.8 South of Crete	-
02 Jul 2015 14:28	First Message by TAT	+ 4 min
02 Jul 2015 14:43	Cancellation Message by TAT	+ 19 min
02 Jul 2015 14:49	End of creation of TAT Report	+ 23 min

Table 1 – List of events

Note: The dissemination time of the cancellation message was limited due to the restricted time available for the demonstration. Otherwise, in real operation, more time is needed in order to cancel an alert

The grid case that was selected is

…Disk2\MAG_775\P0270^P0350^0775\

Corresponding to a magnitude 7.75 Mw, Latitude 35 and longitude 27, i.e. the closest point to the JRC scenario matrix 2.0.

As the case was analysed using the UNESCO NEATMWS Decision matrix, that for Magnitude larger than 7 consider a Tsunami Watch for the whole Basin, including Spain, France and UK (for Gibraltar).

Countries included in TAT message using the Decision Matrix from UNESCO:

```
... TSUNAMI WATCH ...
```

```
THIS                         ALERT                          APPLIES                          TO
CROATIA...FRANCE...GREECE...ISRAEL...ITALY...MONACO...SPAIN...SYRIA...TURKEY...UNITED
KINGDOM

... TSUNAMI INFORMATION ...
THIS ALERT APPLIES TO BELGIUM ... EGYPT ... FRANCE ... GERMANY ... GREECE ...
ISRAEL ... ITALY ... LEBANON ... PORTUGAL ...
```

NOA however also demonstrated how the bulletin would have been composed if the Modelling option would have been selected: TAT relies on TTT for travel time estimation and to the JRC scenario for comparing the measurements and understand when and how much should the height be. The scenario can be used as basis for the creation of the bulletin by activating a flag; when this flag is activated. In this case only Greece is in Watch, Turkey in Advisory and all the other countries in Information mode (*Figure 30*).

TAT could make use of the new codes and technology available for fast and on-the-fly simulation of events. In this way, scenario databases, which are limited to specific parameters and are very large in size, could be used only in selected, special cases.

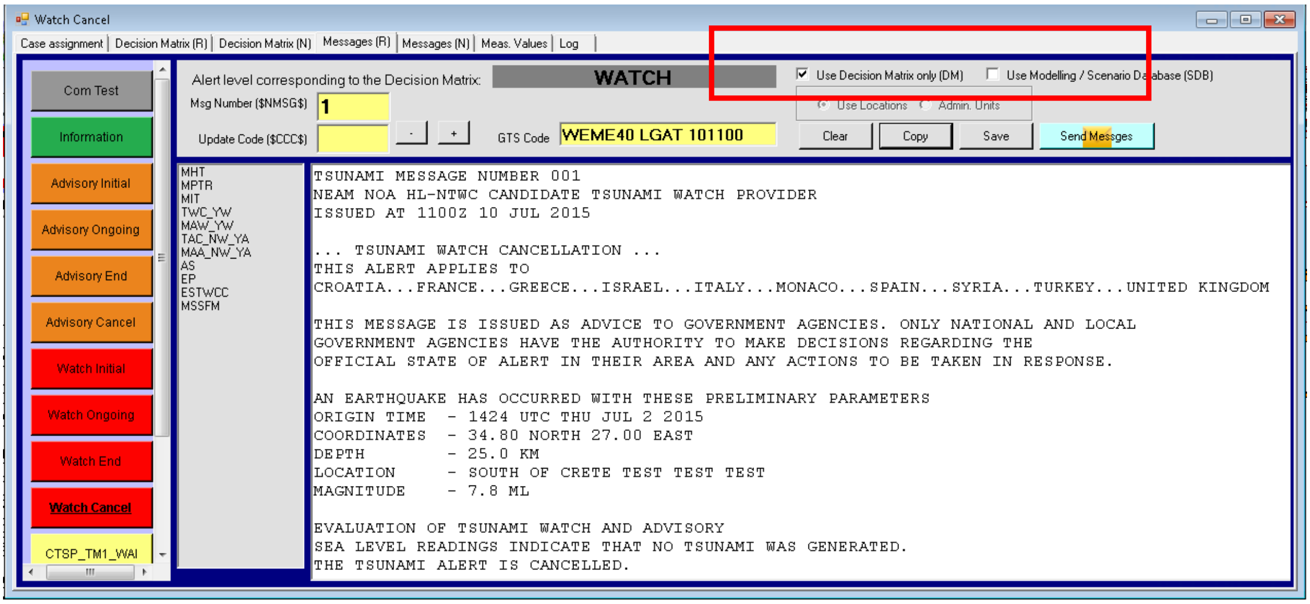


Figure 30 - In the figure the option flag to indicate the use of *Decision Matrix* or *Modelling*

Countries included in TAT message using modelling results:

```
... TSUNAMI WATCH ...
THIS ALERT APPLIES TO GREECE

... TSUNAMI ADVISORY ...
THIS ALERT APPLIES TO TURKEY

... TSUNAMI INFORMATION ...
THIS ALERT APPLIES TO BELGIUM ... EGYPT ... FRANCE ... GERMANY ... GREECE ...
ISRAEL ... ITALY ... LEBANON ... PORTUGAL ... SPAIN ... SWEDEN ... TURKEY ...
IOC (UNESCO) .... ERCC (EUROPEAN COMMISSION)
```

A report in Word was created.

No problem has been found during the analysis of the event. The operator completed all the requested operations and also created a summary report that could be further analysed and completed at a later stage.

5.5.1 Conclusions

The demonstration was very positive. Although the case was unknown to the NOA operators they were able to identify the location, estimate the possible consequences, issue messages according to the NEAMTWS rules, understand that no Tsunami was generated, send out the cancellation message and issue an analysis report. The first message was issued within 4 min from the event notification.

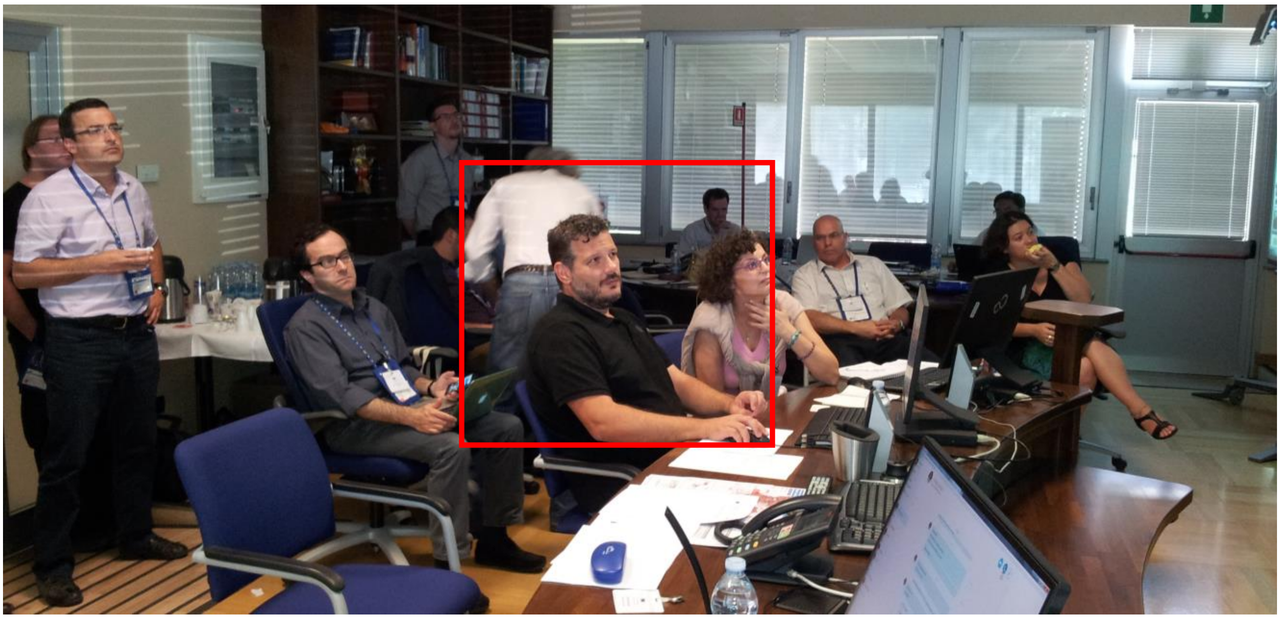


Figure 31 - *M. Charalampakis and K. Liadopoulou at work for the analysis of the event*

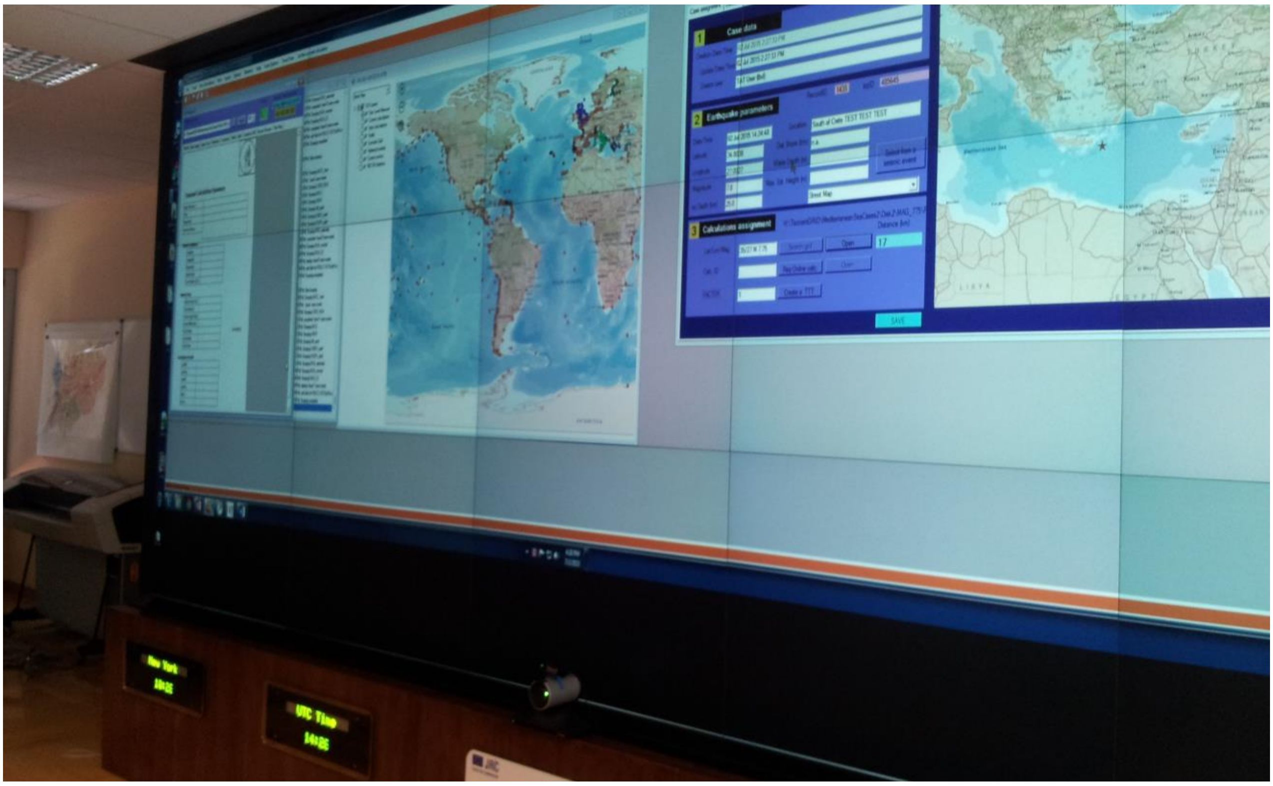


Figure 32 - *The video wall was used to visualize the activities on the TAT (NOA event).*

5.5.2 Appendix to NOA demonstration: TAT Messages 1 and 2

```
TSUNAMI MESSAGE NUMBER 001
NEAM NOA HL-NTWC CANDIDATE TSUNAMI WATCH PROVIDER
ISSUED AT 1428Z 2 JUL 2015

... TSUNAMI WATCH ...
THIS                        ALERT                         APPLIES                        TO
CROATIA...FRANCE...GREECE...ISRAEL...ITALY...MONACO...SPAIN...SYRIA...TURKEY...UNITED
KINGDOM

... TSUNAMI INFORMATION ...
THIS ALERT APPLIES TO BELGIUM ... EGYPT ... FRANCE ... GERMANY ... GREECE ...
ISRAEL ... ITALY ... LEBANON ... PORTUGAL ... SPAIN ... SWEDEN ... TURKEY ...
IOC (UNESCO) .... ERCC (EUROPEAN COMMISSION)

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   - 1424 UTC THU JUL 2 2015
COORDINATES   - 34.80 NORTH 27.00 EAST
DEPTH         - 25.0 KM
LOCATION      - SOUTH OF CRETE TEST TEST TEST
MAGNITUDE     - 7.8 ML

EVALUATION OF TSUNAMI WATCH
IT IS NOT KNOWN THAT A TSUNAMI WAS GENERATED. THIS MESSAGE 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 GREATER THAN 0.5M
AND/OR CAUSE A TSUNAMI RUN-UP GREATER 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.

ESTIMATED INITIAL TSUNAMI WAVE ARRIVAL TIMES AT FORECAST POINTS WITHIN THE
WATCH/ADVISORY AREA 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                  FP COORDINATES  ARRIVAL TIME  ALERT LEVEL
--------------------      --------------  ------------- -----------
CROATIA-DUBROVNIK         42.64N  18.10E  1709Z  02 JUL WATCH
CROATIA-PALAGRUZA         42.39N  16.26E  1730Z  02 JUL WATCH
CROATIA-VELA LUKA         42.96N  16.70E  1742Z  02 JUL WATCH
CROATIA-ZIRJE             43.63N  15.69E  1824Z  02 JUL WATCH
CROATIA-SPLIT             43.50N  16.44E  1902Z  02 JUL WATCH
CROATIA-VELI RAT (DUGI OTO44.15N  14.82E  1906Z  02 JUL WATCH
CROATIA-MALI LOSINJ       44.54N  14.43E  1957Z  02 JUL WATCH
CROATIA-PULA              44.85N  15.82E  2104Z  02 JUL WATCH
CROATIA-POREC             45.22N  13.58E  2122Z  02 JUL WATCH
CROATIA-RIJEKA            45.34N  14.37E  2231Z  02 JUL WATCH
FRANCE-BASTIA             42.70N  9.45E   1804Z  02 JUL WATCH
FRANCE-SOLENZARA          42.83N  9.40E   1808Z  02 JUL WATCH
FRANCE-L'ILE ROUSSE       42.64N  8.93E   1833Z  02 JUL WATCH
FRANCE-AJACCIO            41.93N  8.78E   1835Z  02 JUL WATCH
FRANCE-NICE               43.70N  7.27E   1841Z  02 JUL WATCH
FRANCE-CANNES             43.55N  7.03E   1843Z  02 JUL WATCH
FRANCE-TOULONE            43.11N  5.97E   1846Z  02 JUL WATCH
FRANCE-MARSEILLE          43.31N  5.38E   1903Z  02 JUL WATCH
FRANCE-PORT VENDRE        42.52N  3.11E   1904Z  02 JUL WATCH
FRANCE-SETE               43.40N  3.69E   1937Z  02 JUL WATCH
GREECE-KARPATHOS_MESOCHORI35.64N  27.10E  1434Z  02 JUL WATCH
GREECE-IERAPETRA          35.01N  25.74E  1440Z  02 JUL WATCH
```

