THE COAST and THE SEA

MAN HAS ALWAYS BEEN ATTRACTED TO THE COAST AND THE SEA.

IT IS OUR CONCERN !

FOR THOUSANDS OF YEARS, A LARGE PORTION OF THE WORLD'S POPULATION HAS MADE THEIR HOME ALONG OR NEAR THE COAST.

SOURCE of LIFE

SPECIAL FLORA AND FAUNA

Science, Culture, Arts, Sports, Expeditions, Surveys, Collaborations, Adventure, Humanity, Cooperations, Accordance, Peace and Love

Prof.Dr. Ahmet Cevdet Yalciner
Middle East Tecnical University,
Department of Civil Engineering, Ocean Engineering Research Center
Phone: +90 312 210 54 38 E-mail: yalciner @metu.edu.tr

METU Department of Civil Engineering
Ocean Engineering Research Center
Ankara Turkey

Middle East Technical University
Faculty of Engineering

Department of Civil Engineering
Department of Engineering Sciences

Coastal and Ocean Engineering Division

and

Ocean Engineering Research Center

Prof.Dr. Ahmet Cevdet Yalciner
Middle East Tecnical University,
Department of Civil Engineering, Ocean Engineering Research Center
Phone: +90 312 210 54 38 E-mail: yalciner @metu.edu.tr

METU Department of Civil Engineering
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OUR EXPERTISE

Marine Hazards and Tsunamis, Warning Systems, Numerical and Physical Modeling, Disaster Management, Mitigation Strategies, Coastal Engineering, Coastal Zone Managemet, Marine structures, Ocean Engineering, Planning and Design of Coastal structures, Wave Hydrodynamics, Statistical Analysis, Societal Impacts , Wind and Wave Climate

GOAL

Resilient Societies
against Tsunamis and Marine Hazards

Curtesy of Ayvazovsky

TITLES OF METU CONTRIBUTIONS TO THE PROPOSAL ON MPAs

- Temporal and Spatial Structure of Natural and Biollogical Resources in GIS Environment of Selected MPAs including climate change as a parameter
- Preparadness Against Possible Marine Hazards
- Offshore Wind Turbines, Applications and their Better Performance
- Stock taking analysis-legistative
- Guidelines (including legistlation)
- Management Strategies
- Local to Basin Wide Networking of MPAs
- Participation Background
- Development of Guidelines and Adoptaion of Legistatoins Review and adjuctment
- Application to Selected MPAs
- Monioring and Observation of Selected MPAs
- Knowledge Sharing among partners, Community Partcipation, Dissemination of Results and Public Awareness
- Management and Coordination

Prof.Dr. Ahmet Cevdet Yalciner
Middle East Tecnical University,
Department of Civil Engineering, Ocean Engineering Research Center
Phone: +90 312 210 54 38 E-mail: yalciner @metu.edu.tr
METU Department of Civil Engineering
Ocean Engineering Research Center
Ankara Turkey

