TRIDEC Natural Crisis Management Demonstrator for Tsunamis

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TRIDEC – Collaborative, Complex and Critical Decision-Support in Evolving Crises

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Conclusion

The first system demonstrator, deployed at KOERI's crisis management room (see Fig. 1), has been designed and implemented to support plausible scenarios for the Turkish National Tsunami Warning Centre (NTWC) and to demonstrate the treatment of simulated tsunami threats with an essential subset of a NTWC. The feasibility and the potentials of the implemented approach are demonstrated covering standard operations as well as tsunami detection and alerting functions. The demonstrator presented addresses information management and decision-support processes in a hypothetical natural crisis situation caused by a tsunami in the Eastern Mediterranean (see Fig. 2).

Fig. 1. TRIDEC Natural Crisis Management demonstrator (left screen) at KOERI's crisis management room.

Challenge

The management of natural crises is an important application field of the technology developed in the project TRIDEC, co-funded by the European Commission in its Seventh Framework Programme. TRIDEC is based on the development of the German Indonesian Tsunami Early Warning System (GITEWS) and the Distant Early Warning System (DEWS) providing a service platform for both sensor integration and warning dissemination. In TRIDEC new developments in Information and Communication Technology (ICT) are used to extend the existing platform realising a component-based technology framework for building distributed tsunami warning systems for deployment, e.g. in the North-eastern Atlantic, the Mediterranean and Connected Seas (NEAM) region.

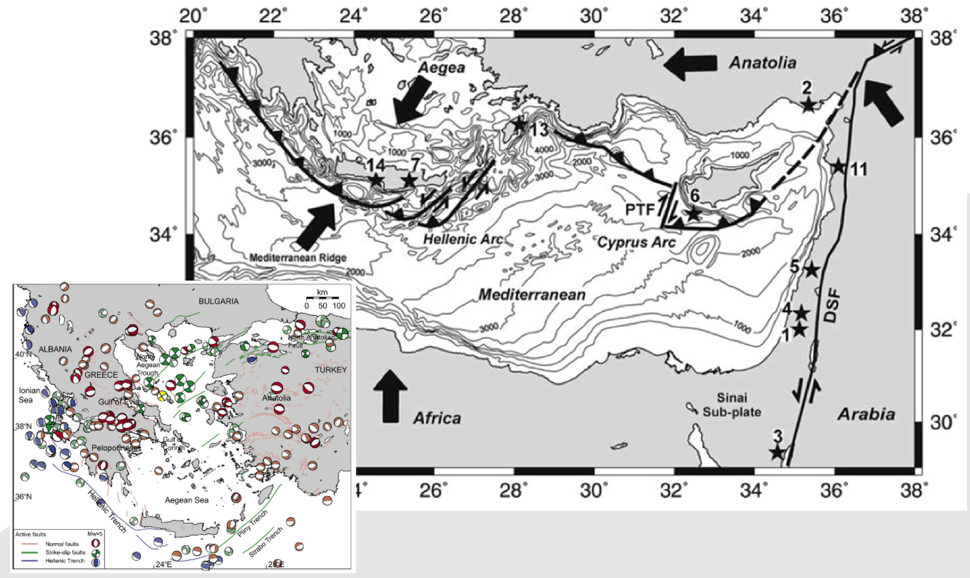

Fig. 2. left) Aegean region, showing active faults and earthquake fault plane solutions (Taymaz et al., 1991, Jackson et al., 1992 (and references therein), Baker et al., 1997) and Harvard centroid moment tensor solutions. Body wave inversion solutions are shown in bright red, blue, and green, others are fainter. The 2001 M=6.4 Skyros earthquake at approximately 24.5°E, 39°N, is indicated in yellow (Nyst and Thatcher, 2004); right) Reported locations of tsunamigenic earthquakes during 11th–15th centuries in the Eastern Mediterranean Sea region (Guidoboni & Comastri 2005a). Large black arrows show relative motions of plates with respect to Eurasia (McClusky et al. 2000, 2003). Bathymetric contours are shown at500 m interval, and are from GEBCO (1997). (Yolsal et. al, 2007).

