Present infrastructure - Pylos submarine observatory

DART clone (tsunami) sensor

Existing cable - NESTOR

Meteor, currents, waves

20-1000m

Sal, Temp, 500m

PA(L) (Passive Acoustic Listener)

POSEIDON-II

AIR-SEA, WATER AND SEA BED OBSERVATORY
The **Pylos** Deep reference station

- In Operation since Nov 08
- 0-1000m Temperature & Salinity sensors: monitoring variability of deep water characteristics

![Graph showing average depth from 16-Sep-2011 to 16-Oct-2011](image)
FUTURE PROSPECTS WITHIN THE FRAME OF POSEIDON-III, KM3NET, ESONET-EMSO PROJECTS

New 48km fiber optics cable
www.grnet.gr/itu-nestor

Poseidon-III SEABED OBSERVATORY
- Pressure (tsunami) sensor (a la NOAA’s DART)
- Passive Acoustic Listener
- Radon sensor
- Salinity
- Temperature
- Oxygen
- CO2

Future KM3NET-EMSO sea bed observatory
Declared Infrastructure in EPOS

Involvement in ongoing Projects

NERA
Network of European Research Infrastructures for Earthquake Risk Assessment and Mitigation
The 365 AD event off Crete

The 365 AD tsunami reached from Alexandria to Dubrovnik. Greek tsunamis travel far.

(Shaw, Jackson, Ambraseys, others, Nature Geophysics 2008)
Current Developments (2)

- Collaboration with JRC/Ispra using TAT
- Preparation of database of hundreds of precomputed scenarios of tsunami propagation identifying target areas
- MOST and ComMIT for operational inundation mapping
- Add continuous GPS station data to rapidly detect uplift/subsidence - in testing phase at NTUA - NOA-IG
- Further Standardization of data exchange procedure for the Hellenic TWS with other national contributors
- The existing Deep Sea Platform (DPS) with a tsunamograph is fully operational (DART clone)?
- Addition of a second DPS at a new site East of Crete, another DART clone?
- Plans for acquisition of other true DARTs for the Aegean and Southern Crete?
Our approach for creating a database of tsunami scenarios for the NTWC in the Hellenic Arc

The Hellenic Arc has been divided in segments and via combinatorial analysis the accumulated slip is then divided into combinations of adjacent segments resulting into MOST scenario events for TRANSFER. (FORTH and METU).


Tinti, et al., 2003.

Papazachos, 1996.
Arrival times for tsunamis generated in the Aegean Sea. (Approximate values based on first zero crossing of offshore numerical tsunamograph.)

<table>
<thead>
<tr>
<th>Location (offshore)</th>
<th>1 365 AD</th>
<th>2 East Hellenic Arc</th>
<th>3 Center Hellenic Arc</th>
<th>4 West Hellenic Arc</th>
<th>5 West Anatolian Fault</th>
<th>6 Amorgos</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW Crete</td>
<td>Ground Zero</td>
<td>60min</td>
<td>10min</td>
<td>35min</td>
<td>115min</td>
<td>60min</td>
</tr>
<tr>
<td>SE Crete</td>
<td>23min</td>
<td>21min</td>
<td>46min</td>
<td>70min</td>
<td>110min</td>
<td>20min</td>
</tr>
<tr>
<td>Koroni</td>
<td>13min</td>
<td>75min</td>
<td>Ground Zero</td>
<td>20min</td>
<td>120min</td>
<td>60min</td>
</tr>
<tr>
<td>Syros</td>
<td>50min</td>
<td>85min</td>
<td>60min</td>
<td>85min</td>
<td>60min</td>
<td>50min</td>
</tr>
<tr>
<td>North Aegean</td>
<td>90min</td>
<td>90min</td>
<td>95min</td>
<td>130min</td>
<td>25min</td>
<td>60min</td>
</tr>
<tr>
<td>Rhodes</td>
<td>60min</td>
<td>&lt;5min</td>
<td>78min</td>
<td>105min</td>
<td>123min</td>
<td>26min</td>
</tr>
<tr>
<td>Fethiye</td>
<td>60min</td>
<td>&lt;10min</td>
<td>80min</td>
<td>105min</td>
<td>125min</td>
<td>30min</td>
</tr>
<tr>
<td>Palermo</td>
<td>130min</td>
<td>180min</td>
<td>105min</td>
<td>90min</td>
<td>-</td>
<td>170min</td>
</tr>
<tr>
<td>Alexandria</td>
<td>90min</td>
<td>55min</td>
<td>105min</td>
<td>130min</td>
<td>170min</td>
<td>60min</td>
</tr>
<tr>
<td>Tel Aviv</td>
<td>120min</td>
<td>90min</td>
<td>140min</td>
<td>170min</td>
<td>205min</td>
<td>110min</td>
</tr>
</tbody>
</table>

In all cases, tsunamis arrive in Greece first!
24/7 Operational System at NOA - HLNTWC

- Seismic Network
  - SeisComP3
  - Acquisition, Automatic Processing, Auto Reporting, Manual Verification
  - Sea-level Network
    - Sea-level Soft
    - Quake Alerting

- Tsunami Model Database
  - TAT
  - Tsunami Model
  - Database

- GIS Platform
  - GTS via HNMO
  - Alerting

- General Secretariat Civil Protection
  - Earthquake Planning and Protection Organization
JRC scenario Matrix
Calculations between 6.5 and 9.5 (every 0.25) have been performed.

