# TRIDEC Cloud – a Web-based Platform for Tsunami Early Warning tested with NEAMWave14 Scenarios

EGU2015-9084, B837

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## Introduction

in times of cloud computing and ubiquitous computing the use of concepts and paradigms, introduced by continuously evolving approaches in information and communications technology (ICT), have to be considered even for tsunami early warning and mitigation systems (TWS or TEWS). Based on the experiences and the knowledge gained in three research projects – 'German Indonesian Tsunami Early Warning System' (GITEWS), 'Distant Early Warning System' (DEWS), and 'Collaborative, Complex, and Critical Decision-Support in Evolving Crises' (TRIDEC, see Hammitzsch et al. 2013) – new technologies are exploited to implement a cloud-based and web-based platform to open up new prospects for TEWS (Fig.1).

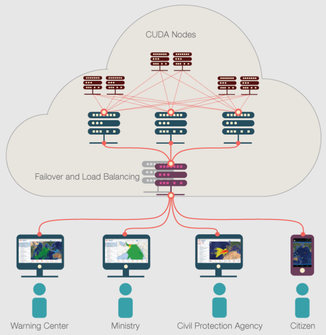


Fig.1: Cloud concept for tsunami early warning systems

The platform, named 'TRIDEC Cloud', merges several complementary external and in-house cloud-based services into one platform for automated background computation with graphics processing units (GPU), for web-mapping of hazard specific geospatial data, and for serving relevant functionality to handle, share, and communicate threat specific information in a collaborative and distributed environment. The platform is meant for researchers around the world to make use of cloud-based GPU computation, to analyze tsunamigenic events, and react upon the computed situation picture with a web-based GUI in a web browser at remote sites.

## Monitoring

The TRIDEC Cloud can be accessed in two different modes, the monitoring mode and the exercise and training mode. The monitoring mode provides important functionality required to act in a real event. So far, the monitoring mode integrates historic and real- time sea level data from http://ioc-sealevelmonitoring.org and latest earthquake information from http://geofon.gfz-potsdam.de. A Simple REST API enables integration of other systems.

In monitoring mode a list displays earthquake events with information on magnitude, location, time, and depth, as well as dip, strike, and rake. An earthquake classification is provided based on a simplified decision matrix and a tsunami prediction is available for critically classified earthquakes based on an attached simulation either computed automatically or manually (Fig.2) in the background.

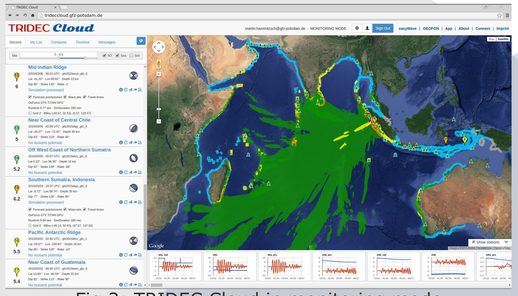


Fig.2: TRIDEC Cloud in monitoring mode

Information on earthquakes is complemented by historic and real-time sea level data. The map displays the position of the sea level stations and small diagrams below the map display the measurements for each sea level station. In default mode diagrams show the real-time data for the stations. For events, selected by the user, diagrams display the relevant sea level data for the selected event. If simulation data for an event has been computed then diagrams display additionally the predicted sea level data and enable the comparison of real data with simulation data for sea level stations. Interactive diagrams allow a detailed analysis and picking of the estimated time of arrival, the estimated wave height, and the period between wave crests. Picked values are available for automated integration in warning messages (Fig.3).

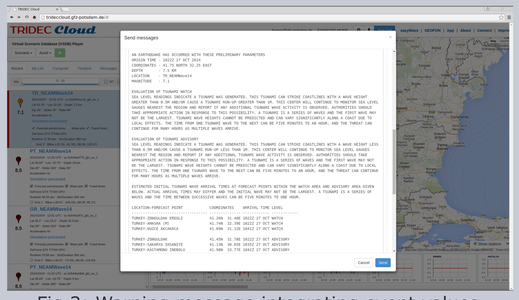


Fig.3: Warning message integrating event values

A timeline allows tracing of information and activities related to an initial event and include: Earthquake events with first information and follow-up refinements; Simulations automatically or manually processed for earthquake event updates; and Warning messages sent.

Thus the timeline enables operators on duty to follow the course of events successively without interference by other occurrence happening in parallel.