GREECE-RHODOS_LINDOS	36.09N	28.09E	1445Z	02	JUL	WATCH
GREECE-SITEIA	35.23N	26.11E	1446Z	02	JUL	WATCH
GREECE-AGIOS_NIKOLAOS	35.21N	25.72E	1449Z	02	JUL	WATCH
GREECE-RHODOS_TOWN	36.46N	28.21E	1451Z	02	JUL	WATCH
GREECE-SANTORINI_ORMOS_FIR	36.42N	25.42E	1455Z	02	JUL	WATCH
GREECE-KOS_KEFALOS	36.74N	26.98E	1455Z	02	JUL	WATCH
GREECE-GAVDOS_KARAVE	34.85N	24.12E	1456Z	02	JUL	WATCH
GREECE-CHORA_SFAKION	35.20N	24.13E	1457Z	02	JUL	WATCH
GREECE-KASTELORIZO_MEGISTI	36.15N	29.59E	1500Z	02	JUL	WATCH
GREECE-KALIMNOS_PANORMOS	36.97N	26.93E	1502Z	02	JUL	WATCH
GREECE-AMORGOS_KATAPOLA	36.83N	25.86E	1503Z	02	JUL	WATCH
GREECE-RETHIMNON	35.38N	24.47E	1506Z	02	JUL	WATCH
GREECE-MILOS_ADAMAS	36.72N	24.45E	1512Z	02	JUL	WATCH
GREECE-KITHERA_KAPSALI	36.14N	23.00E	1517Z	02	JUL	WATCH
GREECE-IKARIA_AGIOS_KIRIKO	37.61N	26.30E	1524Z	02	JUL	WATCH
GREECE-GITHEION	36.77N	22.57E	1525Z	02	JUL	WATCH
GREECE-MONEMVASIA	36.68N	23.04E	1525Z	02	JUL	WATCH
GREECE-KIPARISSIA	37.26N	21.66E	1533Z	02	JUL	WATCH
GREECE-SAMOS_KARLOVASI	37.80N	26.68E	1533Z	02	JUL	WATCH
GREECE-KATAKOLO	37.64N	21.32E	1536Z	02	JUL	WATCH
GREECE-MIKONOS_CHORA	37.45N	25.32E	1540Z	02	JUL	WATCH
GREECE-SIROS_ERMOUPOLI	37.44N	24.95E	1541Z	02	JUL	WATCH
GREECE-KALOGEROI	38.15N	25.29E	1542Z	02	JUL	WATCH
GREECE-ZAKINTHOS	37.78N	20.91E	1543Z	02	JUL	WATCH
GREECE-CEPHALONNIA_ARGOSTO	38.19N	20.49E	1543Z	02	JUL	WATCH
GREECE-TINOS	37.53N	25.16E	1545Z	02	JUL	WATCH
GREECE-ANDROS	37.84N	24.94E	1545Z	02	JUL	WATCH
GREECE-CHANIA	35.53N	24.02E	1547Z	02	JUL	WATCH
GREECE-CHIOS_VOLLISOS	38.47N	25.92E	1549Z	02	JUL	WATCH
GREECE-NAXOS_CHORA	37.11N	25.37E	1550Z	02	JUL	WATCH
GREECE-KERKIRA_PELEKAS	39.59N	19.81E	1603Z	02	JUL	WATCH
GREECE-EVIA_KIMI	38.62N	24.13E	1612Z	02	JUL	WATCH
GREECE-LESVOS_SIGRI	39.21N	25.84E	1613Z	02	JUL	WATCH
GREECE-IGOUMENITSA	39.51N	20.22E	1628Z	02	JUL	WATCH
GREECE-SKIATHOS	39.16N	23.49E	1629Z	02	JUL	WATCH
GREECE-PATRA	38.25N	21.73E	1633Z	02	JUL	WATCH
GREECE-LESVOS_MOLIVOS	39.37N	26.17E	1634Z	02	JUL	WATCH
GREECE-LESVOS_MITILINI	39.10N	26.57E	1635Z	02	JUL	WATCH
GREECE-LIMNOS_MIRINA	39.87N	25.05E	1637Z	02	JUL	WATCH
GREECE-SAMOTHRAKI	40.48N	25.47E	1656Z	02	JUL	WATCH
GREECE-VOLOS	39.35N	22.95E	1700Z	02	JUL	WATCH
GREECE-THASSOS	40.78N	24.71E	1727Z	02	JUL	WATCH
GREECE-KATERINI	40.26N	22.60E	1729Z	02	JUL	WATCH
ISRAEL-HAIFA	32.80N	34.94E	1552Z	02	JUL	WATCH
ISRAEL-HADERA	32.46N	34.87E	1553Z	02	JUL	WATCH
ISRAEL-NAHARIYA	33.01N	35.07E	1554Z	02	JUL	WATCH
ISRAEL-TEL AVIV	32.08N	34.75E	1603Z	02	JUL	WATCH
ISRAEL-ASHDOD	31.81N	34.63E	1603Z	02	JUL	WATCH
ISRAEL-ASHKELON	31.69N	34.55E	1605Z	02	JUL	WATCH
ITALY-SIDERNO	38.27N	16.30E	1610Z	02	JUL	WATCH
ITALY-CROTONE	39.08N	17.13E	1613Z	02	JUL	WATCH
ITALY-CATANZARO	38.83N	16.63E	1613Z	02	JUL	WATCH
ITALY-SIRACUSA	37.22N	15.23E	1615Z	02	JUL	WATCH
ITALY-CATANIA	37.50N	15.09E	1615Z	02	JUL	WATCH
ITALY-REGGIO CALABRIA	38.12N	15.65E	1617Z	02	JUL	WATCH
ITALY-MESSINA	38.20N	15.56E	1620Z	02	JUL	WATCH
ITALY-POLICORO LIDO	40.19N	16.72E	1626Z	02	JUL	WATCH
ITALY-GALLIPOLI	40.05N	17.97E	1627Z	02	JUL	WATCH
ITALY-LAGHI DI SIBARI	39.73N	16.52E	1627Z	02	JUL	WATCH
ITALY-OTRANTO	40.15N	18.50E	1630Z	02	JUL	WATCH
ITALY-TARANTO	40.48N	17.22E	1636Z	02	JUL	WATCH
ITALY-GINOSTRA	38.78N	15.19E	1638Z	02	JUL	WATCH
ITALY-MILAZZO	38.21N	15.27E	1639Z	02	JUL	WATCH
ITALY-VIBO MARINA	38.72N	16.13E	1651Z	02	JUL	WATCH
ITALY-BRINDISI	40.66N	18.00E	1651Z	02	JUL	WATCH
ITALY-CETRARO	39.50N	15.95E	1653Z	02	JUL	WATCH
ITALY-PALINURO	40.03N	15.28E	1658Z	02	JUL	WATCH
ITALY-PALERMO	38.12N	13.37E	1706Z	02	JUL	WATCH
ITALY-BARI	41.14N	16.87E	1712Z	02	JUL	WATCH
ITALY-PONZA	40.90N	12.97E	1713Z	02	JUL	WATCH
ITALY-NAPOLI	40.84N	14.27E	1713Z	02	JUL	WATCH
ITALY-SALERNO	40.68N	14.75E	1716Z	02	JUL	WATCH

ITALY-GELA	37.06N	14.23E	1718Z	02	JUL	WATCH
ITALY-PORTO EMPEDOCLE	37.29N	13.53E	1722Z	02	JUL	WATCH
ITALY-GAETA	41.21N	13.59E	1723Z	02	JUL	WATCH
ITALY-LAMPEDUSA	35.50N	12.60E	1723Z	02	JUL	WATCH
ITALY-ANZIO	41.45N	12.63E	1730Z	02	JUL	WATCH
ITALY-OROSEI	40.44N	9.78E	1733Z	02	JUL	WATCH
ITALY-SCIACCA	37.50N	13.08E	1734Z	02	JUL	WATCH
ITALY-FIUMICINO	41.77N	12.21E	1736Z	02	JUL	WATCH
ITALY-CIVITAVECCHIA	42.09N	11.79E	1739Z	02	JUL	WATCH
ITALY-VIESTE	41.89N	16.18E	1740Z	02	JUL	WATCH
ITALY-BARLETTA	41.33N	16.30E	1742Z	02	JUL	WATCH
ITALY-MAZARA DEL VALLO	37.64N	12.58E	1745Z	02	JUL	WATCH
ITALY-CAGLIARI	39.21N	9.11E	1751Z	02	JUL	WATCH
ITALY-MARINA DI GROSSETO	42.72N	10.98E	1803Z	02	JUL	WATCH
ITALY-MARINA DI CAMPO	42.74N	10.24E	1804Z	02	JUL	WATCH
ITALY-SANTA TERESA DI GALL	41.25N	9.19E	1805Z	02	JUL	WATCH
ITALY-PIOMBINO	42.92N	10.53E	1813Z	02	JUL	WATCH
ITALY-CARLOFORTE	39.15N	8.31E	1818Z	02	JUL	WATCH
ITALY-TERMOLI	42.00N	15.01E	1831Z	02	JUL	WATCH
ITALY-ALGHERO	40.54N	8.32E	1832Z	02	JUL	WATCH
ITALY-ORISTANO	39.86N	8.44E	1832Z	02	JUL	WATCH
ITALY-IMPERIA	43.88N	8.02E	1837Z	02	JUL	WATCH
ITALY-GENOVA	44.41N	8.93E	1839Z	02	JUL	WATCH
ITALY-LIVORNO	43.55N	10.30E	1841Z	02	JUL	WATCH
ITALY-LA SPEZIA	44.10N	9.86E	1848Z	02	JUL	WATCH
ITALY-ORTONA	42.36N	14.41E	1848Z	02	JUL	WATCH
ITALY-PORTO TORRES	40.84N	8.40E	1853Z	02	JUL	WATCH
ITALY-SAN BENEDETTO DEL TR	42.96N	13.89E	1906Z	02	JUL	WATCH
ITALY-ANCONA	43.62N	13.51E	1949Z	02	JUL	WATCH
ITALY-CESENATICO	44.18N	12.42E	2113Z	02	JUL	WATCH
ITALY-RAVENNA	44.49N	12.28E	2132Z	02	JUL	WATCH
ITALY-CHIOGGIA	45.21N	12.30E	2201Z	02	JUL	WATCH
ITALY-TRIESTE	45.65N	13.76E	2220Z	02	JUL	WATCH
ITALY-VENEZIA	45.42N	12.43E	2225Z	02	JUL	WATCH
MONACO-MONTE-CARLO	43.73N	7.43E	1842Z	02	JUL	WATCH
SPAIN-MAHÃ³N	39.89N	4.27E	1834Z	02	JUL	WATCH
SPAIN-BARCELONA	41.39N	2.18E	1858Z	02	JUL	WATCH
SPAIN-PALMA DE MALLORCA	39.57N	2.65E	1903Z	02	JUL	WATCH
SPAIN-IBIZA	38.91N	1.44E	1904Z	02	JUL	WATCH
SPAIN-TARRAGONA	41.12N	1.26E	1907Z	02	JUL	WATCH
SPAIN-CARTAGENA	37.61N	0.98W	1913Z	02	JUL	WATCH
SPAIN-ALICANTE	38.35N	0.48W	1929Z	02	JUL	WATCH
SPAIN-ALMERÃ-A	36.84N	2.47W	1933Z	02	JUL	WATCH
SPAIN-CASTELLON DE LA PLAN	39.99N	0.04W	1944Z	02	JUL	WATCH
SPAIN-VALENCIA	39.48N	0.38W	1950Z	02	JUL	WATCH
SPAIN-MELILLA	35.30N	2.94W	1955Z	02	JUL	WATCH
SPAIN-MÃ¡LAGA	36.72N	4.42W	2001Z	02	JUL	WATCH
SPAIN-CEUTA	35.89N	5.32W	2005Z	02	JUL	WATCH
SPAIN-ALGECIRAS	36.13N	5.45W	2011Z	02	JUL	WATCH
SYRIA-TARTOUS	34.91N	35.86E	1553Z	02	JUL	WATCH
SYRIA-LATTAKIA	35.54N	35.75E	1600Z	02	JUL	WATCH
TURKEY-MUGLA DALAMAN	36.69N	28.78E	1453Z	02	JUL	WATCH
TURKEY-MUGLA AKSAZ (M)	36.84N	28.40E	1457Z	02	JUL	WATCH
TURKEY-ANTALYA FINIKE	36.29N	30.15E	1457Z	02	JUL	WATCH
TURKEY-ANTALYA KAS	36.20N	29.64E	1500Z	02	JUL	WATCH
TURKEY-MUGLA FETHIYE	36.66N	29.11E	1506Z	02	JUL	WATCH
TURKEY-MUGLA BODRUM (M)	37.03N	27.42E	1509Z	02	JUL	WATCH
TURKEY-ANTALYA (M)	36.83N	30.61E	1512Z	02	JUL	WATCH
TURKEY-ANTALYA ALANYA	36.55N	31.98E	1514Z	02	JUL	WATCH
TURKEY-MERSIN BOZYAZI (M)	36.10N	32.94E	1528Z	02	JUL	WATCH
TURKEY-AYDIN DIDIM	37.35N	27.28E	1533Z	02	JUL	WATCH
TURKEY-IZMIR ALACATI	38.25N	26.39E	1549Z	02	JUL	WATCH
TURKEY-MERSIN TASUCU (M)	36.28N	33.84E	1552Z	02	JUL	WATCH
TURKEY-AYDIN KUSADASI	37.87N	27.26E	1554Z	02	JUL	WATCH
TURKEY-MERSIN ERDEMLI (M)	36.56N	34.26E	1558Z	02	JUL	WATCH
TURKEY-IZMIR ALIAGA	38.83N	26.94E	1636Z	02	JUL	WATCH
TURKEY-HATAY ISKENDERUN (M	36.59N	36.18E	1652Z	02	JUL	WATCH
TURKEY-ADANA YUMURTALIK	36.91N	35.98E	1654Z	02	JUL	WATCH
TURKEY-CANAKKALE GOKCEADA	40.23N	25.89E	1659Z	02	JUL	WATCH
TURKEY-CANAKKALE BOZCAADA	39.84N	26.08E	1700Z	02	JUL	WATCH
TURKEY-IZMIR MENTES (M)	38.43N	26.72E	1702Z	02	JUL	WATCH
TURKEY-EDIRNE ENEZ	40.71N	26.05E	1726Z	02	JUL	WATCH

TURKEY-BALIKESIR AYVALIK	39.31N	26.69E	1727Z	02 JUL	WATCH
TURKEY-IZMIR ALSANCAK	38.44N	27.14E	1800Z	02 JUL	WATCH
UNITED KINGDOM-GIBRALTAR	36.13N	5.37W	2008Z	02 JUL	WATCH

SUPPLEMENT MESSAGES WILL BE ISSUED AS SOON AS NEW DATA AND EVALUATION ALLOWS.
THE TSUNAMI ALERT WILL REMAIN IN EFFECT UNTIL AN END OF ALERT IS BROADCAST.

TSUNAMI MESSAGE NUMBER 002
NEAM NOA HL-NTWC CANDIDATE TSUNAMI WATCH PROVIDER
ISSUED AT 1443Z 10 JUL 2015

... TSUNAMI WATCH CANCELLATION ...
THIS ALERT APPLIES TO CROATIA...FRANCE...GREECE...ISRAEL...ITALY...MONACO...SPAIN...SYRIA...TURKEY...UNITED KINGDOM

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 - 1424 UTC THU JUL 2 2015
COORDINATES - 34.80 NORTH 27.00 EAST
DEPTH - 25.0 KM
LOCATION - SOUTH OF CRETE TEST TEST TEST
MAGNITUDE - 7.8 ML

EVALUATION OF TSUNAMI WATCH AND ADVISORY
SEA LEVEL READINGS INDICATE THAT NO TSUNAMI WAS GENERATED.
THE TSUNAMI ALERT IS CANCELLED.
HOWEVER, EARTHQUAKES OF THIS SIZE CAN GENERATE SMALL TSUNAMIS THAT CAUSE LOCALLY CHANGES IN CURRENTS AND RESONANCE IN HARBOURS. AUTHORITIES SHOULD BE AWARE OF THIS POSSIBILITY AND TAKE APPROPRIATE ACTION.

THIS WILL BE THE FINAL MESSAGE ISSUED FOR THIS EVENT UNLESS ADDITIONAL INFORMATION BECOMES AVAILABLE.

