CIESM International Scientific Forum 2014
Advances and Gaps in Black Sea / Mediterranean Sea Oceanography, *Sochi, December 1-3, 2014*

From Tsunami Early Detection and Warning to Multi Hazards Early Detection and Warning

Sergiu Dov ROSEN, M.Sc., P.E.
rosenssr@netvision.net.il;

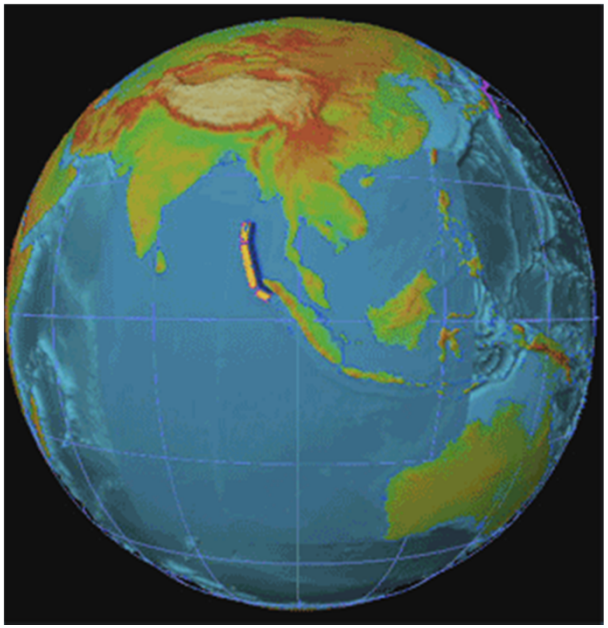
Coordinator, MedGLOSS Sea level Network in the Mediterranean and Black Sea
Member of Steering Committee of ICG/NEAMTWS of IOC/UNESCO
Formerly - Head, Marine Geology & Coastal Proc., IOLR, Haifa

Sicily, after 28.12.1908 earthquake & tsunami

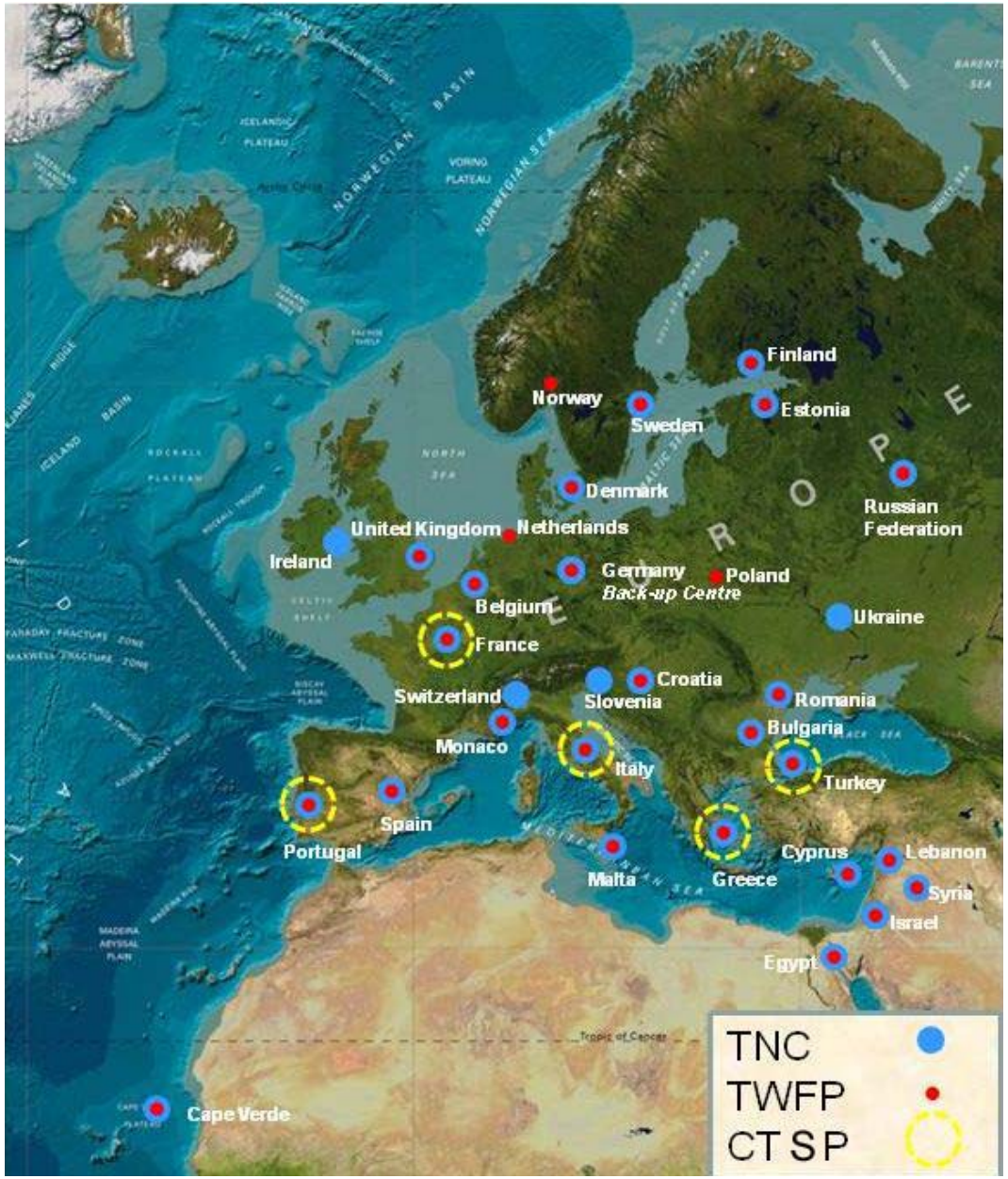
Flooding of railway & highway, Tel Aviv, Dec. 2010

Introduction

Following the disaster induced by the Indian Ocean earthquake and tsunami on 26/12/2004, in November 2005, an Intergovernmental Coordination Group (consisting of national delegates of IOC/UNESCO member states) decided to establish the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and connected seas (ICG/NEAMTWS). Not every earthquake generates a tsunami, but only some of them. Hence, even if an EQ event is detected and characterized in a few minutes, the generation of tsunami waves must be confirmed by monitoring of sea level in real time (recommended 15" sampling rate, data sent every 1') or by additional means



Presently NEAMTWS consists of NEAM seismic and sea level monitoring and RT data sharing and the activities of its managing bodies.