Detection

Monitoring

Assessment

Warning

Mitigation

Resilience

Structural
Societal
Administrative

Research

Collaboration

Data Sharing

Experience

Training

Operation

Insurance

Preparadness

Academia

Decision Makers

Stakeholders

Heritage Areas

Resources

Natural and Marine Protected Areas

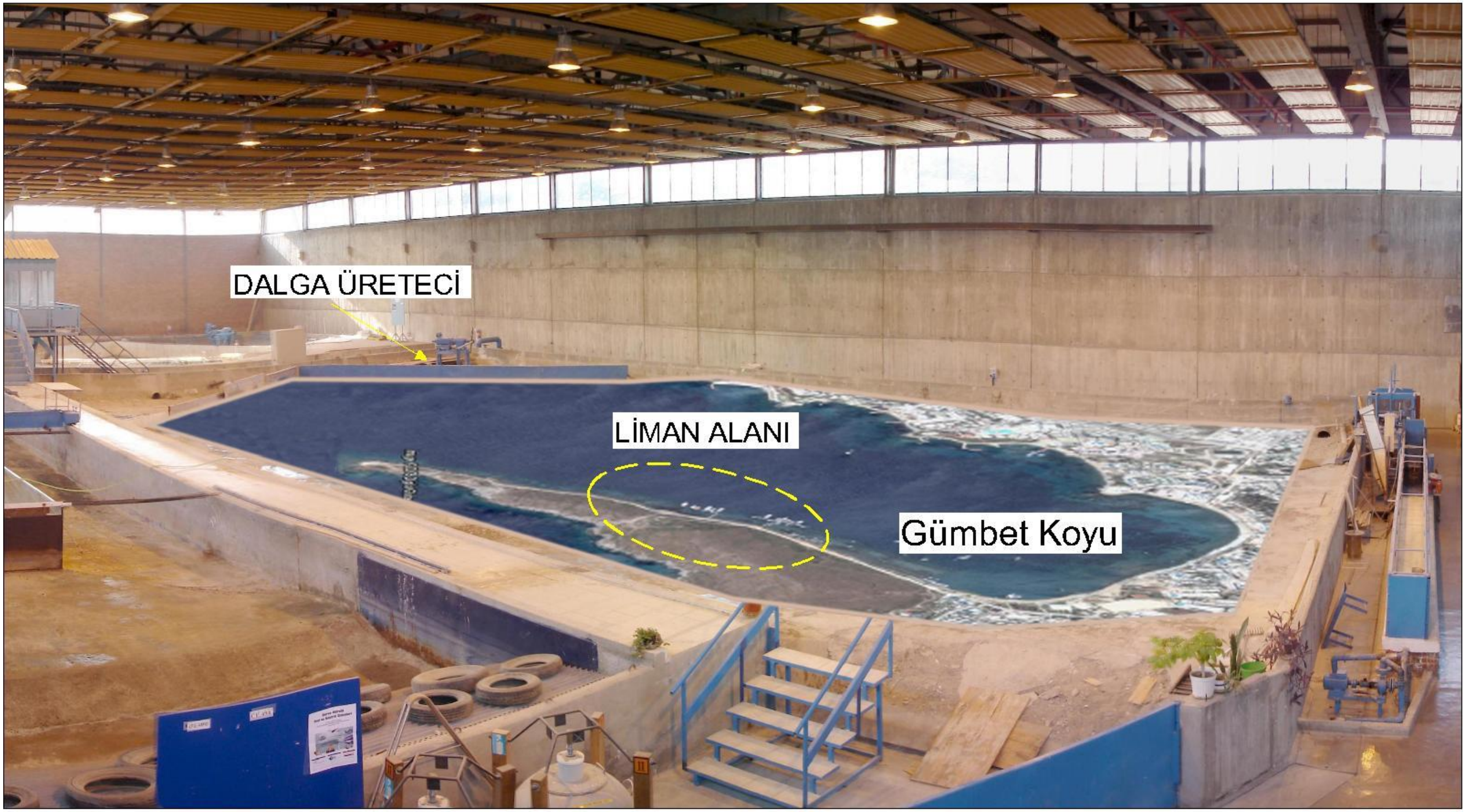
Industrial Complex and

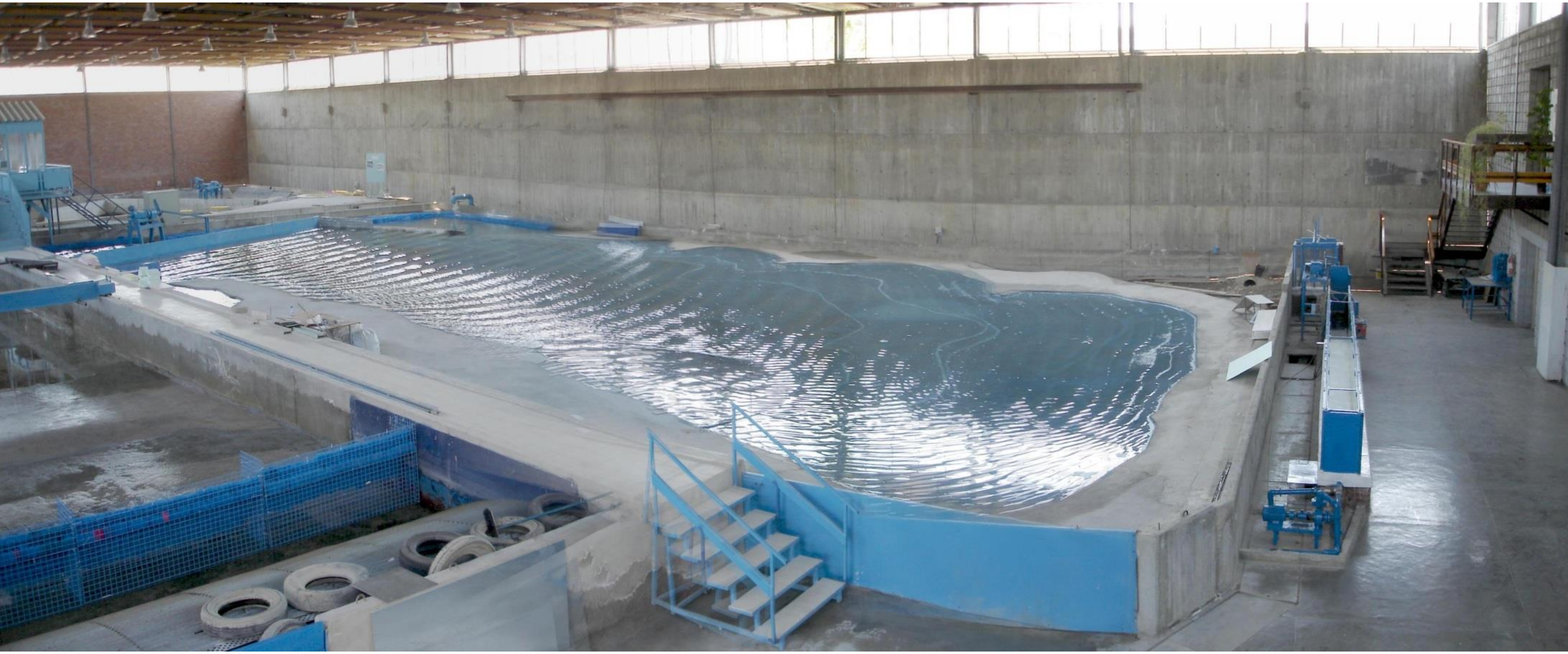
Sensitive/Critical Structures

Areas of Interests

- **Undergraduate Courses**
  - CE 491 Coastal Engineering I *****
  - CE 492 Coastal Engineering II
  - CE 493 Design Of Sea Outfalls
  - CE 494 Port Planning And Design
  - CE 495 Ocean Engineering And Underwater Operations
  - CE 496 Marinas
  - CE 497 Coastal Zone Management

- **Graduate Courses**
  - CE 591 Wave Hydrodynamics
  - CE 593 Statistical Analysis In Coastal Engineering
  - CE 594 Modeling Of Coastal Engineering Problems
  - CE 595 Coastal Sedimentation
  - CE 596 Coastal Pollution
  - CE 598 Coastal And Harbour Structures Design
  - CE 761 Marine Hazards and Tsunamis


DALGA ÜRETECİ
LİMAN ALANI
Gümbet Koyu




DALGA ÜRETECİ
Birim ünitelerin deneylerinin yapılacağı kanal

OUR EXPERTISE