END OF SUNAMI MESSAGE NUMBER 002

Message created using Modelling Option

```
TSUNAMI MESSAGE NUMBER 001
NEAM NOA HL-NTWC CANDIDATE TSUNAMI WATCH PROVIDER
ISSUED AT 1057Z 10 JUL 2015

... TSUNAMI WATCH ...
THIS ALERT APPLIES TO GREECE

... TSUNAMI ADVISORY ...
THIS ALERT APPLIES TO TURKEY

... TSUNAMI INFORMATION ...
THIS ALERT APPLIES TO BELGIUM ... EGYPT ... FRANCE ... GERMANY ... GREECE ...
ISRAEL ... ITALY ... LEBANON ... PORTUGAL ... SPAIN ... SWEDEN ... TURKEY ...
IOC (UNESCO) .... ERCC (EUROPEAN COMMISSION)

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   - 1424 UTC THU JUL 2 2015
COORDINATES   - 34.80 NORTH 27.00 EAST
DEPTH         - 25.0 KM
LOCATION      - SOUTH OF CRETE TEST TEST TEST
MAGNITUDE     - 7.8 ML

EVALUATION OF TSUNAMI WATCH
IT IS NOT KNOWN THAT A TSUNAMI WAS GENERATED. THIS MESSAGE 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 GREATER THAN 0.5M
AND/OR CAUSE A TSUNAMI RUN-UP GREATER 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 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.

ESTIMATED INITIAL TSUNAMI WAVE ARRIVAL TIMES AT FORECAST POINTS WITHIN THE
WATCH/ADVISORY AREA 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                  FP COORDINATES  ARRIVAL TIME  ALERT LEVEL
--------------------      --------------  ------------- -----------
GREECE-SITEIA             35.23N  26.10E  1446Z  02 JUL WATCH
GREECE-IERAPETRA          35.00N  25.74E  1442Z  02 JUL WATCH
GREECE-RHODOS_LINDOS      36.09N  28.09E  1450Z  02 JUL WATCH
GREECE-RHODOS_LINDOS      36.09N  28.09E  1450Z  02 JUL WATCH

GREECE-KARPATHOS_MESOCHORI35.63N  27.09E  1437Z  02 JUL ADVISORY
GREECE-RHODOS_TOWN        36.45N  28.21E  1502Z  02 JUL ADVISORY
GREECE-KASTELORIZO_MEGISTI36.15N  29.59E  1526Z  02 JUL ADVISORY
GREECE-GAVDOS_KARAVE      34.85N  24.12E  1459Z  02 JUL ADVISORY
```

TURKEY-MUGLA DALAMAN	36.69N	28.78E	1459Z	02 JUL ADVISORY
TURKEY-MUGLA FETHIYE	36.66N	29.11E	1652Z	02 JUL ADVISORY
TURKEY-AYDIN DIDIM	37.35N	27.28E	1839Z	02 JUL ADVISORY

SUPPLEMENT MESSAGES WILL BE ISSUED AS SOON AS NEW DATA AND EVALUATION ALLOWS.
THE TSUNAMI ALERT WILL REMAIN IN EFFECT UNTIL AN END OF ALERT IS BROADCAST.

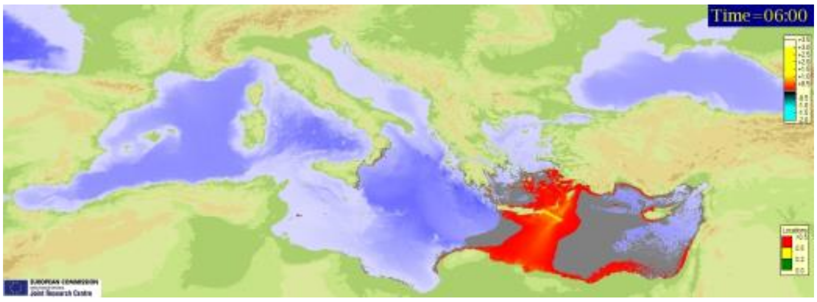
5.5.3 Appendix B1: NOA Report with TAT

Lat/lon/mag: 35/27/7.75

Initial Conditions

This calculation has been performed using SWAN and the JRC computing system

W:\Disk2\MAG_775\P0270^P0350^0775\



Response:
Status Calc
Epicenter

Latitude: **35.00**
Longitude: **27.00**
Magnitude: **7.75**

Depth: **5.00** (km, Top of fault)
Water Depth: **-3061** (m)
Event Date: **02 Jul 2015 14:24:48**

Fault Geometry

Displacement: 3 (m)
Width: 34 (km)
Lenght: 136 (km)
Strike: 303 (deg - North=0)
Dip: 25 (deg)
Rake: 90 (deg)

Calculation Window

Lon Min: -6 (deg)
Lon Min: 42.5 (deg)
Lon Min: 30 (deg)
Lon Min: 47.5 (deg)
Bathymetry: 2 (min)

Execution Server:

List of affected Forecast Points

The list below represents the list of the affected Forecast Points according to the scenario.

Arr. time (time of max)	**Actual Time**	**Country**	**Location**	**Height**		**ID**	
00:00 (Max: 00:22)	02/07/2015 14:46	Greece	Siteia	0.65		35.23	26.1
00:02 (Max: 00:13)	02/07/2015 14:37	Greece	Karpathos_Mesochori	0.25		35.63	27.09
00:12 (Max: 00:18)	02/07/2015 14:42	Greece	Ierapetra	0.67		35	25.74
00:16 (Max: 00:26)	02/07/2015 14:50	Greece	Rhodos_Lindos	1.01		36.087	28.089

00:16 (Max: 00:26)	02/07/2015 14:50	Greece	Rhodos_Lindos	0.85		36.09	28.09
00:23 (Max: 00:38)	02/07/2015 15:02	Greece	Rhodos_Town	0.48		36.45	28.21
00:24 (Max: 01:08)	02/07/2015 15:32	Greece	Agios_Nikolaos	0.17		35.207	25.724
00:25 (Max: 00:35)	02/07/2015 14:59	Turkey	MUGLA DALAMAN	0.3		36.68944	28.77909
00:26 (Max: 00:37)	02/07/2015 15:01	Greece	Kos_Kefalos	0.12		36.742	26.977
00:27 (Max: 00:31)	02/07/2015 14:55	Greece	Santorini_Ormos_Firon	0.1		36.417	25.422
00:27 (Max: 01:02)	02/07/2015 15:26	Greece	Kastelorizo_Megisti	0.24		36.15	29.59
00:27 (Max: 00:59)	02/07/2015 15:23	Turkey	Kastelorizo_Megisti	0.2		36.153	29.594
00:28 (Max: 04:37)	02/07/2015 19:01	Greece	Santorini_Ormos_Firon	0.16		36.42	25.42
00:30 (Max: 00:35)	02/07/2015 14:59	Greece	Gavdos_Karave	0.44		34.85	24.12
00:32 (Max: 00:41)	02/07/2015 15:05	Turkey	MUGLA AKSAZ (M)	0.2		36.83718	28.39772
00:32 (Max: 00:40)	02/07/2015 15:04	Turkey	MUGLA AKSAZ (M)	0.2		36.83718	28.39772
00:32 (Max: 02:28)	02/07/2015 16:52	Turkey	MUGLA FETHIYE	0.22		36.65638	29.11043
00:32 (Max: 02:29)	02/07/2015 16:53	Turkey	ANTALYA FINIKE	0.15		36.29454	30.15343
00:33 (Max: 00:36)	02/07/2015 15:00	Greece	Chora_Sfakion	0.17		35.196	24.132
00:36 (Max: 00:45)	02/07/2015 15:09	Greece	Kalimnos_Panormos	0.1		36.971	26.928
00:38 (Max: 00:40)	02/07/2015 15:04	Greece	Amorgos_Katapola	0.08		36.828	25.861
00:41 (Max: 01:55)	02/07/2015 16:19	Greece	Rethimnon	0.11		35.378	24.472
00:42 (Max: 01:54)	02/07/2015 16:18	Greece	Rethimnon	0.11		35.37	24.47
00:47 (Max: 02:58)	02/07/2015 17:22	Greece	Milos_Adamas	0.18		36.722	24.446
00:51 (Max: 01:33)	02/07/2015 15:57	Turkey	MUGLA BODRUM (M)	0.16		37.03226	27.42347
00:52 (Max: 02:40)	02/07/2015 17:04	Turkey	ANTALYA ALANYA	0.16		36.54539	31.98319
00:53 (Max: 02:45)	02/07/2015 17:09	Turkey	ANTALYA (M)	0.11		36.83041	30.60869
00:53 (Max: 01:31)	02/07/2015 15:55	Greece	Chania	0.08		35.52	24.02
00:58 (Max: 02:40)	02/07/2015 17:04	Greece	Kithera_Kapsali	0.15		36.138	22.999
00:58 (Max: 02:40)	02/07/2015 17:04	Greece	Kithera_Kapsali	0.15		36.14	23
00:58 (Max: 01:08)	02/07/2015 15:32	Greece	Ikaria_Agios_Kirikos	0.15		37.611	26.299
00:58 (Max: 01:08)	02/07/2015 15:32	Greece	Ikaria_Agios_Kirikos	0.15		37.61	26.3
01:01 (Max: 01:01)	02/07/2015 15:25	Greece	Amorgos_Katapola	0.05		36.83	25.86
01:02 (Max: 02:28)	02/07/2015 16:52	Turkey	MERSIN BOZYAZI (M)	0.12		36.09618	32.94027
01:14 (Max: 01:19)	02/07/2015 15:43	Greece	Mikonos_Chora	0.14		37.447	25.324
01:19 (Max: 01:25)	02/07/2015 15:49	Greece	Mikonos_Chora	0.13		37.447	25.324
01:22 (Max: 05:23)	02/07/2015 19:47	Greece	Monemvasia	0.12		36.68	23.04
01:22 (Max: 03:53)	02/07/2015 18:17	Israel	Nahariya	0.12		33.00914	35.0654
01:23 (Max: 04:55)	02/07/2015 19:19	Greece	Githeion	0.12		36.76	22.57
01:23 (Max: 05:07)	02/07/2015 19:31	Israel	Haifa	0.15		32.79721	34.94301
01:26 (Max: 02:31)	02/07/2015 16:55	Israel	Hadera	0.18		32.46491	34.8705
01:29 (Max: 04:09)	02/07/2015 18:33	Greece	Andros	0.07		37.84	24.94
01:34 (Max: 04:15)	02/07/2015 18:39	Israel	Tel Aviv	0.16		32.08095	34.75277
01:35 (Max: 02:40)	02/07/2015 17:04	Israel	Ashdod	0.15		31.8	34.63
01:38 (Max: 03:09)	02/07/2015 17:33	Israel	Ashkelon	0.12		31.69216	34.55093
01:40 (Max: 04:09)	02/07/2015 18:33	Greece	Tinos	0.09		37.534	25.157
01:40 (Max: 04:15)	02/07/2015 18:39	Turkey	AYDIN DIDIM	0.21		37.34912	27.27545
01:44 (Max: 04:19)	02/07/2015 18:43	Turkey	MERSIN TASUCU (M)	0.11		36.28148	33.83597
01:46 (Max: 03:45)	02/07/2015 18:09	Greece	Tinos	0.07		37.54	25.15

01:48 (Max: 04:01)	02/07/2015 18:25	Greece	Siros_Ermoupoli	0.12		37.437	24.948
01:48 (Max: 04:01)	02/07/2015 18:25	Greece	Siros_Ermoupoli	0.12		37.437	24.948
01:49 (Max: 03:53)	02/07/2015 18:17	Greece	Naxos_Chora	0.06		37.107	25.367
01:53 (Max: 04:09)	02/07/2015 18:33	Greece	Kiparissia	0.08		37.25	21.65
02:00 (Max: 04:13)	02/07/2015 18:37	Turkey	MERSIN TASUCU (M)	0.1		36.28148	33.83597
02:05 (Max: 03:25)	02/07/2015 17:49	Turkey	IZMIR ALACATI	0.09		38.25341	26.38655
02:10 (Max: 02:29)	02/07/2015 16:53	Turkey	MERSIN ERDEMLI (M)	0.06		36.56342	34.25503
02:17 (Max: 04:11)	02/07/2015 18:35	Italy	Siracusa	0.09		37.06	15.28
02:18 (Max: 03:43)	02/07/2015 18:07	Italy	Siderno	0.08		38.26	16.3
02:18 (Max: 04:27)	02/07/2015 18:51	Turkey	AYDIN DIDIM	0.14		37.34912	27.27545
02:19 (Max: 03:51)	02/07/2015 18:15	Italy	Messina	0.06		38.18	15.56
02:21 (Max: 03:51)	02/07/2015 18:15	Italy	Reggio Calabria	0.06		38.12172	15.64892
02:22 (Max: 03:37)	02/07/2015 18:01	Italy	Catania	0.08		37.49808	15.09383
02:22 (Max: 03:37)	02/07/2015 18:01	Italy	Catania	0.08		37.44	15.09
02:23 (Max: 05:27)	02/07/2015 19:51	Syria	Lattakia	0.1		35.5377	35.75012
02:27 (Max: 04:23)	02/07/2015 18:47	Italy	Catanzaro	0.09		38.82498	16.63277
02:37 (Max: 04:39)	02/07/2015 19:03	Italy	Crotone	0.07		39.08448	17.13031
02:38 (Max: 04:37)	02/07/2015 19:01	Greece	Katakolo	0.07		37.644	21.323
02:41 (Max: 05:57)	02/07/2015 20:21	Greece	Cephalonnia_Argostoli	0.06		38.193	20.485
02:55 (Max: 05:59)	02/07/2015 20:23	Syria	Tartous	0.08		34.91439	35.85516
03:27 (Max: 04:05)	02/07/2015 18:29	Greece	Samos_Karlovasi	0.07		37.8	26.68
03:29 (Max: 04:37)	02/07/2015 19:01	Greece	Katakolo	0.07		37.64	21.32
03:45 (Max: 04:41)	02/07/2015 19:05	Italy	Otranto	0.06		40.14715	18.49709
03:51 (Max: 04:27)	02/07/2015 18:51	Italy	Crotone	0.07		39.08	17.14
04:05 (Max: 05:57)	02/07/2015 20:21	Greece	Cephalonnia_Argostoli	0.06		38.193	20.485
04:19 (Max: 04:19)	02/07/2015 18:43	Greece	Chios_Vollisos	0.06		38.466	25.917
04:19 (Max: 04:49)	02/07/2015 19:13	Turkey	AYDIN KUSADASI	0.08		37.86975	27.26008
04:33 (Max: 04:49)	02/07/2015 19:13	Greece	Chios_Vollisos	0.05		38.47	25.92
05:01 (Max: 05:45)	02/07/2015 20:09	Turkey	Adana Yumurtalik	0.06		36.76	35.79
05:21 (Max: 05:49)	02/07/2015 20:13	Italy	Gallipoli	0.06		40.05478	17.9724
05:43 (Max: 06:00)	02/07/2015 20:24	Italy	Policoro Lido	0.06		40.18584	16.71673
05:49 (Max: 05:49)	02/07/2015 20:13	Albania	Palermo	0.06		40.06	19.78
05:59 (Max: 05:59)	02/07/2015 20:23	Turkey	HATAY ISKENDERUN (M)	0.05		36.59325	36.18021