ICG/NEAMTWS UPDATED STRUCTURE

Advances and Gaps to be filled

Advances :

- The NEAMTWS is Operational since 2012 and Improving Further

Gaps :

- The tsunami models know to model only the 1st wave of 3-7 waves, in spite that only sometimes the highest is the first wave, because the tsunami generation by tectonic rupture is yet not well understood.
- NEAMTWS does not cover landslide or volcano induced tsunamis
- NEAMTWS does not cover meteo-tsunamis
- NEAMTWS does not deal with flooding by storm surge\wave storms
- NEAMTWS needs additional real time sea level stations
- NEAMTWS needs quality controlled sea level data
- NEAMTWS needs data provision via GTS
- There is a need for quick detection and warning for all above events

To fill the gaps - a multi hazards early detection and warning system will to be proposed later in the presentation

CIESM HAS BEEN SUPPORTING NEAMTWS DEVELOPMENT FROM THE BEGINNING

CIESM

Contributions of the Intl. Mediterranean Science Commission (CIESM)
to a Tsunami Warning System in the Mediterranean and Black Seas

by

Dr Frederic Briand,
Director General, CIESM

www.ciesm.org

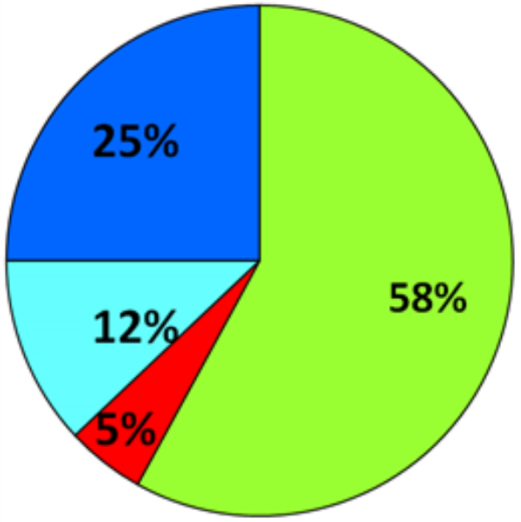
**Presented by Dov S. Rosen,
Coordinator, MedGLOSS**

UNESCO

International Coordination Group for the Tsunami Early Warning and Mitigation System in the North Eastern Atlantic, the Mediterranean and Connected Seas (ICG/NEAMTWS)

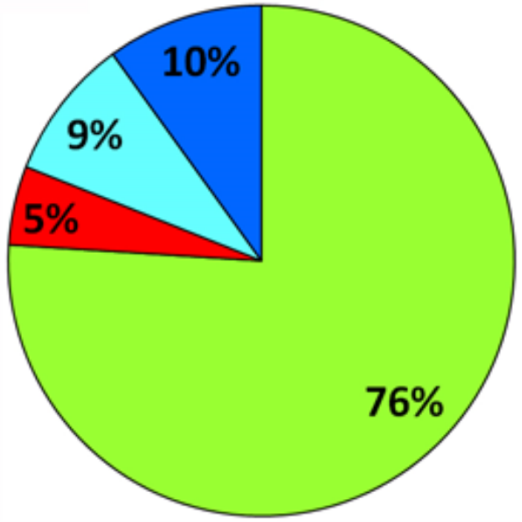
First Session (ICG-I), Palazzo Taverna, Rome, ITALY, 21-22 November 2005

WORLD TSUNAMI STATISTICS DURING THE WHOLE KNOWN HISTORY



- PACIFIC OCEAN
- iNDIAN OCEAN
- ATLANTIC OCEAN
- MEDITERRANEAN

WORLD TSUNAMI STATISTICS DURING 1901-2000



- PACIFIC OCEAN
- iNDIAN OCEAN
- ATLANTIC OCEAN
- MEDITERRANEAN

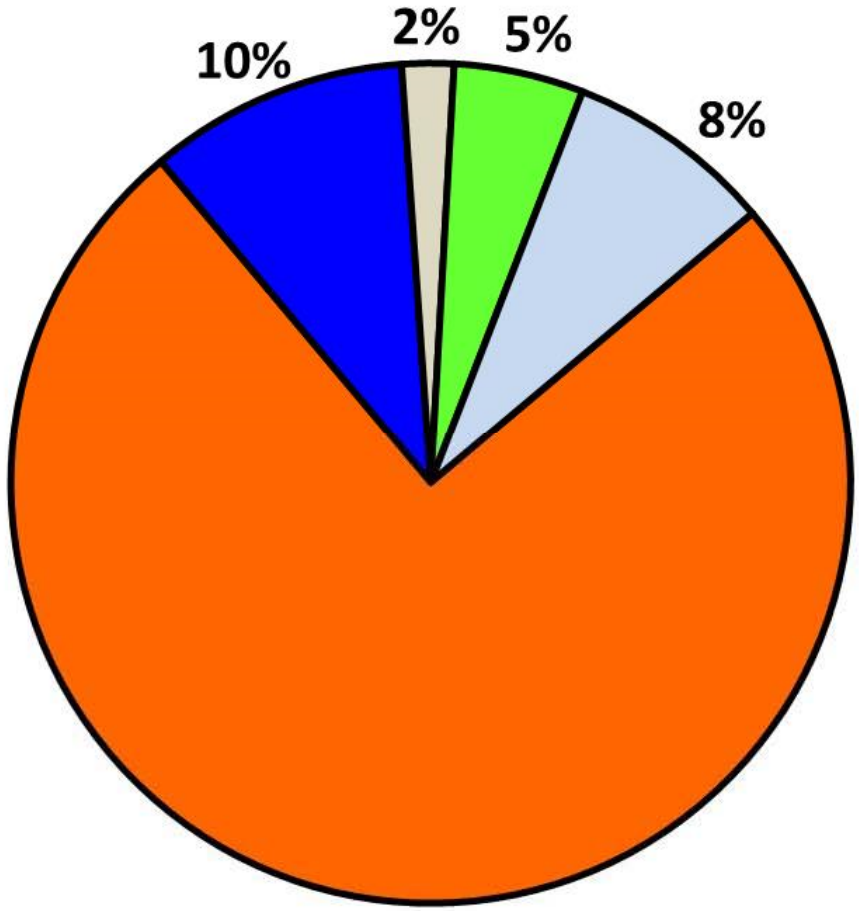
LATEST KILLER TSUNAMI

- 2011
- 2004
- 1946
- 1908

GLOBAL TSUNAMI DISTRIBUTION (ALL EVENTS)

