1. Introduction

Effective tsunami early warning after an earthquake in the Mediterranean basin is made difficult by the short distances and tsunami travel times between earthquake/tsunami source regions and coast lines at risk. For tsunami hazard and risk assessment worldwide, seismic monitoring and analysis currently provide the majority of information available within the first ten minutes after an earthquake. In the future, information from multi-source buoys, GPS, archives and space systems, real-time tsunami forecasting, citizen devices, and other technologies, along with improvements in seismic monitoring and analysis procedures will help to increase the coverage, rapidity and reliability of tsunami warning.

Here we examine the current and potential future contributions of seismic networks and analysis procedures to tsunami early warning in the Mediterranean basin.

2. Short time between earthquake and tsunami

Effective tsunami warning requires notification 5min or more before a tsunami strikes. But the typical distances and tsunami travel times between earthquake/tsunami source regions and coast lines at risk in the Mediterranean are small. Most source regions are coincident with zones of risk, giving an effective warning time of near zero.

For larger earthquakes and larger tsunamis, the tsunami wave travel-time across the entire Mediterranean can be several hours.

3. Current seismic monitoring and analysis

Seismic event detection and location requires about 5 triggered stations with good coverage around the event. The current coverage allows location within <2km in the Northern Mediterranean, but longer (up to ~5km) along the North Africa coast – an important source region for large earthquakes and tsunamis.

After location, rapid, body-wave magnitudes (ML, mb, Mwpd, ...) can be obtained in <2-3min; first-motion (FM) mechanisms in <5sec; CMT moment-tensors and magnitudes (Mww, Mwpd, ...) are available after 10-20min.

With the goal of rapid, evolutionary source and tsunami parameter calculation and display, ongoing and future improvements in seismic monitoring and analysis can greatly aid in effective tsunami warning:

- Dense, “Early-warning” (EEW) networks and Ocean Bottom Seismometers (OBS) in critical source areas.
- More stations near tsunami source regions and in Northern Africa.
- Robust, real-time data feeds with very low latency (<5sec).
- Calculation, dissemination and effective display of rapid, non-saturating magnitudes, direct tsunami discriminant and CMT determinations (TdT50Ex, Mwpd, Mww, ...) Lomax and Michelini (2012)
- Comprehensive information display including decision diagrams.

4. Improvements in seismic monitoring and analysis

5. Timing and reliability of established and newly proposed seismic methods

6. Other technologies

7. Information and decision aids

Evolutionary presentation of graphical and text information along with color-coded decision diagrams are critical for automated and human analysis actions in response to an ongoing event.

8. Conclusions

The current and future state of seismic monitoring for the Mediterranean region can provide within 4-10 min important basic information for earthquake sources, including location, size and faulting mechanism, along with direct indicators of tsunami potential. Comprehensive physical characterizations of the sources, such as CMT moment-tensors and finite faulting models may be available within 20 min.

Since effective tsunami warning requires notification 5 or more minutes before a tsunami strikes, this seismic information can contribute to warning for coastlines at greater than about 50-100 km from a tsunami-generating earthquake. For closer coastlines, warning will require direct response of the affected population, advanced seismic early-warning networks, direct GPS and wave-height measures, and other technologies. Programs emphasizing tsunami awareness and individual response actions for the general population are of utmost importance.

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