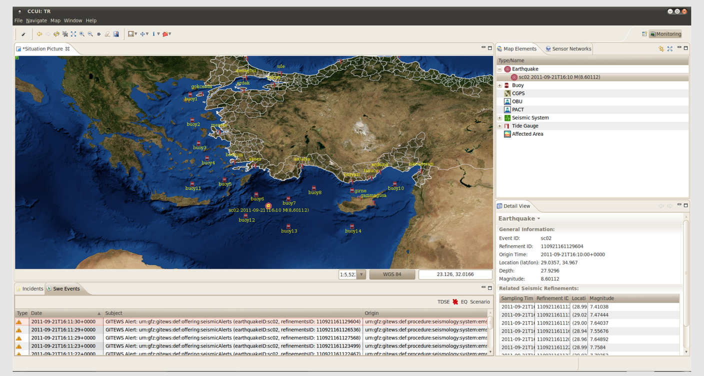

Fig. 8. Monitoring.

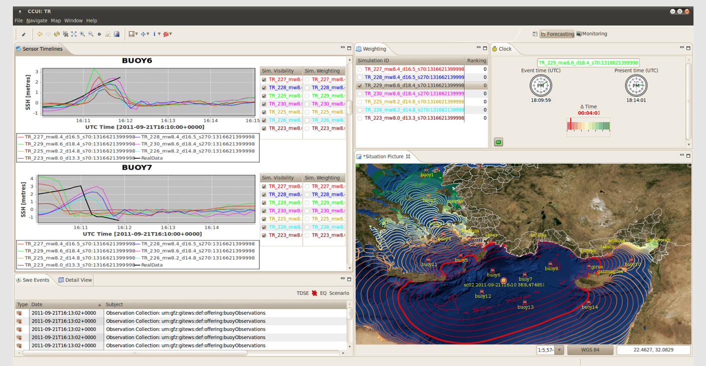

Fig. 9. Forecasting.

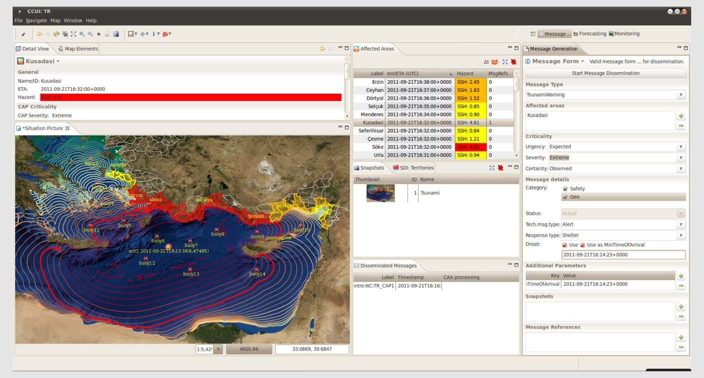

Fig. 10. Message Composition.

Aim

The TRIDEC system will be implemented in three phases, each with a demonstrator. Successively, the demonstrators are addressing challenges, such as the design and implementation of a robust and scalable service infrastructure supporting the integration and utilisation of existing resources with accelerated generation of large volumes of data. These include sensor systems, geo-information repositories, simulation tools and data fusion tools. In addition to conventional sensors also unconventional sensors and sensor networks play an important role in TRIDEC.

Method

KOERI, representing the Tsunami National Contact (TNC) and Tsunami Warning Focal Point (TWFP) for Turkey, is one of the key partners in TRIDEC. KOERI is responsible for the operation of a National Tsunami Warning Centre (NTWC) for Turkey and establishes Candidate Tsunami Watch Provider (CTWP) responsibilities for the NEAM region. Based on this profound experience, KOERI is contributing valuable requirements to the overall TRIDEC system and is responsible for the definition and development of feasible tsunami-related scenarios (see Figs. 3, 4 and 5). However, KOERI's most important input focuses on testing and evaluating the TRIDEC system according to specified evaluation and validation criteria.