BASED ON IOC/UNESCO TSUNAMI DATA BASE

Distribution of causes for tsunami generation



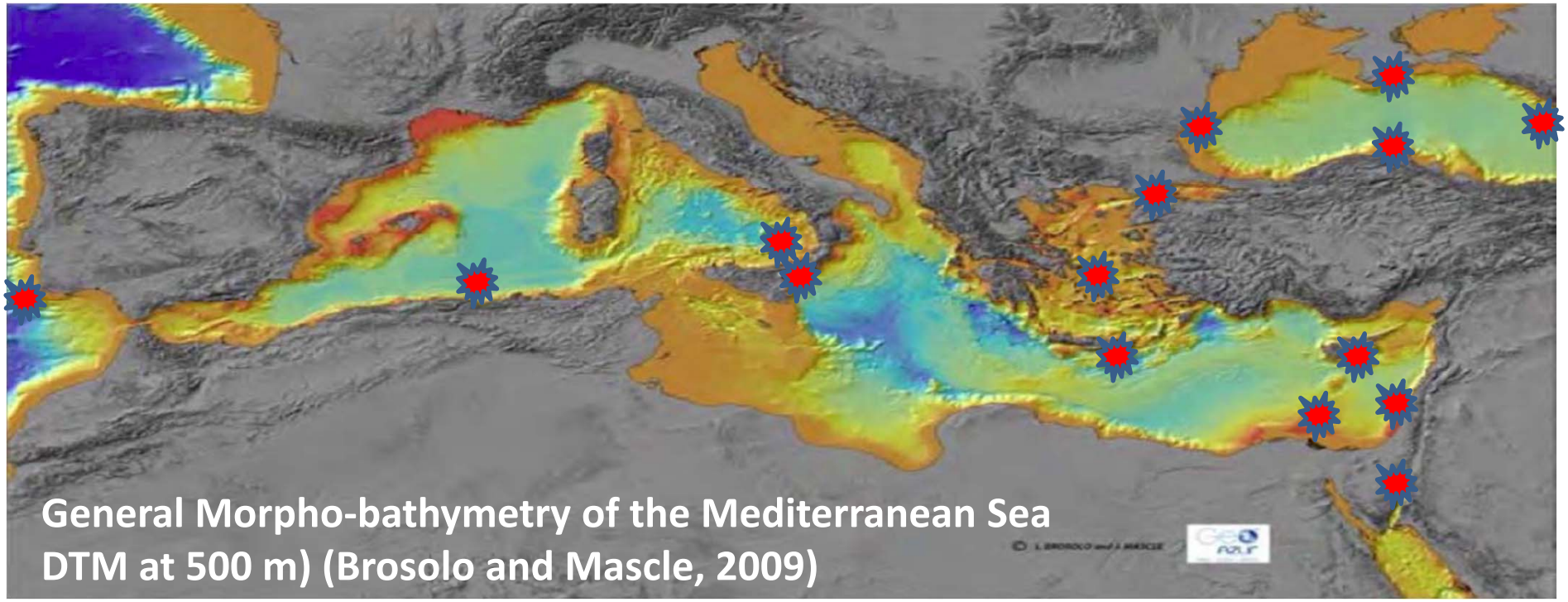
- Tectonic - Earthquakes
- Landslides
- Volcanic Erruptions
- Meteo tsunami
- Unknown

Based on IOC/UNESCO tsunami data base

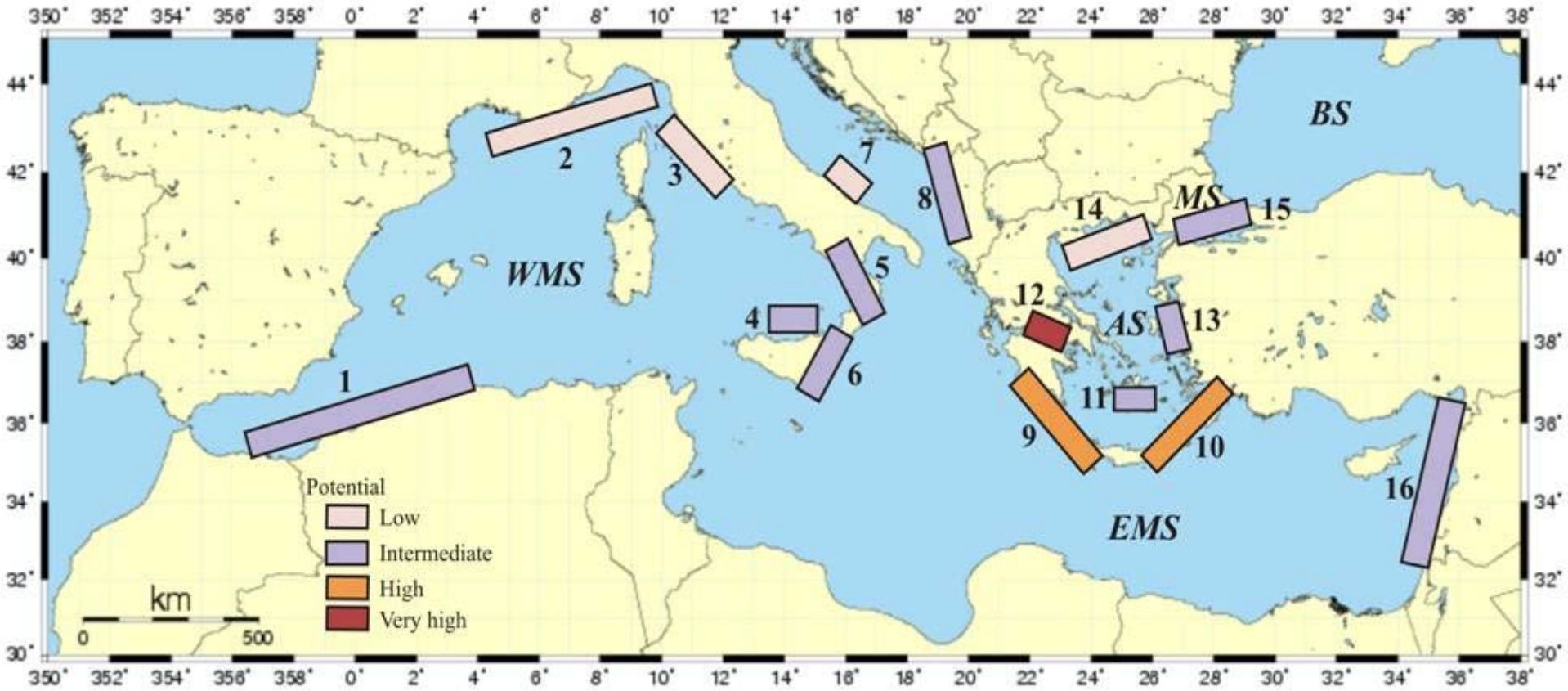
Prepared by S.D.ROSEN, 2014

Potential places for generation of tsunamis in EM

(Adapted after Brosolo and Mascle, 2009)