Table 5 – Arrival times

Images

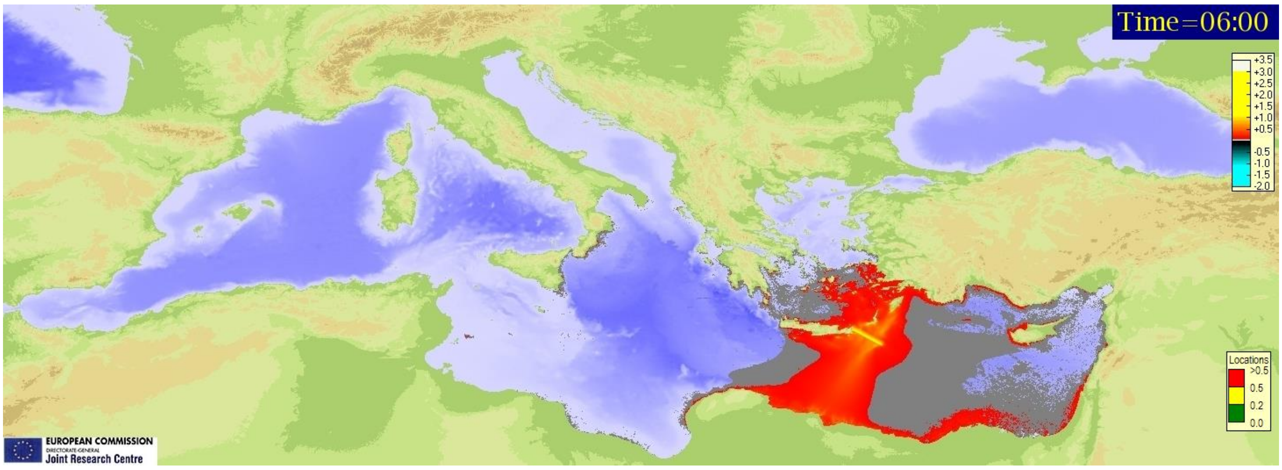


Fig. 1 - Maximum Height

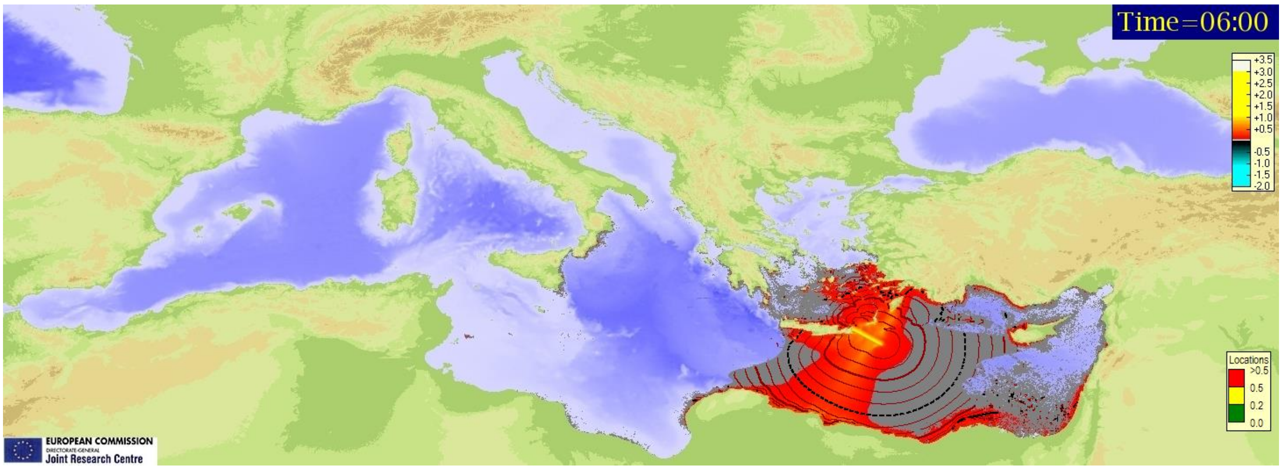
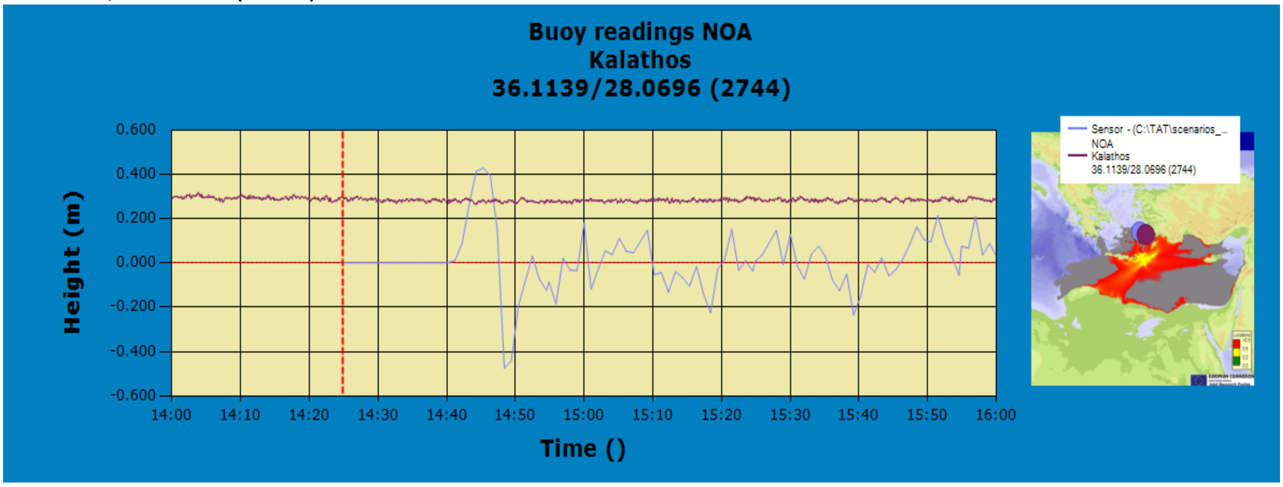


Fig. 2 - Travel Time calculated by wave propagation

Situation Plots

Buoy readings NOA - Kalathos
36.1139/28.0696 (2744)



5.6 TRIDEC-Cloud Demonstration

The TRIDEC-Cloud demonstration was performed using the software running in GFZ, Germany, using a simple browser interface, run on a standard computer present in the Crisis Room, projected on the large video wall. The resolution was therefore the standard 1920x1080 Full HD resolution of the client computer (Figure 33).

Two cases were ready for TRIDEC-Cloud; the one that was chosen was the following:

Date of the event: **2 July 2015 15:23**
Location: **Off-shore Algeria**
Lat/Lon: **37.06/3.66**
Magnitude: **7.5 Mw**
Depth: **20 km**

Figure 33 - Visualization of TRIDEC-Cloud in the large video Wall

As soon as the case was launched with the update of the TRIDEC.xml file on the JRC server the event information appeared in the list of cases in the browser in a few seconds. The operator also received notifications by SMS and e-mail indicating the presence of a case to be analysed.

At that moment the operator clicked on the case and specified the assumed worst case fault parameters by hand. In general TRIDEC-Cloud is used using GEOFON feeds that contain, when available, also the fault parameters. It was mentioned that in the future the system could also rely on a database of fault mechanism that could avoid introducing this data by hand when the same are not provided by the seismological organization.

Included the fault parameters, that were for this case Dip=45, Rake=90 (to select worst cases) and given a strike value of 270 the operator launched an online computation that was concluded in less than 10 seconds for a simulation covering a 3 hours tsunami wave propagation. The calculation was performed using a Mediterranean grid of 2 min cell size. The use of one GPU in this particular case allowed to contain the execution time to very low value. However, it was mentioned that the use of several GPUs is configurable and would make sense when using a grid with higher detail and/or when computing a simulation covering tsunami propagations of 8 hours or more.

Once the computation was concluded it was possible to visualize the alert message that was issued 5 min after the publication of the event due to the time taken by explanations of the operator within the demo (Figure 34). The message contains Tsunami Forecast Points (TFPs) classified with the level ADVISORY due to a limited set-up for the Western Med. Other TFPs classified with the level INFORMATION or TFPs not affected by the 3 hours propagation simulation are not included in the message. In fact the message did not follow the Decision Matrix to classify the TFPs but used the estimated Tsunami heights given by the computed simulation. It was mentioned that messages can be issued much faster and with as many TFPs as required as demonstrated in the fringes of NEAMWave14 in October 2014.

(see http://www.ioc-unesco.org/index.php?option=com_oe&task=viewDocumentRecord&docID=14357).

Finally, the demonstration was extended by feeding an event refinement including the fault parameters with Dip=45, Rake=90, and Strike=60 into the TRIDEC Cloud. Again SMS and e-mail notifications have been sent. But this time the e-mail notification included an automatically generated, preliminary warning message and an URL address for a shared map (http://trideccloud.gfz-potsdam.de/?share=559559cf00529671d35bb02d). Both, the preliminary message and the shared map, were generated automatically by the system based on a computation result instantly available due to an automatically initiated simulation calculation when the refinement was fed into the TRIDEC Cloud. The issuing of warning messages based on the event refinement then was demonstrated analogously as done before with the initial event information. The full timeline, as recorded by the TRIDEC Cloud, for the Algerian scenario is depicted in (Figure 35).

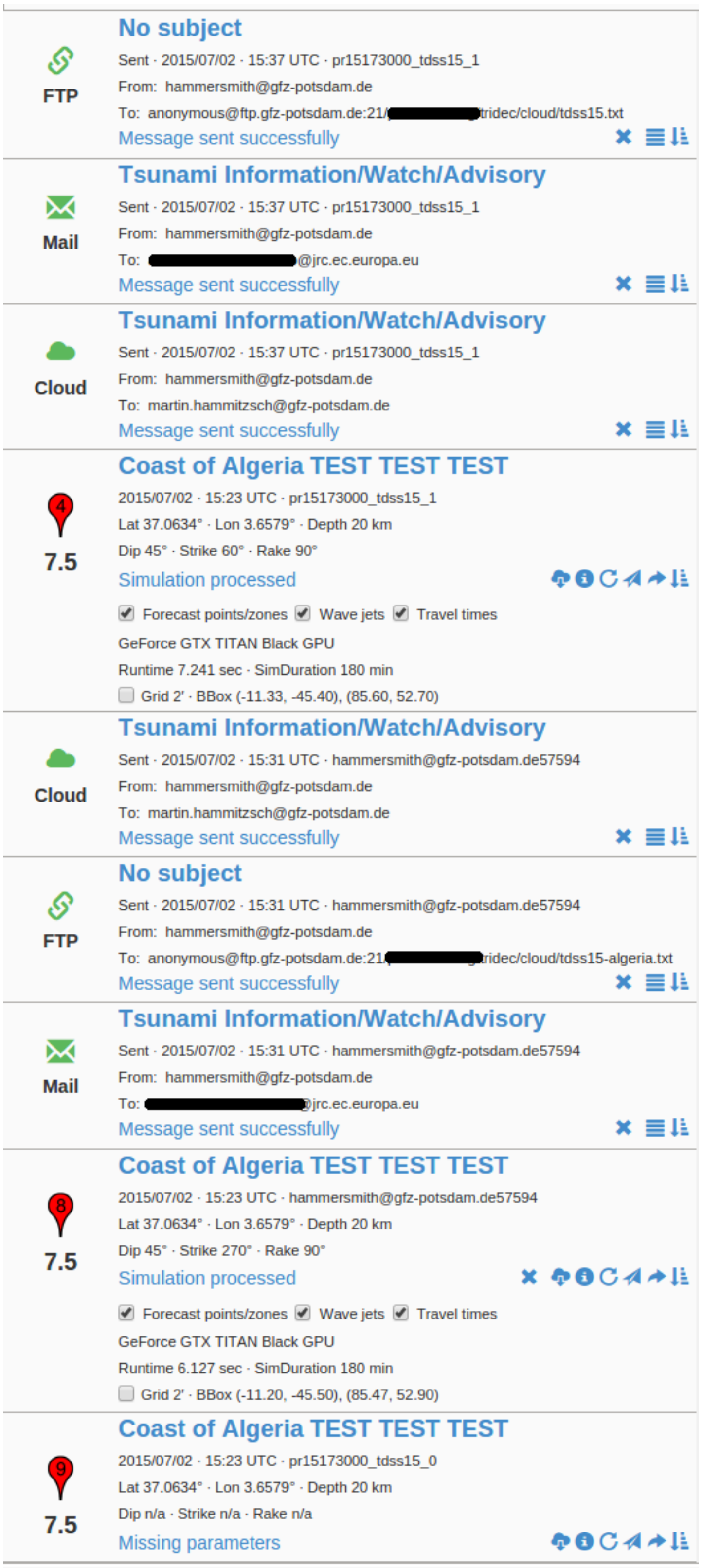


Figure 34 - Timeline of the reports generation

During the generation and issue of the reports it was necessary to include all the email addresses by hand. In an operational system the default addresses should be automatically loaded by the system.

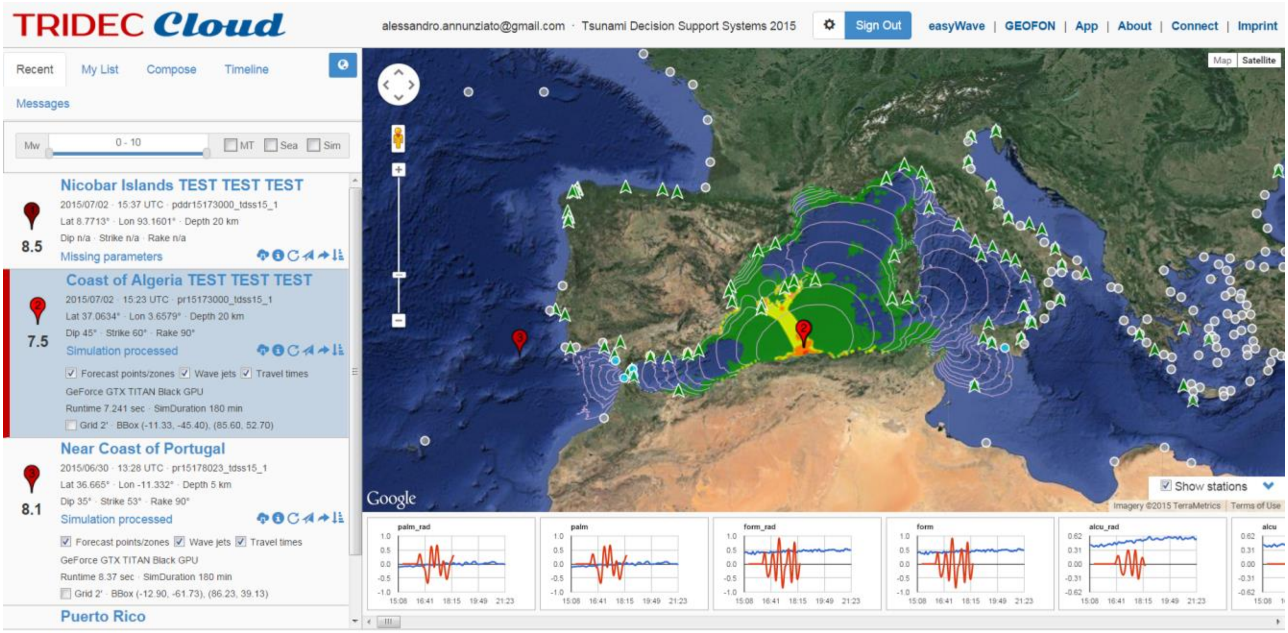


Figure 35 - Visualization of the case analysed by TRIDEC

In addition to the Algerian scenario also the Nicobar Island scenario was used to demonstrate the capabilities of making use of GPUs for instant tsunami propagation calculations. The computation was concluded by using one GPU and a 2 min grid in less than 50 seconds for a simulation covering an 8 hours tsunami wave propagation.

(Figure 36-Figure 37 or shared map at http://trideccloud.gfz-potsdam.de/?share=55d478d90cf24ed10cfef005).

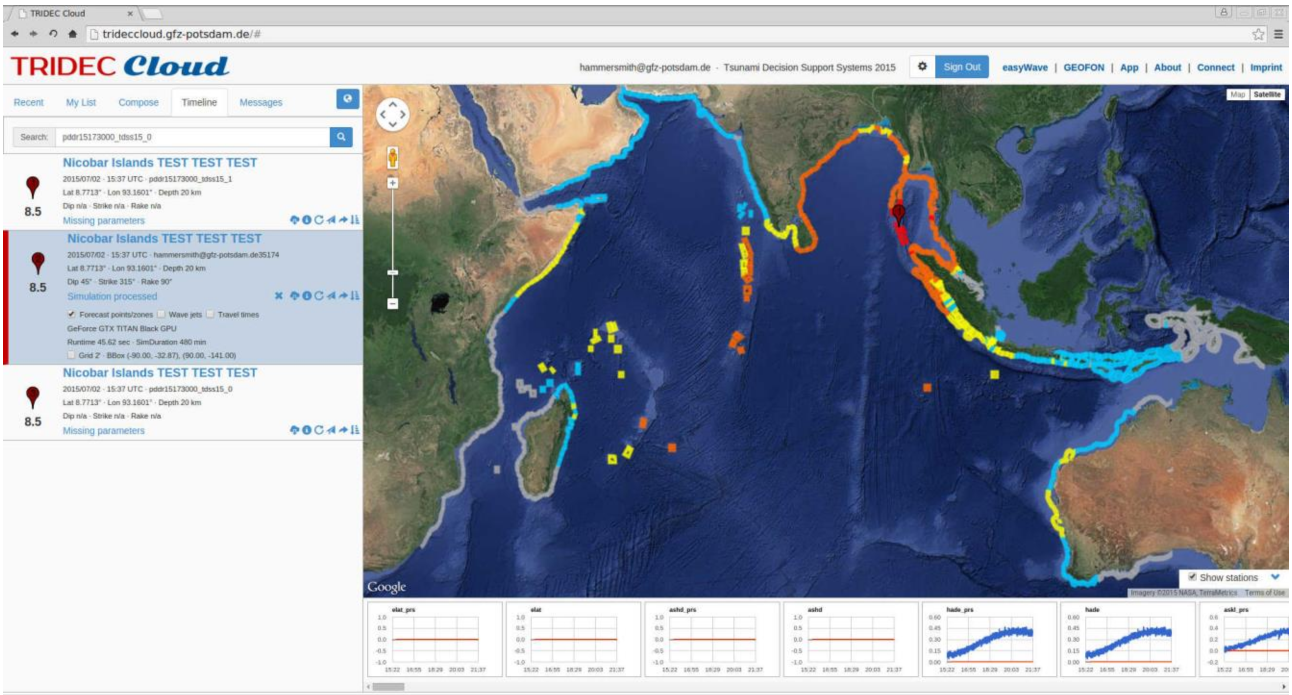


Figure 36 - Classified Coastal Forecast Zones (CFPs) computed for the Nicobar Island scenario