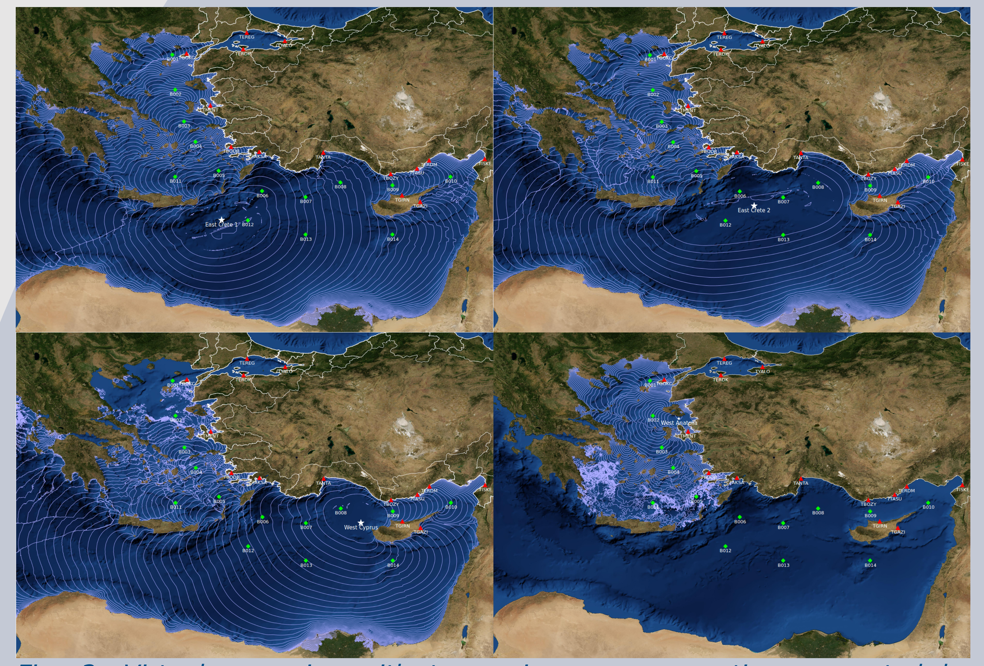

Fig. 3. Virtual scenarios with tsunami wave propagation generated by earthquake events (and with virtual sensor environment) selected for testing, demonstration and validation of Turkish system as well as used for training: East Crete 1, top left) based on historic event in 1303, 27.1°E, 34.5°N, Mw=8.0; East Crete 2, top right) fictitious event, 29.0°E, 35.0°N, Mw=8.5; West Cyprus, bottom left) fictitious event 31.9°E, 35.3°N, Mw=7.3; West Anatolia, bottom right) fictitious event, 26.4°E, 38.9°N, Mw=6.5.

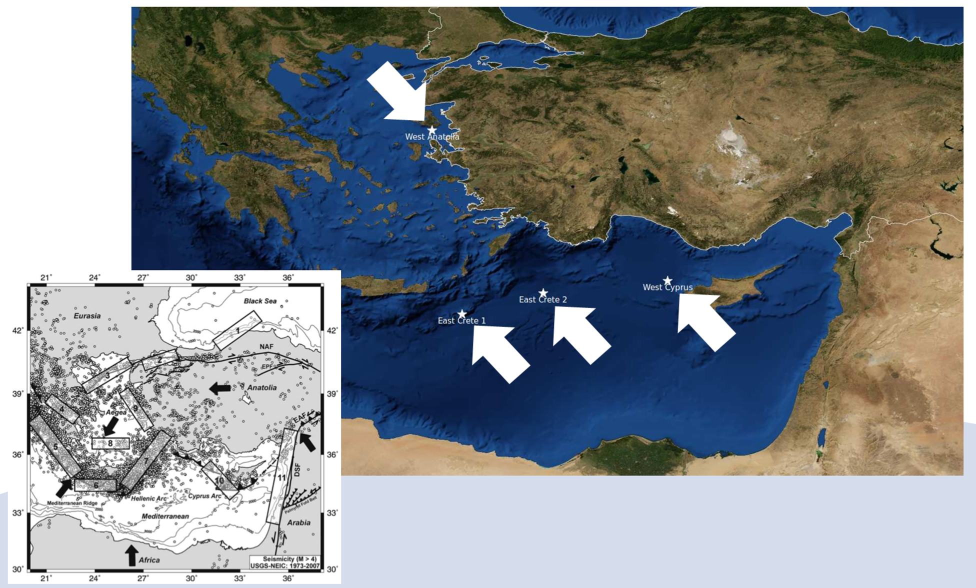

Fig. 4. left) Tsunamigenic zones in the Eastern Mediterranean Sea region. Large black arrows show relative motions of plates with respect to Eurasi (McClusky et al., 2000, 2003). Bathymetric contours are shown at 1000m interval, and are from GEBCO (1997). Seismicity of theregion reported by USGS–NEIC during 1973–2007 for M>4 is shown by small open circles (Yolsalet al., 2007); right) Locations of historic and fictitious earthquake events selected for virtual scenarios .