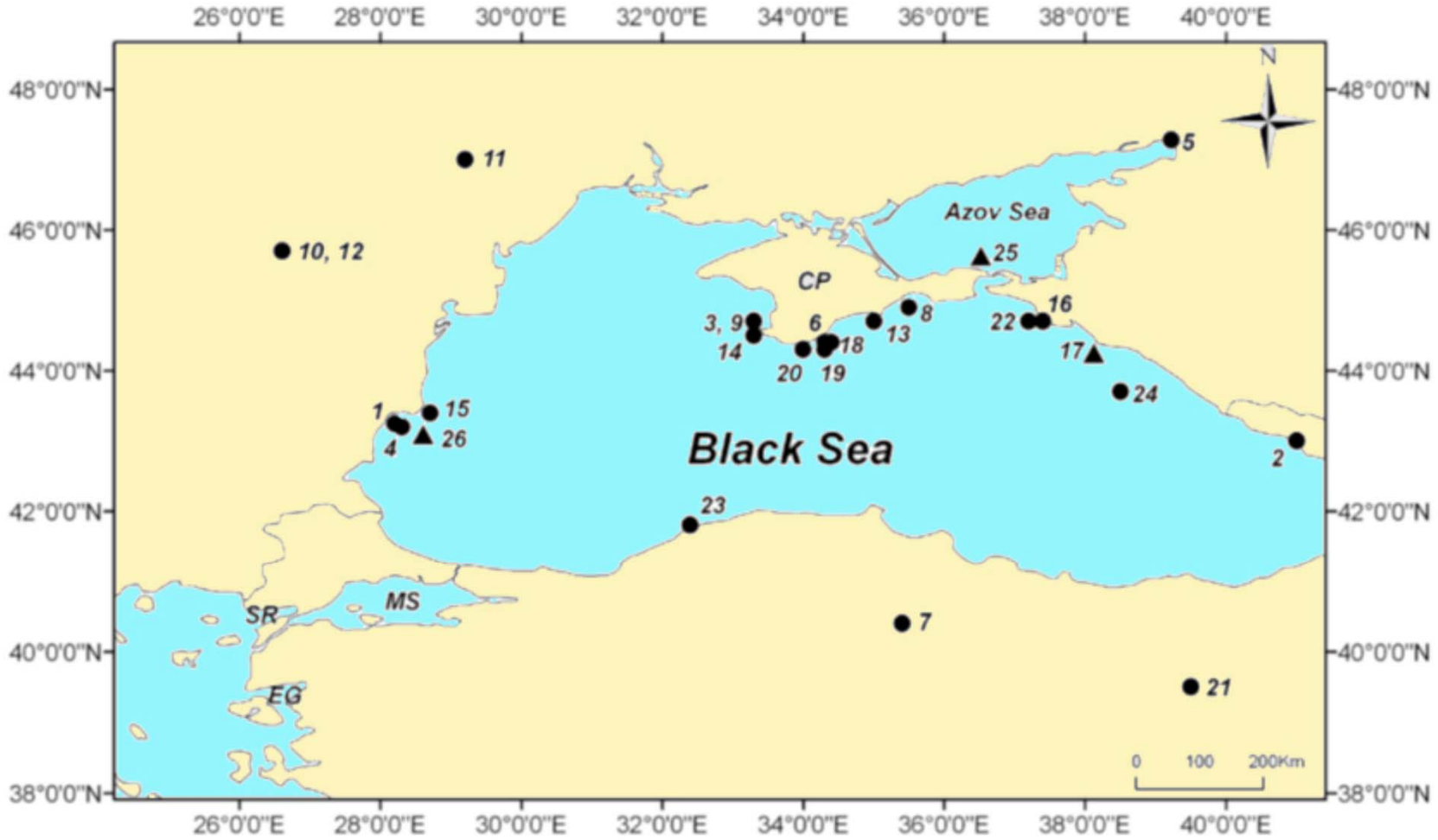


Location of tsunamigenic areas



Past tsunami events areas (numbers) and their tsunami risk (colors)
(From Papadopoulos, 2005)

Sources of tsunami generation in the Black Sea & the Azov Sea



Key: a solid circle is a seismic source, a solid triangle is a gravitative sliding source; CP = Caspian Peninsula, EG = Edremit Gulf, MS= Marmara Sea, SR = Saros Bay.

Source: G. A. Papadopoulos et al., 2011. Tsunamis in the Black Sea,

Sources of tsunami generation in Black Sea (Sahin, 2013)