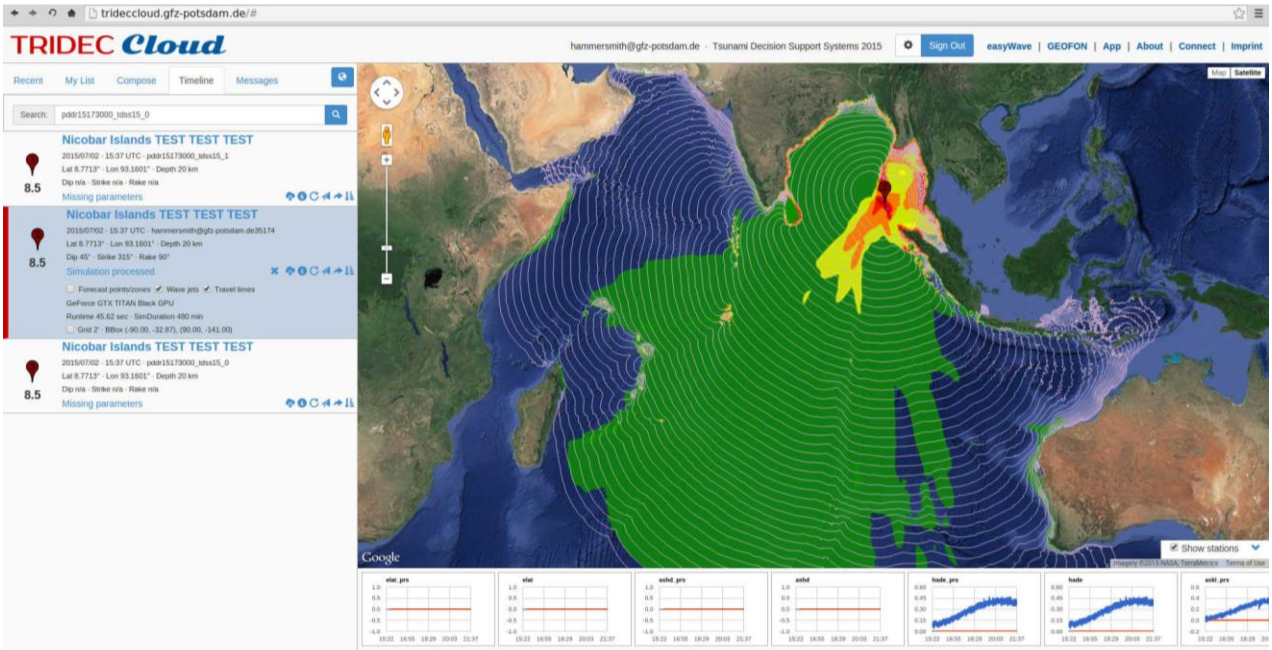


Figure 37 - Wave jets and travel times computed for the Nicobar Island scenario

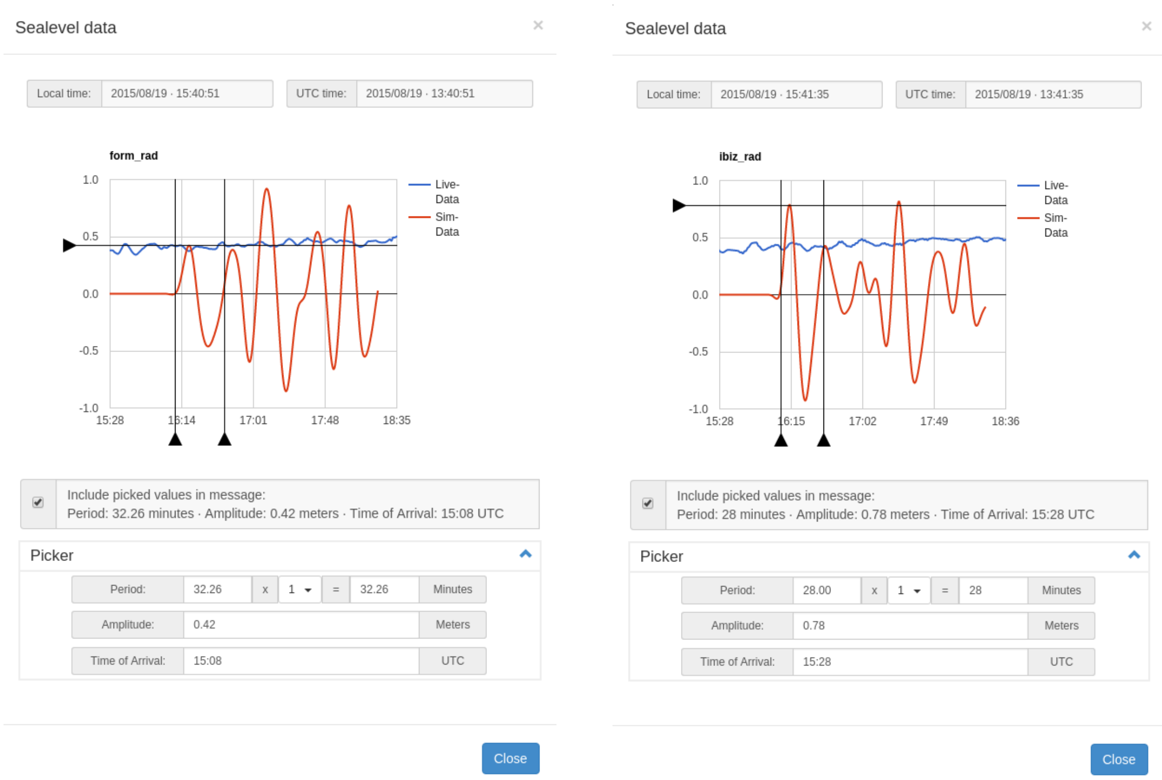


Figure 38 - **Comparison of sea level with measurement (no de-tiding is performed on measured data)**

5.6.1 Conclusions on the TRIDEC-Cloud demonstration

The system showed very important potential to become a fully used DSS for an operational system. At the moment improvements related to convenience functionalities and customizations to meet specific needs would be part of an implementation, but it already is a powerful analysis tool. The fast calculations are really impressive even if it should be necessary to have the possibility to perform also higher resolution calculations in addition to the standard 2 min cell size ones. The system was able to fulfil all the required tasks without large effort from the operator and in very limited time.

5.6.2 Appendix to TRIDEC-Cloud Demo: message created

TSUNAMI EXERCISE MESSAGE NUMBER 001
TDSS15 TEST TSUNAMI WATCH PROVIDER
ISSUED AT 1528Z 02 JUL 2015

```
... THIS IS AN EXERCISE ...

... TSUNAMI ADVISORY ...
THIS ALERT APPLIES TO SPAIN

... TSUNAMI INFORMATION ...
THIS ALERT APPLIES TO ITALY ... MOROCCO ... UNITED KINGDOM
```

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 - 1523Z 02 JUL 2015
COORDINATES - 37.06 NORTH 3.66 EAST
DEPTH       - 20 KM
LOCATION    - Coast of Algeria TEST TEST TEST
MAGNITUDE   - 7.5
```

EVALUATION OF TSUNAMI WATCH
IT IS NOT KNOWN THAT A TSUNAMI WAS GENERATED. THIS MESSAGE 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 GREATER THAN 0.5M AND/OR CAUSE A TSUNAMI RUN-UP GREATER 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 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 EARTHQUAKE AND TSUNAMI MODELLING THERE IS NO THREAT THAT A TSUNAMI HAS BEEN GENERATED THAT CAN CAUSE DAMAGE OR MAJOR EFFECT IN THE REGION. THIS MESSAGE IS FOR INFORMATION ONLY.

ESTIMATED INITIAL TSUNAMI WAVE ARRIVAL TIMES AT FORECAST POINTS WITHIN THE WATCH AREA AND ADVISORY AREA 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 LEVEL
------------------------ -------------- ------------ ------------
SPAIN-ALMERIA            36.84N   2.47W 1616Z 02 JUL ADVISORY
SPAIN-MALAGA             36.72N   4.42W 1655Z 02 JUL ADVISORY
```

SUPPLEMENT MESSAGES WILL BE ISSUED AS SOON AS NEW DATA AND EVALUATION ALLOWS. THE TSUNAMI ALERT WILL REMAIN IN EFFECT UNTIL AN END OF ALERT IS BROADCAST.

```
... THIS IS AN EXERCISE ...
```

END OF TSUNAMI EXERCISE MESSAGE NUMBER 001

5.6.3 Report Generation

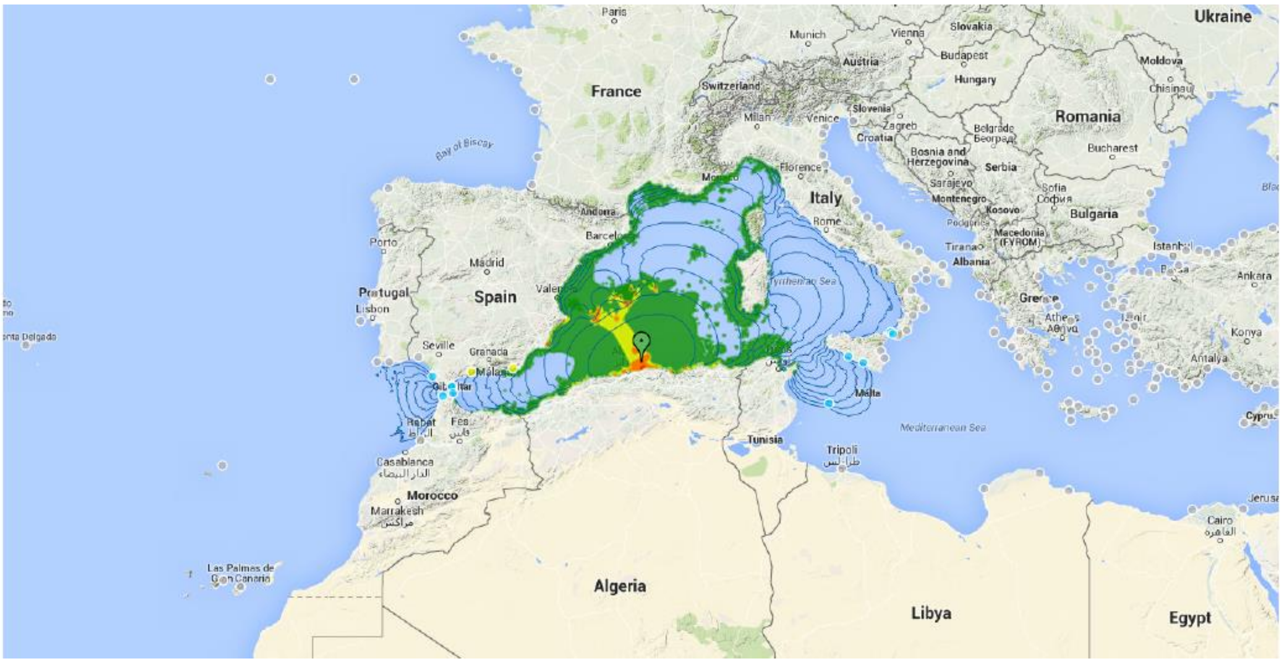


Figure 39 – Map of Tsunami area

Figure 40 – Mr. Martin Hammitzsch during TRIDEC cloud presentation

5.7 UMA Demonstration

The UMA demonstration was performed a bit differently from the others because the code, shown by UMA, is not exactly a DSS but rather it can be included in a way or another in many DSSs given its very fast performance capabilities. For this reason JRC prepared input conditions for HySEA and made them available to UMA at the time of the start of the event; the objective of the UMA demonstration was to show live the duration of one calculation and show some output via a standard NETCDF viewer. The demo was performed live with a VNC connection to Malaga computers.

Two cases were ready for UMA, the ones also prepared for TRIDEC; as TRIDEC choose the Algeria case, also UMA received the same case:

Date of the event: **2 July 2015 15:23**
Location: **Off-shore Algeria**
Lat/Lon: **37.06/3.66**
Magnitude: **7.5 Mw**
Depth: **20 km**
Mesh resolution: 30 arc-sec
Mesh size: 597,600 cells