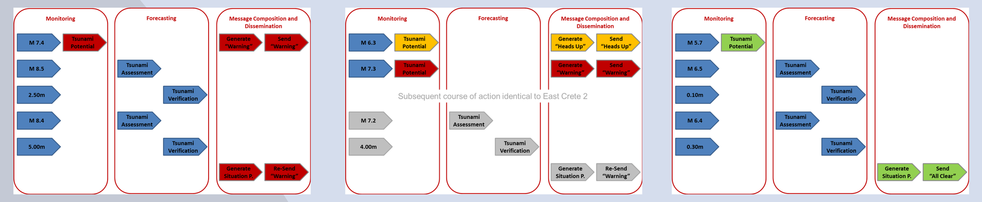

Fig. 5. Storybooks for selected scenarios: left) Earthquake with low uncertainty triggering a tsunami (East Crete 1 and 2); middle) Earthquake with high uncertainty triggering a tsunami (West Cyprus); right) Earthquake felt at the coast not triggering a tsunami (West Anatolia).

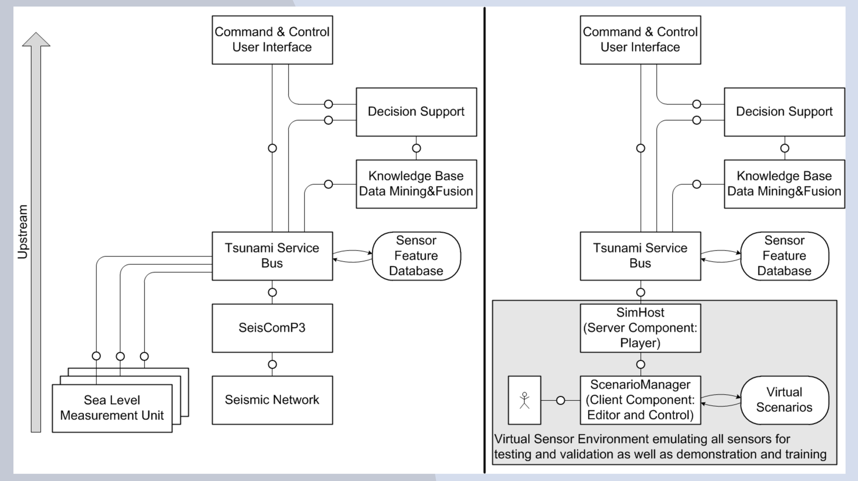

Fig. 6. System connected to real sensor environment (left), and connected to virtual sensor environment (right).

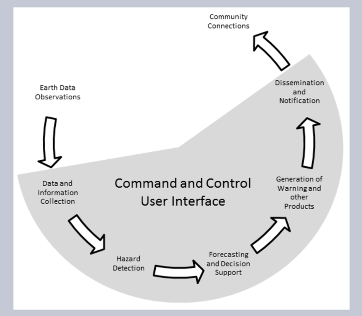

Fig. 7. Key Operational Components of an EWS for tsunami (USIOTWS, 2007) with CCUI.

Validation

For validation, the strategy described by Babeyko et al. (2010) has been applied using hypothetical future events for testing and training of core software system components. The system is being detached from real physical sensors and is being connected to a virtual sensor environment (see Fig. 6) fed by pre-computed so-called virtual scenario datasets of different sensor types. The fully synthetic virtual scenarios contain modelled sensor signals stored in natural sensor formats. Virtual scenarios can be any time played back on input to the software units. The latter does not actually realize if incoming data come from real or from virtual world. Furthermore, synthetic scenarios are fully under control of their developers. That makes them an ideal toolkit to simulate all possible situations which may realize in later operational work. Together with historical events, fully synthetic hypothetical scenarios provide a valuable basis for tuning and testing of the components as well as for teaching and training of the future warning centre personnel. Moreover, historical records, while being of highest priority, nevertheless cannot provide all necessary data for the extensive system verification and validation. Data are sparse and irregular; some sensor types were not available. In this respect, synthetic scenarios, which provide all possible coherent sensor data to the same event, appear to be the best candidates for validation, testing and training. The virtual scenarios selected for validation are listed in Fig. 3.

Future application

In the context of TRIDEC, the overall system with its key operational components (see Fig. 7) including the Command and Control User Interface (CCUI) depicted in Figs. 8, 9 and 10 is currently under further development. More extensive evaluation and revision of this system is expected to be completed in the future with successive demonstrators. The validation of the system performed against a real tsunami event is pending and has been made possible only by deployments. The deployed version of the system at KOERI corresponds to software intended for future use in a national centre for tsunami early warning after extensive location-specific validation has been successfully completed, either with different real events occurring real time or recorded. Also a successful validation importantly includes international communication with other national centres (Lendholt et al., 2012) considering the intended evolution of today's Tsunami Warning Systems (TWS) to regional or even global system-of-systems (Wächter et al., 2012).