Marine Hazards and Tsunamis, Warning Systems, Numerical and Physical Modeling, Disaster Management, Mitigation Strategies, Coastal Engineering, Coastal Zone Managemet, Marine structures, Ocean Engineering, Planning and Design of Coastal structures, Wave Hydrodynamics, Statistical Analysis, Societal Impacts , Wind and Wave Climate

GOAL

Resilient Societies against Tsunamis and Marine Hazards

Curtesy of Ayvazovsky

MANUAL
Tsunami Simulation/Visualization Code
NAMI DANCE NESTED DOMAIN version5.9

For updated pdf copy of this manual

Please refer to

http://namidance.ce.metu.edu.tr/pdf

Development of Tsunami Simulation Structure for Tsunami Warning System in Turkey

M. Erdik[1], N. Özel[1], D. Kalafat[1], O.Necmioglu[1], M. Yılmazer[1], A. C. Yalciner[2], Utku Kanoglu[3], A. Zaytsev[4,5], A. Chernov[6,7], C. Ozer[2]

(1) Bogazici University, Kandilli Observatory and Earthquake Research Institute (erdik@boun.edu.tr, ozeln@boun.edu.tr, kalafato@boun.edu.tr, Ocal.necmioglu@boun.edu.tr, mehmety@boun.edu.tr /Fax: +90 216 3321711

(2) Middle East Technical University, Department of Civil Engineering, Ocean Engineering Research Center, Ankara, Turkey (yalciner@metu.edu.tr, cozer@metu.edu.tr, / Fax: +90 312-2101800)

(3) Middle East Technical University, Department of Engineering Sciences, Ankara, Turkey (kanoglu@metu.edu.tr / Fax: +90 312-2101800)