## Exercise and Training

The exercise and training mode enables training and exercises with virtual scenarios. This mode disconnects real world systems and connects with a virtual environment that receives virtual earthquake information and virtual sea level data re-played by a scenario player. Thus operators and other stakeholders involved are able to train skills and prepare for large exercises and real events. The exercise and training mode is identical to the monitoring mode except from the virtual data (Fig.4).

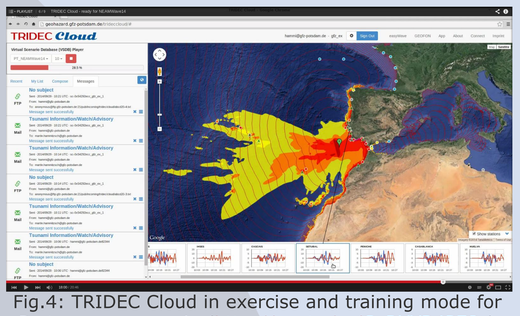


Fig.4: TRIDEC Cloud in exercise and training mode for Portuguese scenario (http://youtu.be/CaRXYR4PE8s)

The exercise and training mode has been used in an opportunity provided by the international NEAMWave14 tsunami exercise to test the TRIDEC Cloud as a collaborative activity based on previous partnerships and commitments at the European scale (Hammitzsch et al. 2014). The TRIDEC Cloud has not been involved officially in the NEAMWave14 scenarios. However, the official scenarios have been used with involved partners for testing in exercise runs on October 27, 2014 (14:30-17:30 UTC) with the Turkish scenario, on October 28, 2014 (8:00-12:00 UTC) with the Portuguese scenario, and on October 29, 2014 (13:00-16:00 UTC) with the Greek scenario (Fig.5).

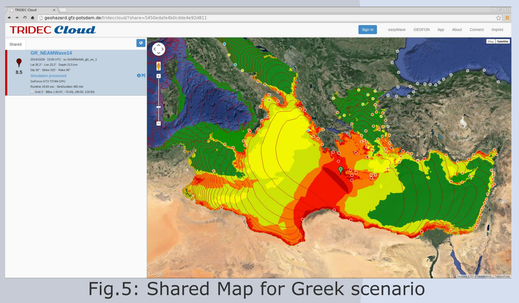


Fig.5: Shared Map for Greek scenario

## Warning Dissemination

The generation of warning messages is based on internationally agreed message structures and includes static and dynamic information based on earthquake information, instant computations of tsunami simulations, and actual measurements. Generated messages are served for review, modification, and addressing in one simple form for dissemination via Cloud Messages, Shared Maps, e-mail, FTP/GTS, SMS, and FAX.

Cloud Messages are complementary to e-mail, FTP/GTS, SMS, and FAX. This type of message is sent internally within the TRIDEC Cloud to other users and not only contain text information (the message itself). Additionally Cloud Messages integrate interactive and dynamic event and simulation data. Thus recipients are enabled to interact dynamically with the map and diagrams beyond traditional text information (Fig.6).

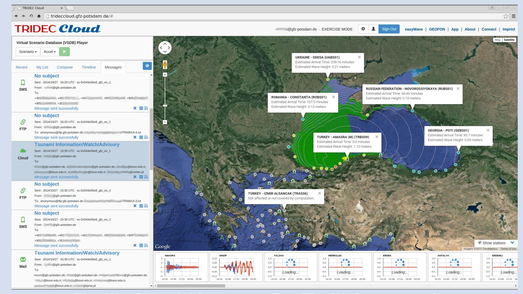


Fig.6: Cloud Message for Turkish scenario

Shared Maps are maps with related data that are shared with others by using URL addresses. A map link can be sent either to a list of closed recipients via e-mail, or to the public via twitter, Google Plus, and Facebook. Recipients open the web address in their web browser and thus can interact immediately with the shared map. This feature works even if the recipient is not a TRIDEC Cloud user. But if the recipient is a TRIDEC Cloud user Shared Maps can be copied into the recipient's user account. Thus users are enabled to fully interact with Shared Maps, modify, reprocess, and use them for further warning message dissemination (Fig. 5).

## References

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For further reference videos showcasing the different functionalities are available on YouTube: https://www.youtube.com/playlist?list=PLhQpA_m5ywciiV4HHIoam-8PFPYQIIMOq

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