MedGLOSS Map of Near-Real Time and Delayed Mode
Network of Sea Level Monitoring Stations
Near Real Time Stations
Delayed Mode Stations
Candidate NRT Stations
0 km 200 400 600 800
MedGLOSS
ATLANTIC OCEAN
Bay of Biscay
Mediterranean Sea
Black Sea
Sea of Azov
Adriatic Sea
Aegean Sea
Gulf of Sidra
PORTUGAL
SPAIN
FRANCE
ITALY
SLOVAKIA
UKRAINE
RUSSIA
ROMANIA
CROATIA
BOSNIA & HERZ.
YUGOSLAVIA
BULGARIA
FYRO MACEDONIA
ALBANIA
GREECE
TURKEY
CYPRUS
SYRIA
LEBANON
JORDAN
SAUDI ARABIA
EGYPT
LIBYA
TUNISIA
ALGERIA
MOROCCO
ATLAS MOUNTAINS
TRIPOLITANIA
Paris
Stuttgart
Znojmo
Ivano-Frankivsk
Zaporizhzhya
Mariupol
Taganrog
Mykolayiv
Odessa
Krasnodar
Novorossiysk
Stavropol
Cherkessk
Sochi
Sokhumi
Batumi
Eupatoria
Simferopol
Sevastopol
Nantes
Poitie
Niort
Clermont-Ferrand
Genève
Trento
Ljubljana
Dravograd
Pécs
Arad
Targu Mureş
Galaţi
Ploieşti
Piteşti
Bucharest
Constanţa
Belgrade
Rijeka
Trieste
Milan
Turin
Lyon
Grenoble
Gap
Aurillac
Albi
Toulouse
Montpellier
Marseille
Bordeaux
La Coruña
A Coruña
Oviedo
Santander
Orense
León
Pamplona
Andorra la Vella
Logroño
Valladolid
Saragossa
Girona
Lleida
Barcelona
Tarragona
Madrid
Segovia
Leiria
Oporto
Aveiro
Badajoz
CASTILLA-LA MANCHA
Albacete
Castellón de la Plana
Valencia
Palma
Córdoba
Murcia
Faro
Seville
Málaga
Cartagena
Almería
Tangier
Larache
Melilla
Oran
Cherchell
Algiers
Alger
Annaba
Bejaïa
Ech Cheliff
Tlemcen
Ouazzane
Taza
Oujda
Rabat
Casablanca
Marrakesh
Ouarzazate
Zagora
Biskra
Batna
Tébessa
Al Kāf
Tunis
Hawmat as Suq
Dūz
Tripoli
Al Khums
Miṣrātah
Yafran
Banghāzī
Valletta
Palermo
Catania
Catanzaro
Cagliari
Ajaccio
Bastia
Rome
Naples
Florence
Arezzo
Perugia
Monaco-Ville
Genoa
Bologna
Split
Niš
Podgorica
Shkodër
Sofia
Varna
Edirne
Zonguldak
Karabük
Çorum
Erzincan
Sinop
Samsun
Bafra
İstanbul
İzmit
Kocaeli
Çankırı
Sivas
Tunceli
Elâzığ
Ankara
Fengari
Bursa
Bilecik
Kütahya
Aksaray
Kayseri
Diyarbakır
Konya
Gaziantep
Mersin
İçel
Aleppo
Halab
Manbij
Antakya
Antalya
Denizli
Aydın
İzmir
Balıkesir
Uşak
Salonica
Larisa
Pandokrator
Ioánnina
Lamía
Delphi
Patras
Athens
Kalámata
Kalamai
AEGEAN ISLANDS
Iráklion
Heraklion
Nicosia
Latakia
Homs
Damascus
Beirut
Haifa
Irbid
Amman
Jerusalem
Al Quds
Beersheba
Be er Sheva
Az Zaqāzīq
Tanţā
Cairo
Suez
El Suweis
Beni Suef
El Minya
Alexandria
El Iskandariya
Marādah
MAṬRŪḤ

Map of NEAMTWS Active Real Time Sea Level Stations and of Potential Additional Sea Level Stations

Legend: Yellow - Real Time Operational Station; Red - Real Time Not Working;
White - Potential Existing Sea Level Station for Upgrading to Real Time