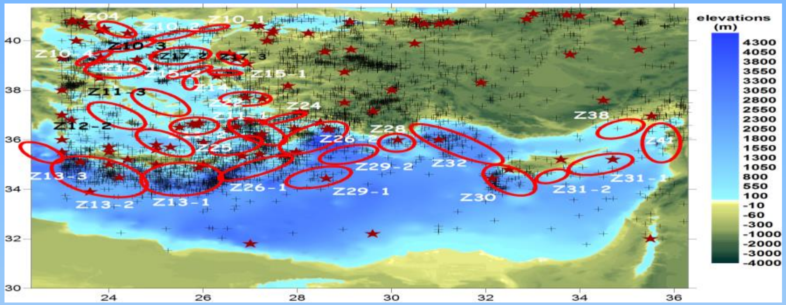
(4) Special Research Bureau for Automation of Marine Researches, Yuzhno-Sakhalinsk, Russia (aizaytsev@mail.ru),

(5) Applied Mathematical Department, State Technical University, Nizhny Novgorod, Russia, aizaytsev@mail.ru)

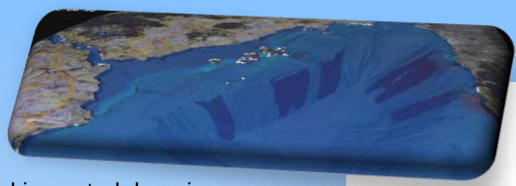
(6) Department of Applied Mathematics, Nizhny, Novgorod State Technical University, Russia achernov@nntu.nnov.ru

(7) Institute of Marine Geology and Geophisics, Yuzhno-Sakhalinsk, Russia (achernov@nntu.nnov.ru)

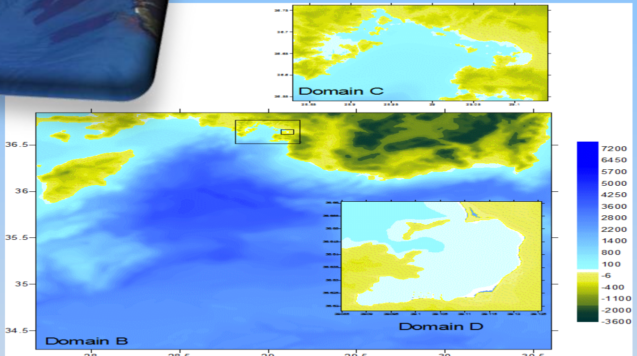
• **Bogazici University, Kandilli Observatory and Earthquake Research Institute (KOERI)** is planned to function as one of the Regional Tsunami Watch Centers foreseen by the Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and connected seas (ICG/NEAMTWS).



• **The determination of the sources** of the tsunamis is one of the important issues in a tsunami warning system. Eastern Mediterranean has experienced many earthquakes and tsunamis in history. The active faults and their possible rupture characteristics are examined. The possible tsunamigenic sources which may be effective in Eastern Mediterranean basin are determined.

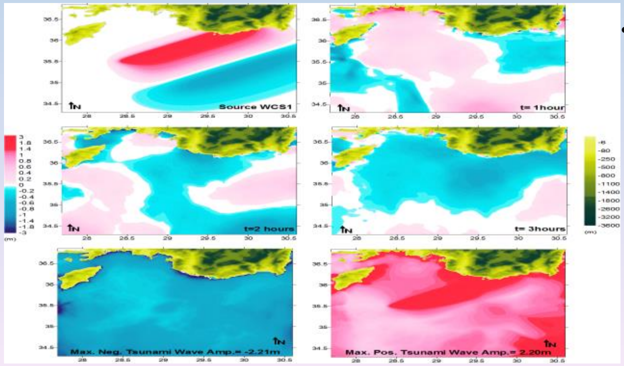


• The tsunami sources in the **Eastern Mediterranean, Black Sea and Marmara** are considered.



• **The study domains** considering different sources and target areas are selected in nested domains.

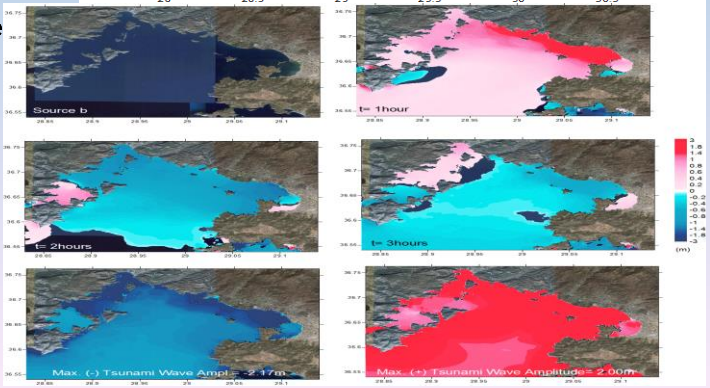
• **NAMI DANCE** is used for the simulation and visualization of tsunamis developed in collaboration with Ocean Engineering Research Center, Middle East Technical University, Turkey and Institute of Applied Physics, Russian Academy of Science, Russia. NAMI DANCE has been tested and verified parallel to TUNAMI-N2 in the international workshops. It is developed by using C++ programming language for faster simulation and better visualizations based on similar numerical procedures of TUNAMI–N2. It follows leap frog scheme numerical solution procedures (Shuto, Goto and Imamura, 1990) and has several modules for development of all requirements.