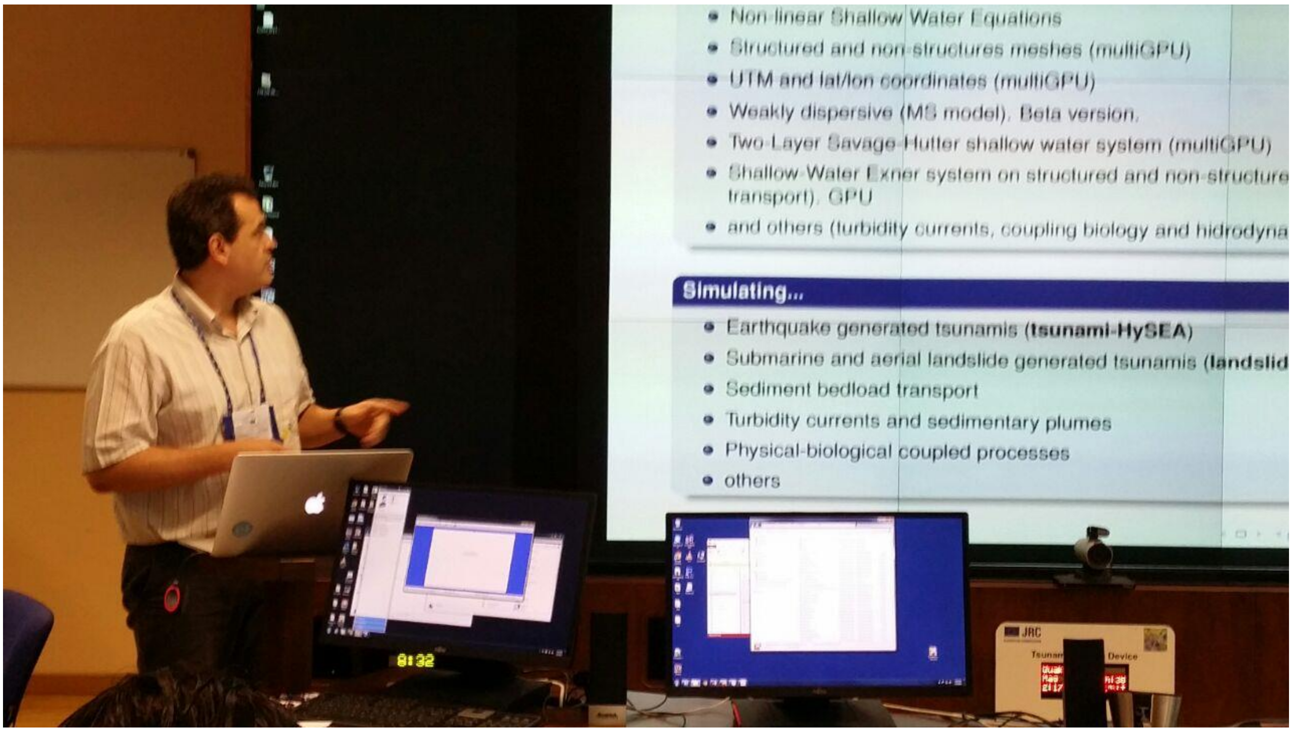


Figure 41 – José M. González Vida during UMA demonstration

Visualization of UMA demonstration displayed on the video wall

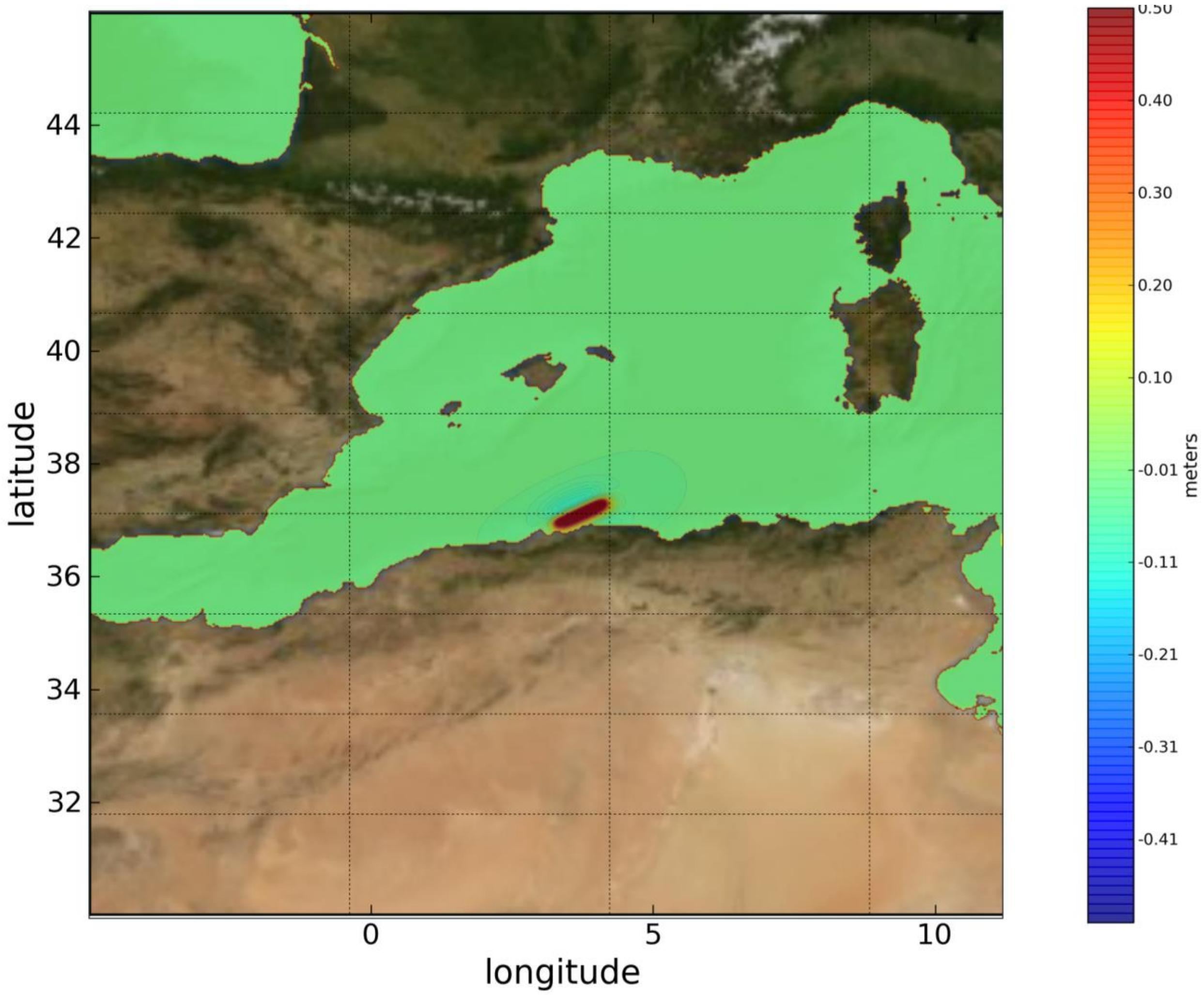


Figure 42 - Zoom view of initial conditions (TIME: 0)

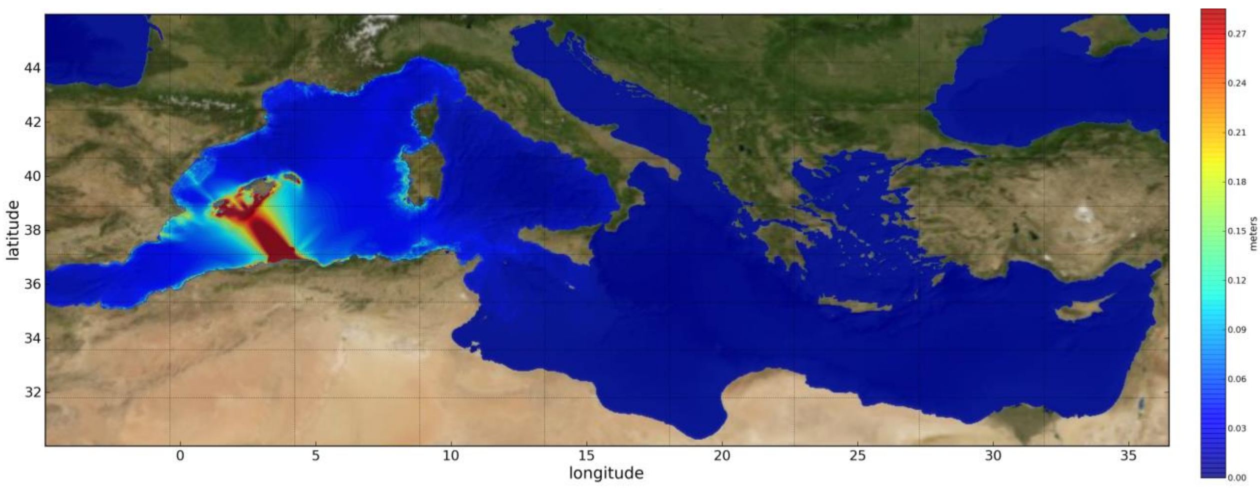


Figure 43 - Map with maximum wave amplitudes

Timeline of the calculations

Date	Event	Time difference
02 Jul 2015 15:23	Mw 7.7 in Aegean Sea	-
02 Jul 2015 15:23	Full non-linear calculation completed	+ 27s

Table 6 – Recorded events

Less than 27 seconds were required to perform 4 hours of wall-clock simulation with HySEA using a 30 arc-sec resolution mesh with 597,600 cells. HySEA always use the non-linear shallow water equations.

The brief analysis that was done, showed similar behaviour of the TRIDEC case that was run adopting similar fault conditions (strike=60, dip=45, rake=90) but in 2 arc-min resolution mesh.

Conclusions on the UMA demonstration

The UMA calculation system provided to be a very powerful calculation tool that could be either integrated or interfaced with other DSSs.

The multiGPU version of tsunami-HySEA was able to fulfil the required task (full calculation of a tsunami) without large effort from the operator and in very limited time.

5.8 NOAA Demonstration

NOA demonstration was performed using the **Tweb** application. It is a web-based tsunami modeling tool used to generate and view tsunami forecasts. Tweb collects and extends tools developed at the NOAA Center for Tsunami Research (NCTR) for use in both research and operational tsunami forecasting. Built to utilize modeling and forecasting tools developed for NOAA's Tsunami Warning Centers, Tweb's first release implements the NOAA Method of tsunami forecasting.

The demonstration was performed using the large video wall in the crisis room as web client. The huge resolution of the screen (5120x2304) caused some small problems to the visualization of the tool (too small fonts, too high number of tiles to be downloaded and so slow response during zooming) but nevertheless it was impressive and very illustrative of the situation.

Two cases were ready for NOAA

1. **Japan Event**
2. Alaska event

the one that was chosen by NOAA (without knowing the details) was the following:

Date of the event: **3 July 2015 08:06 UTC**
Location: **Off-shore North of Japan**
Lat/Lon: **38.338902/145.349503**
Magnitude: **8.4 Mw**
Depth: **20 km**

Events timeline

It should be noted that, although this could have been easily achieved, there was a direct reading of the test cases from the online RSS file. Therefore the conditions have been inserted by hand by V. Titov.

No report was produced for this event but several demonstrations of the online capabilities of the system were shown. As such Tweb is a very powerful analysis tool but does not have the specific features of an operational tool (messages or reports creation, verification and comparison of sea levels)

5.9 Conclusions

The demonstration was very positive. Although the case was unknown to the NOAA operator the case was run without problems, showing that it is possible to have online signals inversion from the DART and verification with tidal gauges. The system does not create bulletins or reports for the moment.

Figure 44 - *V. Titov at work for the analysis of the event*

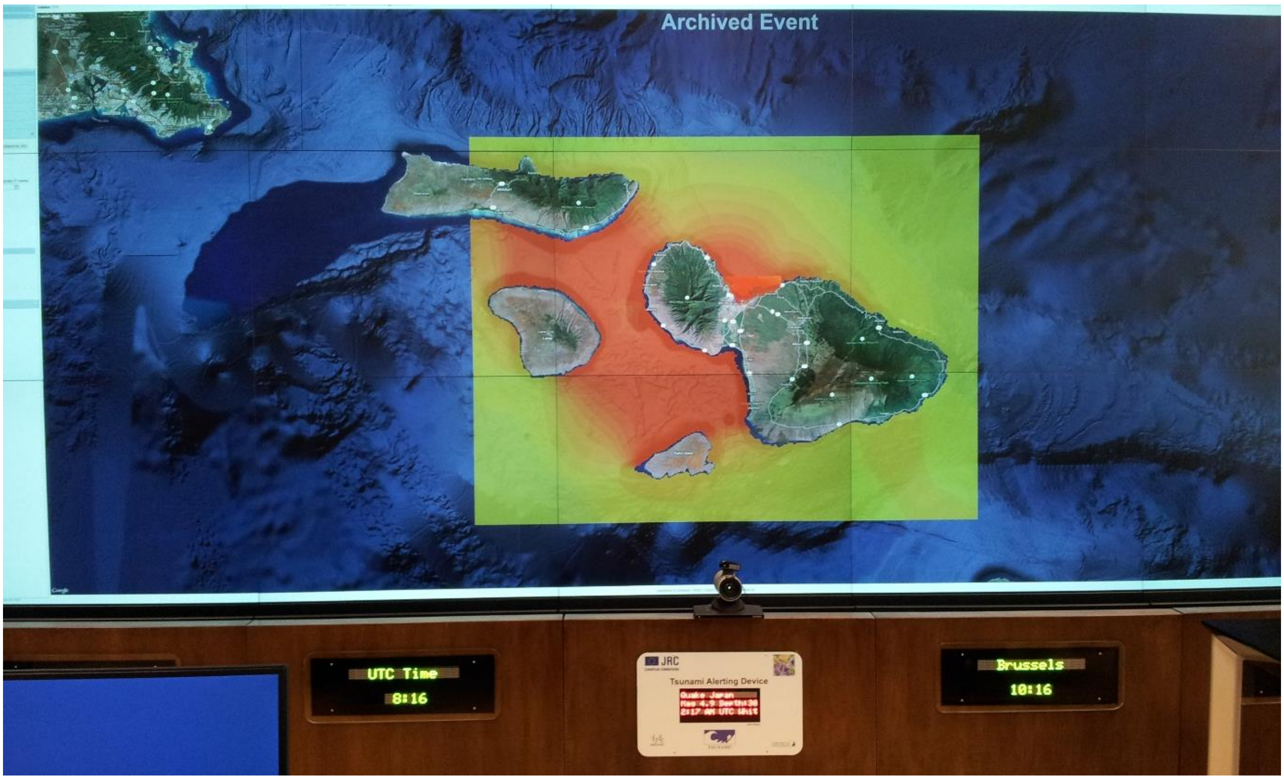


Figure 45 - *Tweb and its components allow to perform an online inundation analysis based on the inversion solution obtained using DART signals. In the figure one location in Hawaii*

Figure 46 - The same location shown above, with larger zoom level, to show the inundated areas

5.10 SHOA Demonstration

The SHOA demonstration was performed by showing which would be the typical response of a case by the Chilean Navy, responsible of Tsunami monitoring. However due to the impossibility to make an online case JRC indicated one case to SHOA some days in advance and the case was analysed off-line.

The case requested was the following:

Date of the event: **22 Jun 2015 1:46 UTC**
Location: **Off-shore Chile**
Lat/Lon: -**28.3073/-72.060**
Magnitude: **8.2 Mw**
Depth: **25 km**

Visualization of SHOA demonstration displayed on the video wall

Timeline of the calculations

Date	**Event**	**Time difference**
22 Jun 2014 01:46	Mw 8.2 off-shore Chile	-
	This particular case was not analysed	

Table 7 – List of events

ORDEN TRANSITORIA INTERNA DE
LA DIRECCIÓN DEL SHOA

OTI 004

SERVICIO HIDROGRÁFICO Y OCEANOGRÁFICO DE LA ARMADA DE CHILE

DESTINATARIO	:ONEMI	**FAX**	: 2-2524337, 2-2524338
CIUDAD	: SANTIAGO	**FECHA**	: 26-6-2015
CATEGORIA	: INFORMATIVO CON HORAS ESTIMADAS DE ARRIBO		
EVALUACION	Inserte evaluación		

INFORMACION DEL SISMO OCURRIDO

HORA LOCAL	: 27-9-2013 05:35	**FUENTE**	: CSN
HORA RECEPCION INFORMACION	: 26-6-2015 14:12	**HORA EMISION BOLETIN**	: 26-6-2015 14:30
MAGNITUD	: 8.2	**PROFUNDIDAD**	: 25.0
LATITUD	: -28.307	**LONGITUD**	: -75.06
REFERENCIA	: 82 km al O de Vallenar		

LAS HORAS ESTIMADAS DE ARRIBO SERÍAN LAS SIGUIENTES:

Bloque	**Nivel de Alerta**		**Hora de arribo**	**Arribado**
Arica y Parinacota	Alerta	0 1 2	27-09-2013 05:56 (Hora de Chile Continental)	SI
Tarapaca	Alarma	0 1 2 3	27-09-2013 05:56 (Hora de Chile Continental)	SI
Antofagasta Norte	Alarma	0 1 2 3	27-09-2013 05:50 (Hora de Chile Continental)	SI
Antofagasta Sur	Alarma	0 1 2 3	27-09-2013 05:50 (Hora de Chile Continental)	SI
Atacama Norte	Alarma	0 1 2 3	27-09-2013 05:51 (Hora de Chile Continental)	SI
Atacama Sur	Alarma	0 1 2 3	27-09-2013 05:50 (Hora de Chile Continental)	SI
Coquimbo	Alarma	0 1 2 3	27-09-2013 05:50 (Hora de Chile Continental)	SI
Valparaiso	Alarma	0 1 2 3	27-09-2013 05:50 (Hora de Chile Continental)	SI
Libertador General Bernardo Ohiggins	Alarma	0 1 2 3	27-09-2013 05:58 (Hora de Chile Continental)	SI
Maule	Alerta	0 1 2	27-09-2013 06:03 (Hora de Chile Continental)	SI
Biobio	Alarma	0 1 2 3	27-09-2013 05:50 (Hora de Chile Continental)	SI
Araucania	Alarma	0 1 2 3	27-09-2013 05:52 (Hora de Chile Continental)	SI
Los Rios	Alerta	0 1 2	27-09-2013 05:51 (Hora de Chile Continental)	SI
Los Lagos Norte	Alarma	0 1 2 3	27-09-2013 05:50 (Hora de Chile Continental)	SI
Los Lagos Sur	Alarma	0 1 2 3	27-09-2013 05:53 (Hora de Chile Continental)	SI
Aysen	Alarma	0 1 2 3	27-09-2013 05:50 (Hora de Chile Continental)	SI
Magallanes	Alarma	0 1 2 3	27-09-2013 05:54 (Hora de Chile Continental)	SI
Antartica Chilena	Informativo	0	--	--
Juan Fernandez	Alerta	0 1 2	27-09-2013 05:53 (Hora de Chile Continental)	SI
San Felix	Alerta	0 1 2	27-09-2013 05:53 (Hora de Chile Continental)	SI
Isla de Pascua	Alarma	0 1 2 3	27-09-2013 05:54 (Hora de Chile Continental)	SI

Figure 47 - Example of bullettin with Time of Arrival estimation.

The demonstration was not exactly the one for the case above but rather a more detailed description of the **Sistema Integrado de Predicción y Alerta de Tsunami (SIPAT).**

The system is based on:

- Seismic parameters acquisition
- Scenario identification
- Tsunami hazard identification (zones)
- Data output for bulletins
- Recording and storing

The scenario creation is under way and is based on variations of a number of parameters:

- Magnitudes 7, 7.5, 8, 8.5, 9 and 9.5;
- Dip: between 5 and 30 every 1 degree;
- Rake between 70 and 110 every 10 degree
- Depth: between 0 and 40 km every 5 km
- Shear modules: 10, 30 and 50 GPa
- 5 L:W relationships

Those parameters would lead to about 1.9 million scenarios. In order to reduce them to a more reasonable number, some simplification are applied (i.e. 3 magnitudes 7.5, 8. And 8.5) to have in the end about 1500 scenarios. The rules applied to issue messages for near field events are: Magnitude between 7.5 and 7.9 WATCH, above WARNING.

Figure 48 - The figure above reports the DSS used in the SIPAT system for an historical case.

