IN SITU DETECTION OF TSUNAMI AND OTHER SEA LEVEL RELATED HAZARDS - FROM A CONCEPTUAL APPROACH TO IMPLEMENTATION AT MEDGLOSS STATIONS

Sergiu Dov Rosen [1]* and Sagi Raz [2]
[1] Israel Oceanographic & Limnological Research and MedGLOSS Focal Center, Haifa, 31080, Israel - rosen@ocean.org.il
[2] Raz - Handasa Bio-medical engineering

Abstract
This paper presents first author's concepts for fast in situ detection of sea level induced hazards (tsunami, seiche, extreme sea levels, storm surge, extreme sea states, meteo tsunamis) and their implementation at sea level stations of MedGLOSS network. This is accomplished via real time low latency multi sensors (atmospheric pressure, wind, sea level) data gathering and by the processing and analysis of the data, using a specially developed software package. The basic idea is based on gathering the sensors data for a number of overlapping and time sliding windows of varying length and frequency and by analyses of cross correlations, trends, spectral and cross spectral data analyses.
Keywords: Sea Level, Tides, Time Series, Sampling Methods, Instruments And Techniques

Introduction
The importance of rapid detection and alert of tsunamis for providing early warning against such events has reached full recognition already at the first meeting of the Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North Eastern Atlantic, the Mediterranean and Connected Seas (ICG/NEAMTWS), because of the relatively small size of the Mediterranean Sea and the implicit short warning times for sites on its coasts. Along with the adopted decision for setting up a multi parameters and multi hazard early warning system, detection of these hazards using sea level monitoring sensors implicates continuous low latency monitoring of the sea level surface elevation at selected sites. While typical tsunami waves have wave periods from above 5 minutes to about 60 minutes (at least in the Mediterranean), there are additional infragravity waves in this wave period range of other origins which may superpose or be miss-identified as tsunami waves. Such infragravity waves can be due to bounded wave groups, as well as free waves such as edge waves, atmospheric pressure fluctuations (meteo-tsunamis), wind gusts, etc. Within the list of other hazards induced by sea level rise we may list flooding and/or coastal erosion due to storm surges via wind induced set-up (usually associated also with barometric lows), due to storm waves induced large superelevation within the surf zone (growing towards a maximum at the waterline) and extreme spring tides. Hazards due to sea level lowering, inducing coastal erosion and removal of various types of debris from the land and foreshore are due to tsunamis, while wind induced set-down or barometric highs may lead to navigation problems. It is thus obvious that the monitoring of sea surface fluctuations for the detection of tsunami waves must be capable to monitor at the same time other types of sea level fluctuations due to non-tsunamigenic origin and for this reason a low latency monitoring rate of the sea level is compulsory.

Paper contents
The paper will discuss the following aspects:

a. Monitoring and proper identification methods of the type of sea level hazard as a function of the location of the monitoring station (deep water, transient depth, surf zone, inside a harbour).

b. Present approach used for detection of tsunami waves in deep water for early warning.

c. The conceptual approach used for detection of tsunami waves in deep water as well as near the shore, separately for each type of location.

d. The sensors complementary to tide gauges, sampling rates and methods of data processing for rapid identification of sea level hazards.

e. Conceptual approach used for rapid detection of the hazards, including multi size and overlapping sliding data windows and the short term trend analyses, identification of the infragravity waves due to bounded long waves via Smoothed Instantaneous Wave Energy History (SIWEH) analyses (Funke and Mansard,1979), run length (Battjes and Van Vledder, 1984), temporal and spatial group steepness via Hilbert transform (Haller and Dalrymple, 1995), etc.

f. The approach chosen for the development of the special software package for rapid detection of sea level related hazards using the low latency data from submerged Paroscientific pressure sensor, Aanderaa wind station and Setra barometer with which are equipped some of the real time MedGLOSS sea level stations selected for participation in the preliminary NEAMTWS tsunami detection pilot network.

To enable the above concepts, first the MedGLOSS RT MONITOR software real time clock data gathering, analysis and real time data transmission was developed by the second author based on the specifications of the first author, and implemented at a number of MedGLOSS stations using the National Instruments LabView software development package and cRIO-9072 CompactRIO Controller and Chassis Integrated System with WINDOWS XP PRO operating system.

Based on the low latency data gathered by the RT MONITOR software, a sequence of windows of the data, covering overlapping and the sliding time windows from 17 minutes to 1/2 day are used to for fast determination via trend analyses, spectral and cross spectral analyses, correlation and other statistical data analyses methods as indicated above, based on the observed data, when such event is encountered and the sources leading to the fast sea level changes (tsunami, infragravity waves, seiche, storm surge, etc.). Finally, in the case that such an event would be detected, a near real time warning communication via Internet will be generated.

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