Example of Real Time sea level data monitoring for NEAMTWS

UNESCO IOC

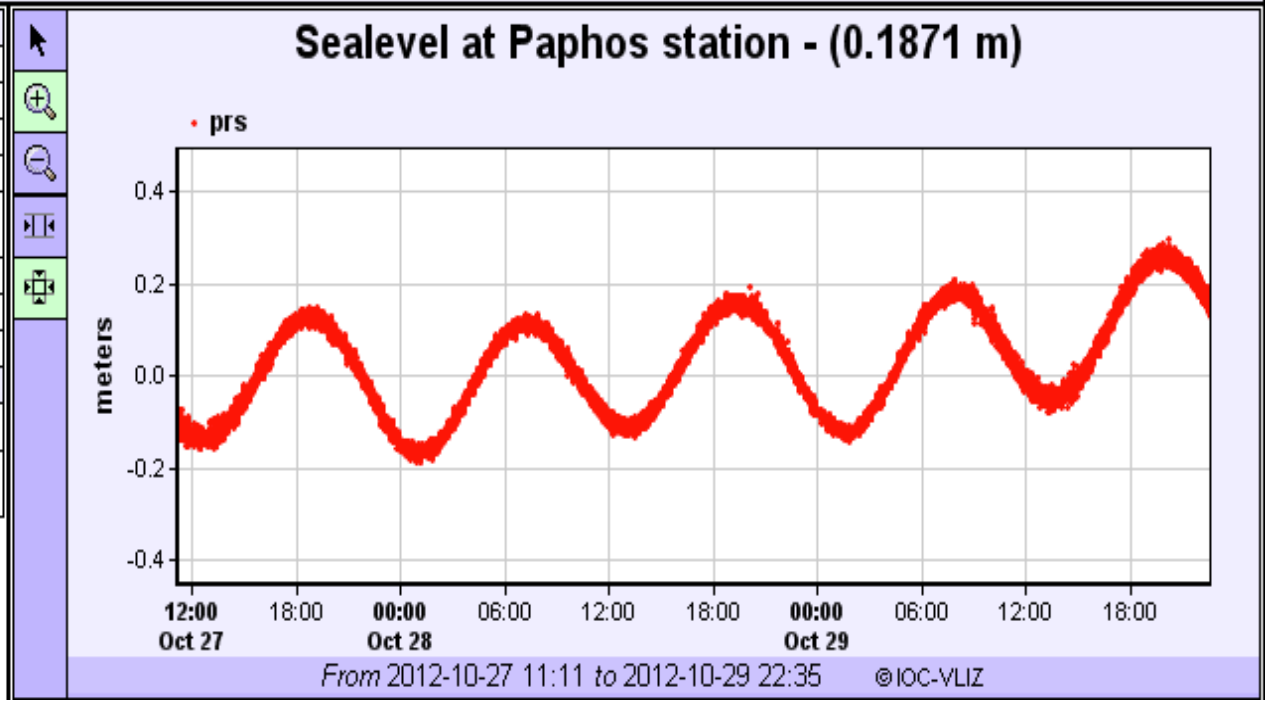
SEA LEVEL STATION MONITORING FACILITY

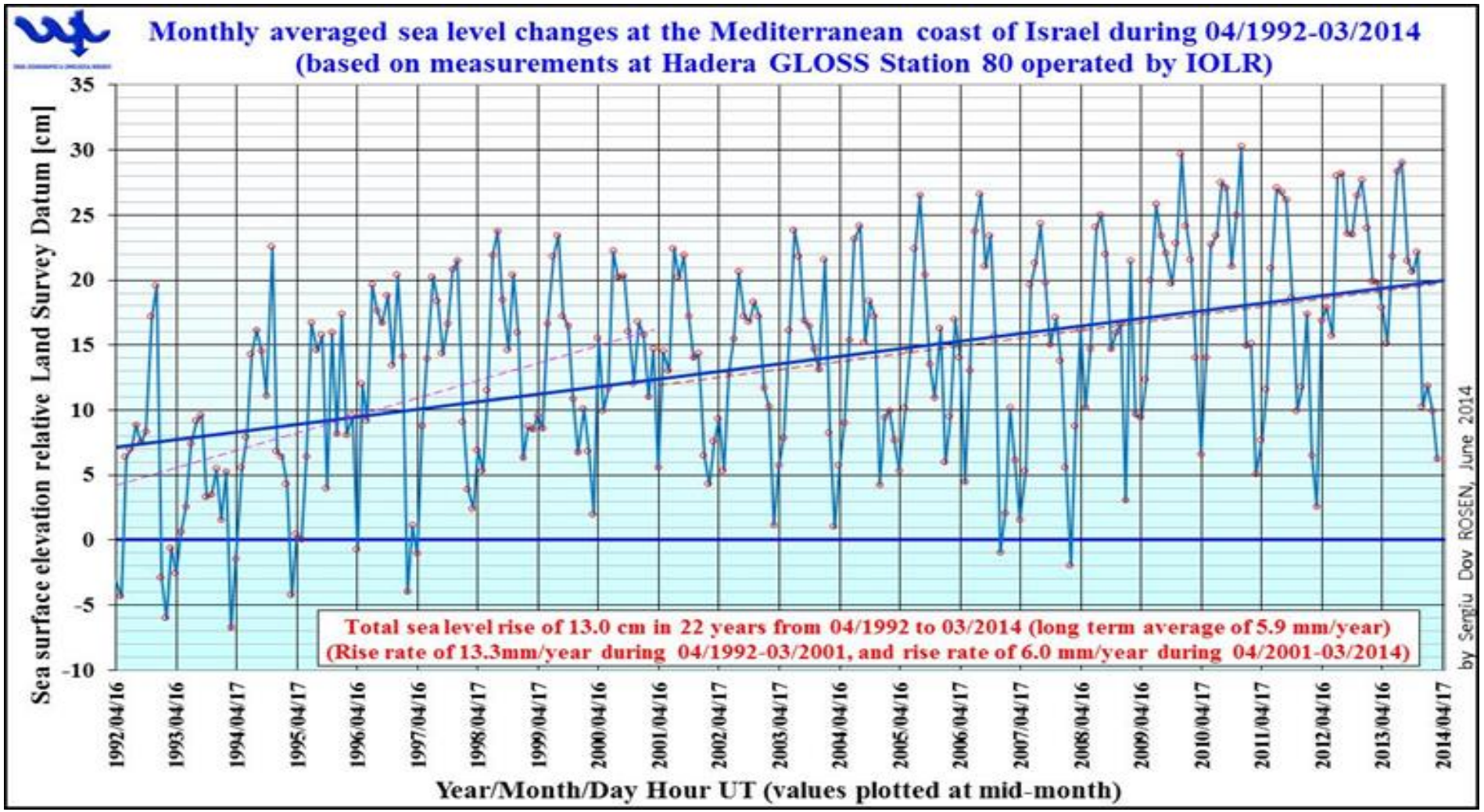
Intro | Map | Station lists | Station details | Services

[previous station] Station Paphos at GMT [next station]

[more details] [show data] [show on map] [monitor]

Station metadata	
Code	papho
Country	Cyprus
Location	Paphos
Status	Operational
Local Contact	Cyprus Oceanography Center (Cyprus)
Latitude	34.755128
Longitude	32.408819
Connection	FTP box
Sensor 1	
Type of sensor	prs
Sampling rate (min)	0.25

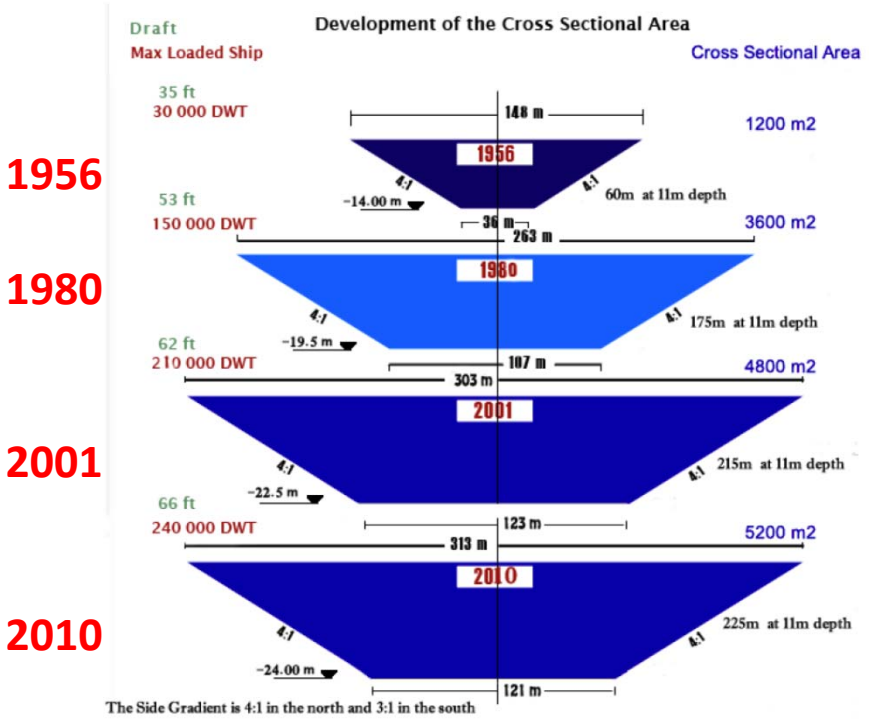




Increased sea level rise in the South Eastern Mediterranean relative to present global average rate (~3mm/year) due at least partly by the increased salinity in the area by the increased Suez Canal salty flow