Datos de tsunami por punto de pronóstico

Archivo '2015-June-26-14_12_53.kml' creado exitosamente. Descargar aquí.

Datos del sismo

Magnitud
8.2

Latitud
-28.307

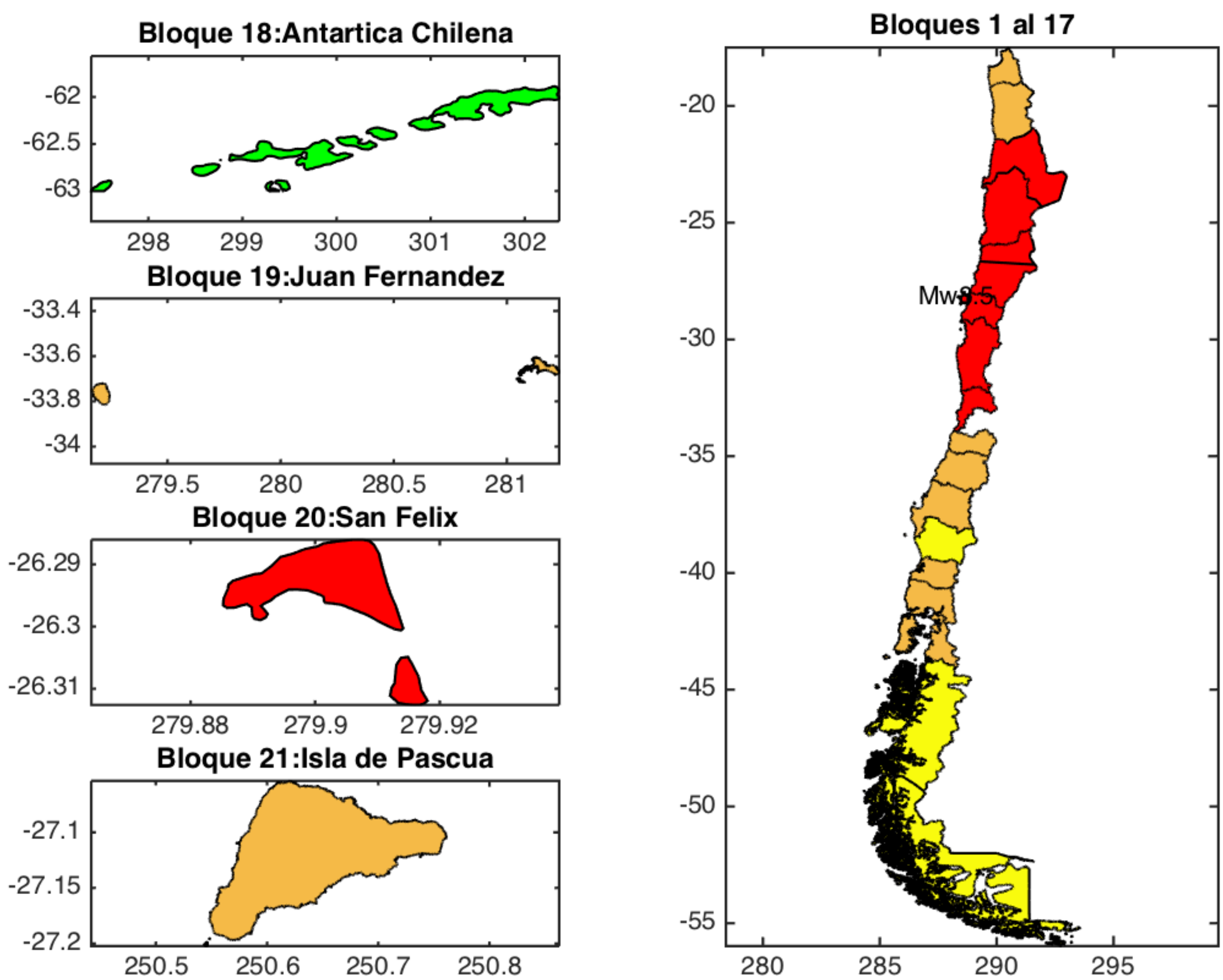
Longitud
-75.06

Profundidad
25.0

Hora
27-9-2013 05:35

Localidad	Altura [m]	Tiempo de llegada[min]	Nivel de Alerta
Callao	2.57	23	Alerta
Atico	2.24	17	Alerta
Matarani	0.82	20	Precaucion
Arica	2.79	21	Alerta
Pisagua	1.9	26	Alerta
Iquique	3.45	25	Alarma
Patache	3.99	21	Alarma
Tocopilla	3.98	15	Alarma
Pacifico	2.33	18	Alerta
Mejillones	1.25	18	Alerta
Antofagasta	1.94	25	Alerta
Paposo	1.5	24	Alerta
Taltal	3.9	15	Alarma
Caleta Pan de Azucar	3.51	19	Alarma
San Felix	2.55	18	Alerta

Figure 49 - For the event above the list of locations, arrival time and alert level are shown for each zone along the Chilean coast.



The objective is the creation of alert maps, as the one above, that reports color coding corresponding to WATCH and WARNING.

It is interesting that given a case, the alert level is the one corresponding to all the possible scenarios contained inside the fault plane; so one bulletin can contain data related to the height obtained by several pre-calculated scenarios (see figure below).

Tabla N°3: Altura de Ola en Metros en Punto de Pronóstico

	Escenarios Candidatos					
Punto de Pronóstico	sc13753	sc14958	sc38203	sc50221	Altura Máxima	Nivel Alerta
1	2.6	2.4	**3.1**	2.8	3.1	Alarma
2	**2.8**	2.5	2.6	2.7	2.8	Alerta
3	2.4	**2.6**	2.1	2.3	2.6	Alerta
...	...	...	...	...	...	...
962	0.4	0.5	**0.6**	0.3	0.6	Precaución

A Sea level monitoring programme is used to check the status of the sea level but no online comparison of the sea level with the estimated values from the calculated scenarios is provided.

Conclusions on the SHOA demonstration

SHOA is a real Tsunami National Warning Center having a strong legal responsibility (some staff member of SHOA have still legal issues for the behaviour during the 2010 Chile Tsunami). For this reason all the activities are strictly codified in procedures that must be followed: far field events are followed by using PTWC alerts while for near field events independent pre-calculations. The proposed case was a near field event and the demonstration was not related to this particular event but all the activities done for a similar event.

6 Discussion

At the end of the workshop, a round table discussion was organized and moderated by JRC. The discussion revolved around a set of questions which are reported below:

- Can tasks be fully performed?
- Would you include additional features (tech)? If yes, specify
- Describe your ideas for potential improvement
- Identify strengths, weaknesses, and opportunities of the tool(s)
- Can your software/tool be integrated into more complex systems? If yes, how?
- What are your plans for future developments? (e.g. integration into social media)
- What are your expectations pertaining to the tool?
- Identify gaps (e.g. early warning capabilities, understanding crisis dynamics etc.)
- Does the tool/software help the user performing the tasks? Yes/No
- Is the GUI (Graphical User Interface) user-friendly?

The main aims of the discussion were to identify both new opportunities for collaboration and for tools integration and also to “bridge the gap” between the scientific and technical level and the operational dimension. There are new tools and functions that could be integrated into existing tools. The debate aimed at touching upon strengths and weaknesses in order to share ideas for potential improvements and future plans. It is worth noting that, despite being structured, the debate was flexible enough to allow space for comments and considerations which went beyond the questions. Due to time constraints, not all questions were considered during the discussion. Therefore, the participants had the opportunity to send their answers to JRC over the weeks that followed the event.

In the following section, either issues that emerge during the discussion or answers provided later on by the participants are captured.

6.1 SHOA

With regards to SHOA (Chile), the tools which have been implemented at a national level, can perform all relevant tasks but, as mentioned in 4.2.5, the Chilean case is different from others due to its proximity to the tsunami source. They are working to improve the time of response (e.g. alerting the population). The TTDS with pre-modeled scenarios (1528 pre-modeled events), will be able to provide a first evaluation of the situation in less than 1 minute in order to issue the first bulletin within 5 minutes after the earthquake. After the database implementation, more real-time buoys will be needed too, along with the general need to also integrate flooding and inundation maps in the current system. During the debate, the usefulness of flooding maps for risk assessment was raised. This triggered a short discussion among the participants on the use and the effectiveness of those maps. Pertaining to the use, concerns were raised with reference to both specific skills in order to read flood maps properly, while pertaining to the effectiveness reflections were made on potential benefits which could be significant if flooding maps have an impact on actual evacuation plans. Questions were also raised on the opportunity to link tsunami wave prediction systems to pre-prepared flood forecasts. Other plans for integration include sea level sensors and GPS measurement in real-time.

Ideas for improvement revolve around six main dimensions which include both technical and non-technical aspects. First, the integration of sensors such as tidal gauges, DART buoy accelerometers and GPS in order to get a fast identification of the focal mechanism, and in doing so, avoiding false alarms. Second, cover as many scenarios as possible in the database. Third, link the TDSS results to flood maps in order to help stakeholders to take better decision as far as evacuation plans are concerned. Fourth, develop a specific "training mode" to use during daily drill exercises and fifth, use GPU and social networks (Table 8 – Strengths, weaknesses and opportunities of the tools (Table 8).

Strengths	• TTDS will allow to the division of the countries into areas, according to different tsunami threats
Weaknesses	• While the tsunami amplitude is represented • SOPs will be changed with a transition period in order to develop stronger training
Opportunities	• Use HySEA for real-time processing. This might improve the bulletins after the first one is issued • The use of social network for tsunami threat evaluation

Table 8 – Strengths, weaknesses and opportunities of the tools

6.2 KOERI

With regard to KOERI (Turkey), the first part of the discussion was focused on TAT. Pertaining to its use, tasks can be fully performed. There are opportunities for improvement and additional features can be added. It was highlighted that, at the moment, it is not possible to have a web interface for several reasons, one them being the challenges to back up a web interface, in the case of a communication shut down.

It was mentioned that TAT has facilitated international cooperation and this has led to important synergies, also echoed in the workshop. The discussion turned then to the benefits of organizing such an event, in particular, fostering collaboration and driving innovation in the IT field. This topic was also raised during the debate around TRIDEC Cloud (Germany), in which the need for *"more interoperability within the same toolbox*" was mentioned and emphasis was given to the chance of having TAT source code for further development and customization. The key concepts here were innovation, interoperability and integration.

Pertaining to the Intergovernmental Coordination Group of the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and connected areas (ICG/NEAMTWS), the requirements of KOERI were fulfilled. Additional features, like the integration of interactive maps, were stressed along with the idea of setting up a dedicated web site where end-users could access warning features through single-factor authentication. However, the software as such cannot be integrated into more complex systems and, as is stands, it is designed for the "needs of yesterday's end-users" but not for today's and tomorrow's. Having said that, the graphical user interface is user-friendly.

Strengths	• In-house build • Independency
Weaknesses	• Limited resources on technological development • TSUCOMP: the system is not mature yet, but is capable to address all

	operational requirements of the NEAMTWS-CTSP.
Opportunities	• It could be used by NTWCs in developing countries almost as plug-and-play

Table 9 - Strengths, weaknesses and opportunities of the tools

6.3 TRIDEC Cloud

As far as TRIDEC Cloud is concerned, all relevant tasks required to act in a real event (from monitoring to disseminating early warning messages) are covered. However, the platform depends on other systems and it serves only one link in the overall early warning and fast response chain. Important features that would be included pertain to the the integration of the following:

- High detail bathymetry and detailed earthquake focal mechanism,
- Forecast models to cover specific regions (with better and extended forecasting, e.g. expected run-ups),
- Pre-computed simulation databases in parallel to instant tsunami propagation calculations,
- Additional data to provide extended information for situation pictures (e.g. expected losses and damage),
- Other systems to support the "toolbox" mentioned above,
- Community tools in a distributed enviroment that enables collaboration within the community.

Lastly, another important feature would be the coverage of natural hazards and related disasters.

In addition to that, future developments were described, pointing out that they depends on three aspects: the TRIDEC community which asks for specific features, the plans of the system provider and research questions to investigate opportunities relevant for early warning and fast response purposes.

TRIDEC Cloud can be integrated into more complex systems as it supports interfaces. It is possible to integrate the data for further use in any other system. Thus other systems are enabled to take data out of the TRIDEC Cloud, to access event data and simulation computation results and to embed maps and messages in other places. Other sources are also supported with the interfaces to feed data into the TRIDEC Cloud to integrate: a) latest earthquake event data b) historic earthquake catalogues and c) latest and historic sea level measurements. Additionally it is possible to instruct instant simulation computations by making use of the interfaces.

Future developments include:

- Multi-channel dissemination of customized, user-tailored warning messages and complementary, interactive warning products such as Shared Maps and Cloud Messages supported on mobile devices,
- International centre-to-centre communication in a collaborative environment,
- National communication of public authorities and government agencies, including relief units,
- Integration of conventional and unconventional sensors and sensor networks addressing crowd mapping eyewitness and situations reports, social media channels, QCN and others to support rapid in-situ crowd-sourced measurement by people actually experiencing the crisis event, e.g. using mobile devices,
- Open, standards-based interoperability between systems to support the system-of-systems and toolbox approaches,

- Automatic integration of latest satellite and airborne device imagery, e.g. in conjunction with the International Charter Space and Major Disasters

Strengths, weaknesses and opportunities emerged as follows:

Strengths	• Requirements: a web browser and an Internet connection. No additional installation needed • Simple, effective and responsive user interface
Weaknesses	• TRIDEC Cloud is currently not being used in an operational environment
Opportunities	• Possibility to connect with TAT to obtain a complex integrated tool

Table 10 - Strengths, weaknesses and opportunities of the tools

A question pertaining to the use of TRIDEC Cloud was asked, in particular how to get an account. Asking for account creation at http://trideccloud.gfz-potsdam.de/ to sign-in through the web interface is the only thing which is requested at the moment.

6.4 RIMES

In the case of RIMES (Thailand), some minor tasks during offline event were not fully perfomed (e.g discrepancies between the actual and the standard format of the message). The drawbacks of manual input were discussed in relation to ideas for potential improvements. The tool, as already pointed out during the presentation, is not entirely automated yet and this might cause mistakes and requires human intervention and constant attendance. The staff on duty should only check the generated information for confirmation insead of entering data manually. However, it was also pointed out that attendance is nevertheless always needed in case of event management. Before sending an important alert, human intervention is unavoidable. It was also reiterated the need for more training and, overall, for more human resources. Organizing training modules tailored for different member countries is not a trivial task due to the variety of socio-cultural background and experiences in crisis management. Moreover, counties have different demands and requirements which make early warning capabilities challanging as information has to be customized following a basic standard to avoid confusion.

The software can easily be integrated with other tools into more complex systems. Integration into social media has not been taken into account yet, as more work is needed to make it more realiable as far as accuracy of information is concerned. The GUI is user friendly (but it can be improved) and the software helps the user perfoming the tasks.

Strengths, weaknesses and opportunities can be represented as follows:

Strengths	• Asian countries unified system
Weaknesses	• The manual input of data into the device which might lead to mistakes
Opportunities	• It can be developed further, also by other agencies • More functions can be added in the future

Table 11 - Strengths, weaknesses and opportunities of the tools

6.5 NOA

NOA (Greece) uses TAT, so the analysis was mainly focused on this tool. With regards to tasks, those described in the Operational Users Guide of NEAMTWS can be fully perfomed. Potential tsunamigenic events can be analysed and relevant tsunami warning messages can be disseminated. It emerged that having more tsunami codes available to run the simulations would be very helpful. While there is a web version, one with more features would be greatly appreaciated. More standandardized export capabilities of the results of the analysis would be convenient too (e.g. grids and shapefiles). The implementation of export features could have direct benefits, *inter alia* the integration in maps and bulletins generated by Civil Protection. Once again, as shown below, the chance of having TAT source code for further development and customization was emphasized, reinforcing the idea that, for a warning centre, it would be essential to have "full access" to the tool in order to gain complete understanding.

TAT's strengths, weaknesses and opportunities are identified as follows:

Strengths	• The comprehensiveness of the tool for early warning purposes and for tsunami analysis • Dissemination of warning messages through fax, e-mail, GTS and SMS
Weaknesses	• Restrictions in developing and customizing the tool (close architecture)
Opportunities	• To follow fast running codes development

Table 12 - Strengths, weaknesses and opportunities of the tools.