Historical events

Grid points

Mediterranean area

JRC collaboration - Tsunami calculation grid

TAT at NOA HLNTWC
Current decision matrix for the Mediterranean showing tsunami message categories related to detected earthquake depth, location and magnitude

<table>
<thead>
<tr>
<th>Earthquake Depth</th>
<th>Location</th>
<th>Magnitude (Mw or Mwp)</th>
<th>Tsunami Potential</th>
<th>Type of Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;100 km</td>
<td>Offshore or close to the coast (&lt;100km)</td>
<td>&gt;=7</td>
<td>Potential for a destructive tsunami in the whole basin &gt;400km</td>
<td>Basin-wide Tsunami Watch</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.5 to 7.0</td>
<td>Potential of destructive regional tsunami &lt;400km</td>
<td>Regional Tsunami Watch/Basin-wide Tsunami Advisory</td>
</tr>
<tr>
<td></td>
<td>Offshore or close to the coast (&lt;40km)</td>
<td>6.0 to 6.5</td>
<td>Potential for destructive local tsunami &lt;100 km</td>
<td>Regional Tsunami Advisory</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.5 to 6.0</td>
<td>Weak potential of local tsunami</td>
<td>Information Message</td>
</tr>
<tr>
<td></td>
<td>Inland (&gt;40km and &lt;100km)</td>
<td>5.5 to 7.0</td>
<td>Weak potential of local tsunami</td>
<td>Information Message</td>
</tr>
<tr>
<td>&gt;=100 km</td>
<td>Offshore or inland (&gt;100 km)</td>
<td>&gt;=5.5</td>
<td>Nil</td>
<td>Information Message</td>
</tr>
</tbody>
</table>
Expected Developments and Further Improvements
NEAMTWS Tsunami Exercises

involvement of the

Gen. Secr. Civil Protection

in

NEAMWave12

NEAMTIC
CIVIL PROTECTION in Greece

General Secretariat for Civil Protection at Ministry of Citizen Protection

Earthquake followed by tsunami in the Mediterranean sea

With the financing of the Civil Protection Financial Instrument of the European Union

Διάγραμμα που δείχνει την θέση του σεισμού και την αντιστοιχία του σε τομείς του ΕΑΤΙΚΟΥ ΣΥΣΤΗΜΑΤΟΣ ΠΡΟΣΤΑΣΙΑΣ ΚΑΙ ΕΚΤΑΚΤΗΣ ΠΡΟΣΤΑΣΙΑΣ.
MULTI HAZARD TOOLS available at HCMR
Surface currents monitoring (Straits of Dardanelles): CORI SYSTEM

DARDANELLES OUTFLOW IS AN IMPORTANT DRIVING MECHANISM FOR THE AEGEAN SEA HYDROLOGY AND CIRCULATION.

KNOWLEDGE OF DARDANELLES OUTFLOW IS A KEY ISSUE FOR:

• MODEL VALIDATION
• IMPROVEMENT OF MODEL FORECASTS
HYDRODYNAMIC MODELING AND DATA ASSIMILATION TOOLS AT THE BASIN SCALE

The basin scale model is based on POM code implemented at a 1/10 spatial resolution.

The hydrodynamic model is one-way coupled with the POSEIDON atmospheric model provides the net shortwave, the downward longwave radiation, wind speed, air-temperature and relative humidity.

Data Assimilation - SEEK Filter

- **Observations** ($\text{obs}_i$)
- **MODEL** ($\mathbf{M}$)
  - **Forecast** $\mathbf{x}_i^f$:
    - $l_{i}^{f} = \mathbf{M} \left( \mathbf{x}_{i-1}^{a} + 6 \mathbf{U}_{i-1}^{-1} \right) - \mathbf{x}_i^{f}$
  - **Evolution of correction base** $\mathbf{Hl}_i$:
    - $l_{i}^{f} = \mathbf{M} \left( \mathbf{x}_{i-1}^{a} + 6 \mathbf{U}_{i-1}^{-1} \right) - \mathbf{x}_i^{f}$
  - **Projection of calculated cor. base to obs.** $\mathbf{HL}_i$
  - **Calculate** $\mathbf{U}_i^{-1} = \mathbf{P}_i^{-1} + (\mathbf{HL}_i) \mathbf{R}_i^{-1} (\mathbf{HL}_i)$
- **Analysis** $\mathbf{x}_i^a$:
  - $\mathbf{x}_i^a = \mathbf{x}_i^f + \mathbf{U}_i^{-1} (\mathbf{HL}_i) \mathbf{R}_i^{-1} \mathbf{error}$
- **Quality Control**

OCEAN SATELLITE DATA + OCEAN IN SITU DATA
(1st Dec 2008): Venice has been hit by the biggest flood in more than 20 years, with waters rising 1.56m (5ft) above normal.

Poseidon Sea Surface Height forecast 24hrs in advance (1.3m)

Maximum tidal elevation during that date = 25cm
Forecasting Efficiency 24hrs in advance
Huge wave kills 2 on cruise ship in Mediterranean (3 March 2010)

Wind Wave Forecast issued on 2 March 2010

Mediterranean and Black Sea
Significant Wave Height on Wednesday (03/03/10) 12:00 UTC

Color denotes Significant Wave Height in meters
......thank you......