Change of the wet cross section of Suez Canal in time (1989-2010)

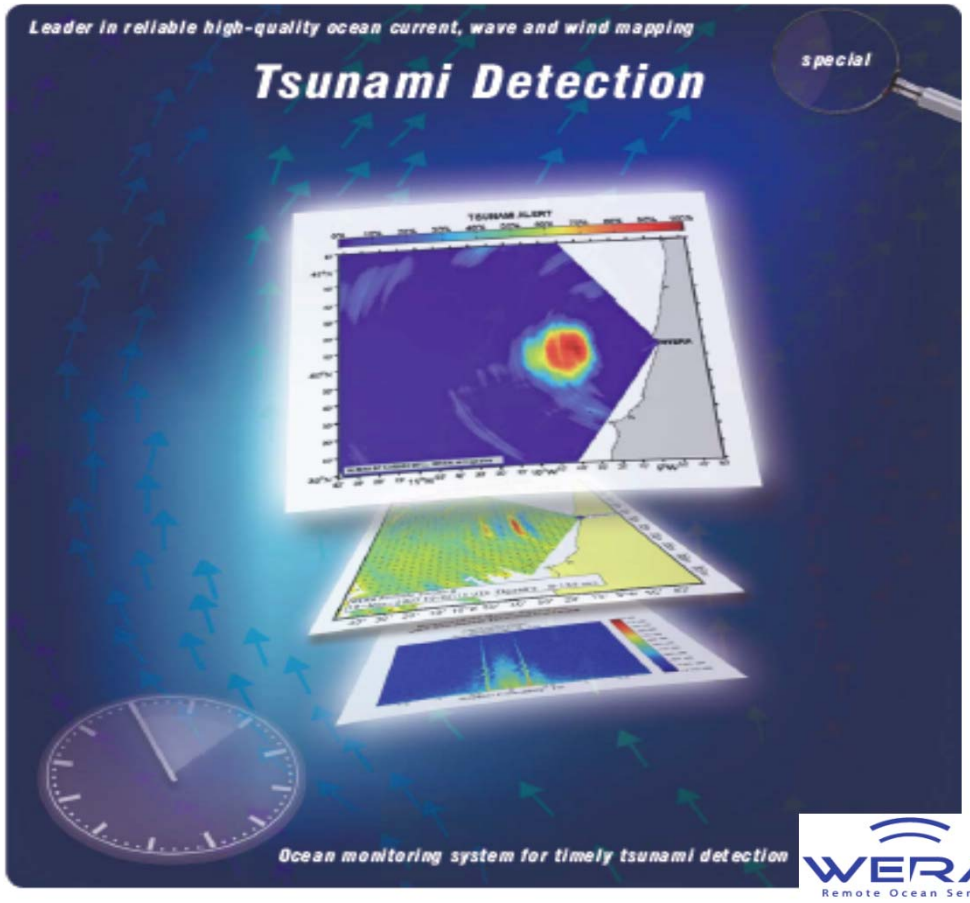
ITEM	UNIT	1869	1956	1962	1980	1994	1996	2001		2010
Percentage increase									1869-2001	
WIDTH AT 11M DEPTH	M	44	60	90	160	210	210	210	477%	
MAX DRAFT OF SHIPS	FEET	22	35	38	53	56	58	62	282%	
OVERALL LENGTH	KM	164	175	175	190.25	190.25	190.25	190.25	116%	
DOUBLED PARTS	KM	-	29	29	78	78	78	78	269%	
WATER DEPTH	M	10	14	15.5	19.5	20.5	21	22.5	225%	24
CROSS SECTIONAL AREA	M2	304	1100	1800	3600	4300	4500	4800	1579%	5208
MAX. TONNAGE (DWT)	TON	5000	30,000	80,000	150,000	180,000	185,000	210,000	4200%	



The increased saltier water flow (saltier than both the Red Sea and Mediterranean Sea) into the Mediterranean Sea at Suez Canal is estimated to be sinking to the sea bottom of the Nile delta cone, consisting of unconsolidated fine sediments and with time scour into its toe, increasing the sediment deposit instability, eventually leading to a landslide and tsunami or, in case of a strong earthquake at the Hellenic Arc but deeper than 100 km (not tsunamigenic) its seismic waves may be strengthened at the Nile cone and trigger landslide and tsunami, even before sufficient toe scour would occur.