6.6 CAT-INGV

As far as CAT-INGV (Italy) is concerned, both the tasks of issuing alerts and the observation of sea level data for providing "ongoing" and "cancellation" messages have been working well. The hazard estimation simplified matrix (NEAMTWS) has been improved in order to reduce false alarms. Additionally, they have been working on the implementation of scenario-based alerts. However, due to the absence of fast direct measurements of tsunamis in the Mediterranean Sea, a vast amount of different combinations of pre-calculated scenarios (e.g. focal mechanism, slip distribution etc.) have to be analyzed "on the fly". As a consequence, the forecast is: a. based on a set of a priori assumptions (e.g. local tectonics and earthquake scaling laws), b. based on previously observed seismicity and c. fully probabilistic for the uncertainty of earthquake parameters and numerical modeling of tsunami propagation and impact. Overall, dealing with big data might be a challenge.

The software can be integrated into more complex systems and plans for future developments include:

- The enhancement of the bilateral cooperation with other Mediterranean Institutions for better monitoring with strong motion and GPS.
- The identification of best practices to communicate alerts to media (and through social media) and citizens (together with the Italian Civil Protection Department as well as local authorities, and experts in social sciences)

- The development of probabilistic analysis of tsunami hazard in the region. This could be also useful to develop evacuation maps and routes.

Strengths, weaknesses and opportunities are articulated as follows:

Strengths	• Human resources (quantity and quality) • Software for sea-level data (JET) and software (Early-Est) estimating locations, magnitudes, fault plane solutions and tsunami discriminants
Weaknesses	• Data communication (from remote stations and other networks is not always 100% safe) • Sea-level data are not well distributed over the Mediterranean
Opportunities	• The software for earthquake detection and magnitude estimation, developed for the CAT, “Early-Est”, is fully available for other users/centers, either via web or on-site. Besides location parameters, it provides Mb, Mwp, Mwpd and fault plane solutions and, in addition, it also provides “tsunami potential” discriminants based on the direct P-wave measurements, not used (yet) in tsunami forecast operations, but explicative for rapid evaluations of the severity of the tsunami threat • INGV, with its long-standing seismic monitoring experience, is fully available for mutual exchanges, capacity building initiatives, mutual training, etc.

Table 13 - Strengths, weaknesses and opportunities of the tools.

Another interesting aspect that emerged relates to the alerting system. In the national Italian context this is a significant issue, especially after L’Aquila earthquake (2009) and subsequent issues revolving around preditions and responsibility. INGV exchanges information with Civil Protection who is responsible for issuing alerts both to local authorities and to citizens. What needs to be carefully considered, is the legal responsibility of people working at INGV. The difference between the scientific level (e.g. tsunami forecast) and the political level (e.g. decision on evacuation) have to be addressed. This issue was raised several times during the workshop.

6.7 HySEA UMA

Pertaining to HySEA (University of Malaga), the tasks during the demonstration were fully performed in 26 seconds. They are currently working to improve the system and add new features, in particular:

- A static balance to get a better GPU load in the multi-GPU version (In the model devoted to TEWS, Tsunami-HySEA),
- A weakly dispersive version in order to include these effects combined with fast computation times,
- An efficient (in terms of computation time) nested-meshes version in order to compute the inundation stage with multi-GPU frameworks (Tsunami-HySEA). The aim is to provide a real-time inundation assessment.

Additionally, they are working on adopting multi-GPU Multi Level Monte Carlo (MLMC) techniques to be used in conjunction with the Tsunami-HySEA model. The ability to provide probabilistic solutions is a potential improvement UMA has been working on.

HySEA can be integrated into more complex systems as the input/output of the model can be adapted to any system or even provide the required parametric output of any system.

Strengths, weaknesses and opportunities are described as follows:

Strengths	• The combination of reliable, robust and efficient higher order finite volume models that are able to run with arbitrary topo-bathymetries and with free-in-land boundary conditions
Weaknesses	• The architecture dependency on CUDA, in order to obtain the maximum performance of nVidia GPUs
Opportunities	• FTRT Multi-GPU based models can be a new valuable additional tool for the TEWS and decision makers • HySEA could be easily either integrated or interfaced with other DSSs

Table 14 - Strengths, weaknesses and opportunities of the tools

Tsunami HySEA, combined with a very efficient multi-GPU implementation, is offering good and accurate results in really faster real time (FTRT) computation times. Overall, there is a good balance between accuracy and computation. The challenge here in fact is to give the best of a numerical model (as far as accuracy is concerned) in really short computation times. The weakness outlined above, might be avoided by coding an OpenGL based version but at the prize of a lower performance.

The expectations pertaining to the tool concern its use by the tsunami research community and, more generally, around the world given the flexibility, simplicity, robustness and rapidity and reliability of such a numerical tool for tsunami simulations.

The tool helps the user performing the tasks and the capability of simulating both propagation and/or inundation experiments in faster than real-time adds a new perspective to tsunami simulations. It does not implements any graphical user interface but it could be easily integrated in any existent GUI by adapting the input/output to the system.

Overall, a “fil rouge” that was not always clearly expressed but nonetheless arose during the round-table discussions was the necessity to test the tools within operational environments. Benchmark levels, in fact, are at least two: scientific and operational. In future research, efforts shouls be made in order to transit from the scientific perspective to the operational without losing crucial lessons learned. Questions were also raised pertaining the very expression “operational tool” (What does it entail? A certification process? A checklist? Or is a tool operational when an operational agency uses it?).

7 Conclusions

The workshop was a very good opportunity for several research and operational team to discuss for 1 and ½ day on the same topic, i.e. Decision Support Systems. Very often this occupies a small part of overall discussions on the Tsunami monitoring while here these systems were deeply analysed and could also be seen in action when an unknown event was proposed.

The main conclusions that could be drawn are the following

- Decision Support Systems are essential tools for Tsunami Monitoring. The more user-friendly and the more flexible a tool is, more is appreciated and used. The reliability and the quality of the results are essential for who needs to analyse Tsunami events. TRIDEC and Tweb tools demonstrated to be very user-friendly and fast running to allow an easy integration in the monitoring centres procedures

- The availability of fast running codes, such as HySEA, demonstrated to be a valid alternative to the lengthy development and giant space occupancy of scenario databases. *Who is currently using logarithmic table paper sheets instead of handy calculators to have the same answer ?*

- Some systems, such as TAT or TsuComp, proved to be effective for the purpose of generating the required alerting messages. TAT contains a number of graphical and functional options not yet present in TsuComp but the last one showed to be very easy to use and fast running.

- Some operational systems, like the ones of Rimes and Shoa, indicate that the time available for deciding to evacuate or not an area is larger than in the case of Mediterranean Sea Monitoring centres. For this reason it is important to have different strategy for close or far sources

- Liability is an issue and DSSs can help the operators to judge and take proper and justified decisions. How the liability of the decision is trasferred to the owner or the developers of the DSS is under discussion

- The possibility to see in action other systems is considered very useful and the formula adopted could be repeated in other context and other meetings, to involve other participants

- Early Est (with tsunami discriminants) is available for testing and performance comparisons.

- It is of utmost importance, in a complex tectonic setting like the Mediterranean, and in the absence of direct tsunami measurements (e.g. DARTs), to switch from impossible deterministic tsunami forecast to fully probabilistic forecast, accounting for the uncertainties on earthquake parameters (hypocentre, magnitude, mechanism, fault size, slip distribution).

8 Appendices

8.1 List of Acronyms

ENCML	European Crisis Management Laboratory
CAT	Centro Allerta Tsunami
CEA	Commissariat Energie Atomique
DART	Deep Ocean Assessment and Reporting of Tsunami
DSS	Decision Support System
ETA	Estimated Time of Arrival
EWH	Estimated Wave Height
FTRT	Faster Than Real Time
GDACS	Global Disaster Alert and Coordination System
GPU	Graphic Processing Unit
GTIMS	Global Tsunami Informal Monitoring service
HySEA	Hyperbolic Systems and Efficient Algorithms
INGV	Istituto Nazionale di Geofisica e Vulcanologia
IPMA	Instituto Português do Mar e da Atmosfera
IT-cTSP	Italian Candidate for Tsunami Service Provider
JRC	Joint Research Centre
KOERI	Kandilli Observatory and Earthquake Research Institute
MLMC	Multi-Level Monte Carlo
NCTR	NOAA Center for Tsunami Research
NEAMTWS	Tsunami Early Warning and Mitigation System in the North-eastern Atlantic
NEMA	National Emergency Management Authority
NEMC	National Earthquake Monitoring Centre
NOA	National Observatory of Athens
NOAA	National Oceanic and Atmospheric Administration
NOA-HLNTWC	NOA-Hellenic National Tsunami Warning Center
NTWCs	National Tsunami Warning Centre
PTWC	Pacific Tsunami Warning Center
RIMES	Regional Integrated Multi-Hazard Early Warning System for Africa and Asia
RSS	Really Simple Syndication
SHOA	Servicio Hidrográfico y Oceanográfico de la Armada de Chile
SINAMOT	Sistema Nacional de Monitoreo de Tsunamis de Costa Rica
SIPAT	Sistema Integrado de Predicción y Alerta de
SWAN	Shallow Water Analysis
TAD	Tsunami Alerting Device
TAT	Tsunami Alerting Tool
TEWS	Tsunami Early Warning System
TFP	Tsunami Forecast Point
TFZ	Tsunami Forecast Zone
TSP	Tsunami Service Provider
TsuComp	Tsunami Message Composer
TTT	Tsunami Travel Time
Tweb	Tsunami WEB application
UMA	Universidad de Málaga, Málaga
WMO	World Meteorological Organization

8.2 List of Participants

	NAME	ORGANIZATION	COUNTRY/Int ORG	TYPE	EMAIL
1	Ioannis Andredakis	Joint Research Centre (JRC)	EC		ioannis.andredakis@jrc.ec.europa.eu
2	George Breyiannis	Joint Research Centre (JRC)	EC		george.breyiannis@jrc.ec.europa.eu
3	Chiara Fonio	Joint Research Centre (JRC)	EC		chiara.fonio@jrc.ec.europa.eu
4	Francesco Mugnai	Joint Research Centre (JRC)	EC		francesco.mugnai@jrc.ec.europa.eu
5	Daniele Galliano	Joint Research Centre (JRC)	EC		daniele.galliano@jrc.ec.europa.eu
6	Alessandro Annunziato	Joint Research Centre (JRC)	EC		alessandro.annunziato@jrc.ec.europa.eu
7	Carlos Zúñiga	SHOA	Chile	National Provider	carzu80@gmail.com
8	Silva Enrique	SHOA	Chile	National Provider	esilva@shoa.cl
9	Silvia Chacón	SINAMOT	Costa Rica	Official National Tsunami Warning Center (NTWC)	silviachaconb@gmail.com
10	Sven Reissland	GFZ	Germany	User	svenr@gfz-potsdam.de
11	Martin Hammitzsch	Potsdam	Germany	Demonstration of TRIDEC	martin.hammitzsch@gfz-potsdam.de
12	Marinos Charalmpakis	NOA	Greece	National Observatory of Athens	cmarinos@noa.gr
13	Liadapoulou Kleoniki	NOA	Greece	EWS Operator	kleoniki@noa.gr
14	Amir Yahav	NEMA	Israael	National Emergency Management Authority	amir_yahav@mod.gov.il
15	Alessandro Amato	INGV	Italy	National Institute of Geophysics and Volcanology	alessandro.amato@ingv.it
16	Miguel Angel Esbri Palomares	ATOS	Spain	Provider	miguel.esbri@atos.net
17	José Manuel González Vida	Univ. Malaga	Spain	Software Developer	jgv@uma.es
18	Macias Jorge	Univ. Malaga	Spain	Software Developer	jmacias@uma.es
19	Elouie R. Lepiten	RIMES	Thailand	Tsunami and Earthquake Monitoring Unit	louie@rimes.int
20	Ocal Necmioglu	KOERI	Turkey	EWS Operator	ocal.necmioglu@boun.edu.tr
21	Vasily Titov	NOAA	USA	Software Developer	vasily.titov@noaa.gov

8.3 Agenda

[TDSS-2015] Tsunami Decision Support Systems 2015
Joint Research Centre, Ispra, 2-3 July 2015
European Crisis Management Laboratory (bld. 68)

Thursday 2 July 2015, Morning session

Start	End		
09:30	09:50	Welcome and Introduction to the Workshop	A. Annunziato
09:50	10:10	Driver presentation	C. Fonio
		Participants presentations	
		Regional Tsunami Watch Providers	
10:10	10:25	NOA - Greece	M. Charalampakis
10:25	10:40	KOERI - Turkey	O. Necmioglu
10:40	10:55	INCOIS - India	K. Chodavarapu Patanjali
10:55	11:10	RIMES - Thailand	E. R. Lepiten
11:10	11:25	INGV - Italy	A. Amato
11:25	*11:35*	*Coffee break*	
		National Watch Providers	
11:35	11:50	SHOA - Chile	C. Zuniga
11:50	12:05	NEMA - Israel	A. Yahav
12:05	12:20	SINAMOT - Costarica	S. Chacon
		System Providers	
12:05	12:20	TRIDEC - Germany	M. Hammitzsch
12:20	12:35	NOAA - USA	V. Titov
12:35	12:50	JRC - EC	A. Annunziato
12:50	13:05	University of Malaga	JM Castro
13:05	13:15	ATOS	MA Esbri Palomares
13:15	*14:15*	*Lunch at JRC Cantine*	

Thursday 2 July 2015, afternoon session

Start	End	
		Demonstrations
14:15	15:45	INCOIS, RIMES
15:45	16:35	KOERI
16:35	17:25	NOA
17:25	18:15	TRIDEC

20:00 Dinner offered by JRC at Belvedere Hotel, Ranco

- **Friday 3 July 2015**

08:30 Pick-Up at Hotels

09:00 Arrival JRC Main Gate (Security Passes, Stickers for Devices)

Meeting Room , Bldg. 68

Start	**End**		
		Demonstrations	
09:30	10:20	SHOA	
10:20	11:10	NOAA	
11:10	*11:25*	*Coffee break*	
		Discussion	
11:25	11:40	Introduction	C. Fonio, F. Mugnai
11:40	13:10	Discussion	All
13:10	13:40	Conclusions	A. Annunziato
13:40	*14:40*	*Lunch at JRC Cantine*	
		If necessary we can continue until 15:00	
14:40	*15:00*	*Visit To JRC Visitors Centre, if time permits*	

8.4 Comments

KOERI
Dear Alessandro,

I would like to thank you wholeheartedly for organizing this event. I believe it was very useful and stimulating and provided a critical and strategic assessment of where we are and what the future of TWS' would be. I really look forward that a collaborative framework could be established among the most of the participants, if not all. In my point of view, the combination of JRC-UMA-TridecCloud could really provide a state-of-the-art system that could de facto end the non-technical complexities raised within the NEAMTWS, at least. In addition, I have the feeling that the TRIDEC Cloud can easily be extended as a platform to address other types of natural disasters and crises.

Best regards,

Öcal

SHOM
Dear Alessandro,
I would like to express all my gratitude for your kind invitation for the TDSS workshop. During the 2 intense days I realized all the progress done for several operational offices and investigation centers along the world.
We had take notes of several points which will be analyzed in order to improve our system, such as real time tsunami modeling using HySEA model, to get arrival time for the highest waves in our report, to use the tools presented by GFZ and NOAA, to use GDACS as source of information, to get involved with DRIVER project, and the last but not the least, to keep connected with all the professional and its institutions related to this business which is save lives of people in the coastal areas.
Also I hope SNAM's presentations and our experiences, comments, advices and recommendations had helped you to reach the goal and filled your expectations as well.
Definitely I would like to make stronger the ties built the last week.
Please extend this acknowledge to all your team which made such a great job!

Warm regards from Chile

Carlos Zúñiga

RIMES
I just would like to say thank you to JRC / ECML team specially to Alessandro for giving us the opportunity to attend the workshop. It was indeed very informative and useful for me. I hope we can continue exchanging notes to further enhance our capability as we further develop our system to provide more accurate information.
grazie mille,
Louie

TRIDEC Cloud
Dear Alessandro,
It was a great pleasure meeting you in Ispra.
Indeed, your happiness is well deserved - I can only return compliments: Brilliant workshop! Such a healthy and productive environment is hard to achieve. Good job.
Best wishes,
Martin

NEMA
Thank you Alesandro and JRC/ECML team for a very interesting and efficient workshop, a great atmosphere and wonderful people.
Thank you and all the best
Amir

SHOA
As Louie I want also to thank Alessandro for the opportunity and everybody else for making the Workshop so interesting.
Hope to see you in the future!
Silvia

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