FILING PART OF THE GAP: A MULTI HAZARD EARLLY WARNING SYSTEM

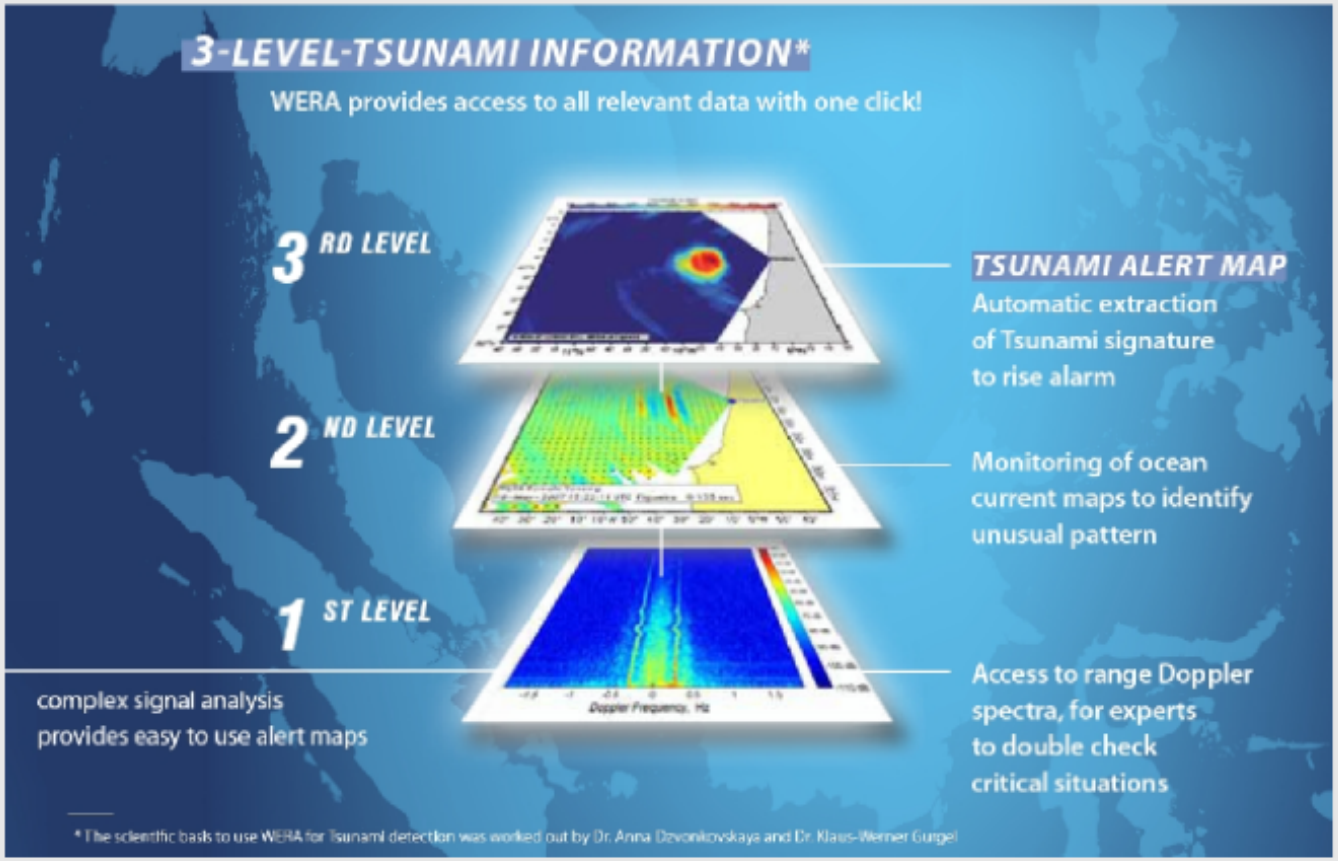
HIGH FREQUENCY RADAR STATIONS NETWORK



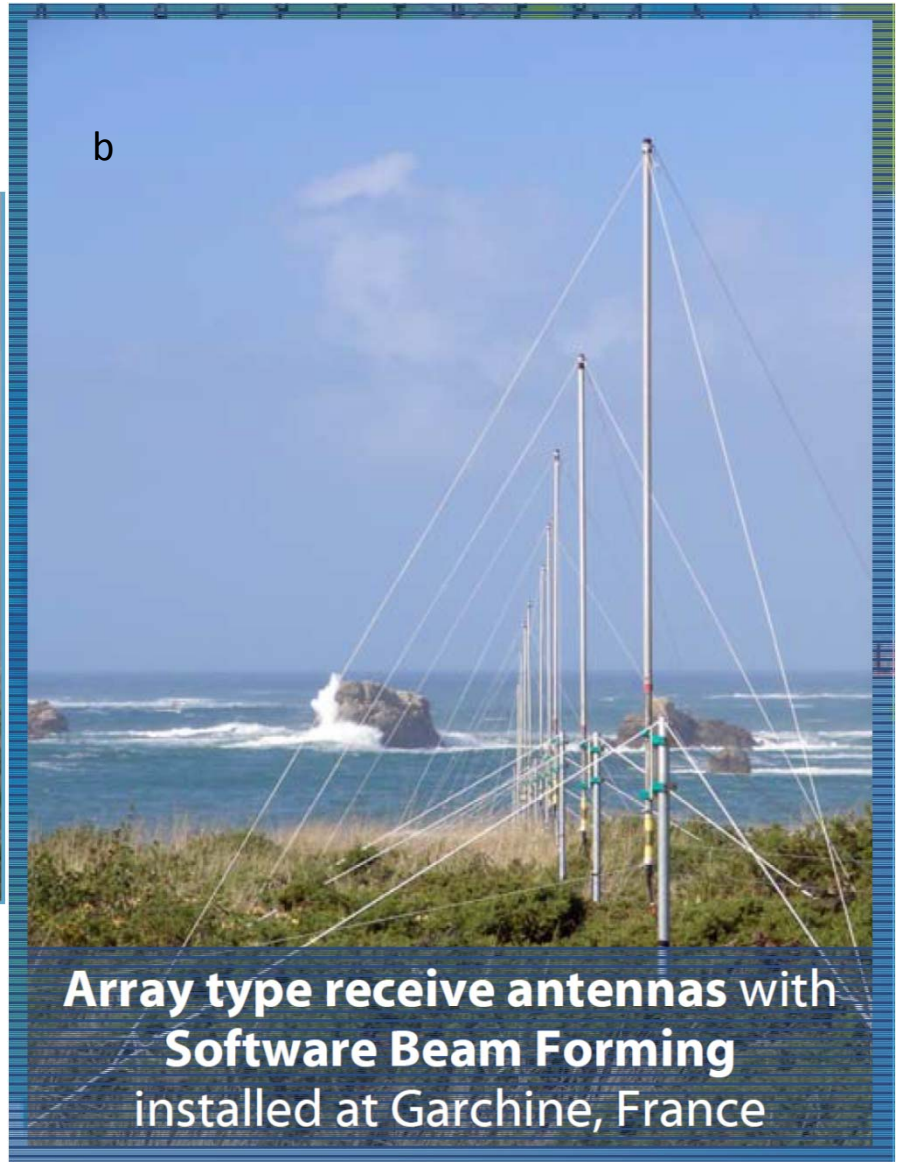
+

Densifying and Upgrading of Sea Level Monitoring Stations to Real Time Data Transmission via GTS

WERA combines all information for modern Coastal Management; measurements with high spatial and temporal resolution of Surface Currents, Wind Direction and Wave Parameters and provides access to all relevant data with one click!



WERA can be fully integrated into a national Tsunami Early Warning System providing valuable data to reduce the false alarm rate improving the reliability of the entire system. For timely Tsunami detection, the shelf edge should be located > 50 km off the coast.



WERA HF radar transmit (a) and receive (b) antennas

Conclusion and Recommendation :

An early warning system from landslide tsunamis is needed for the regions with landslide tsunamigenic potential, which must be able to detect landslide tsunamis as soon as possible after occurrence.

To fill the existing gaps in knowledge and early warning for all tsunami and other marine hazards it is proposed to develop a Multi Hazard Early Detection System consisting of:

a. A network of array high frequency radars (WERA),
b. Densifying of the Real Time sea level gauges network,
c. A few complementary DARTs and/or GPS tsunami buoys.


Thank you!
Большое спасибо!