The sea state at different time steps, distribution of max. (+) and max. (-) tsunami wave amplitudes

• **A series of simulations** are performed using the selected sources in the selected domains. The propagation and coastal amplification of tsunamis are assessed to constitute a knowledge-base for the planned tsunami watch system.

• Open MP capabilty, high performance computing capability, high resolution near shore data, segmentation of the source mechanisms and nested simulations are new modules of computational tool NAMI DANCE.

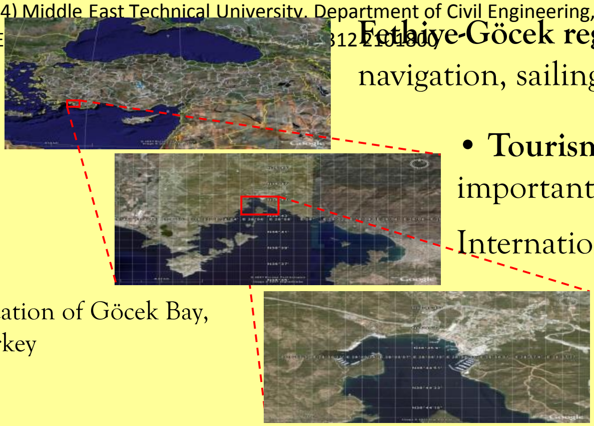


The sea state at different time steps, distributions of max. (+) and max. (-) tsunami wave amplitudes

Monitoring and Control of Human Effects on the Water Quality in Special Environment Protection Areas (SEPA), Fethiye-Gocek Measurements in Turkey

A. Cizmeli [1], E. Alp [2], S. Duzgun [1], H. Orek [3], A.C. Yalciner [4], C. Ozer [4], Z. Yucel [1]

(1) Middle East Technical University, Institute of Applied Sciences, Geodetic and Geographic Information Technologies Division, Ankara, 06531, Turkey
Email: sa.cizmeli@usherbrooke.ca, duzgun@metu.edu.tr, Fax: +90 312 2101800,
(2) Department of Environmental Engineering, Middle East Technical University, Ankara 06531, Turkey, Email: emrealp@metu.edu.tr,
Fax: + 903122102646,
(3) Middle East Technical University, Institute of Marine Sciences, Erdemli, Icel, Turkey, Email: orek@ims.metu.edu.tr, Fax: +90 324 521 2327,
(4) Middle East Technical University, Department of Civil Engineering, Ocean Engineering Research Center, Ankara, Turkey
E[illegible] 312 2101800



Location of Göcek Bay, Turkey

Fethiye-Göcek region, the unique marine area having numerous calm bays for safe and enjoyable navigation, sailing and yachting is one of those Specially Protected Areas in Turkey.

- **Tourism potential** has became one of the mo[illegible] important destinations of the both Turkish and International blue voyagers.

- The increase in tourism capacity → increase in economical activities → **environmental problems.**

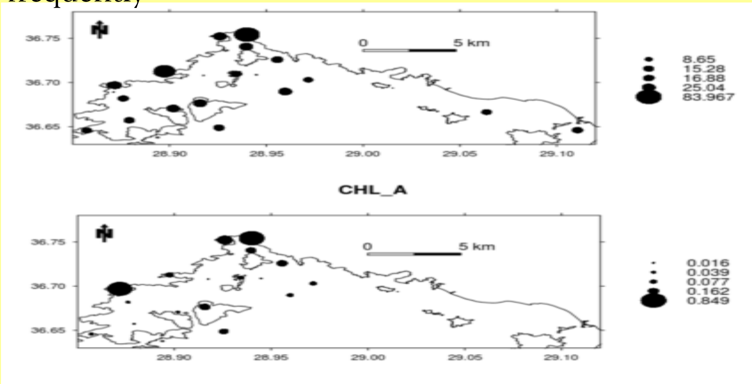
- The **pollution level** of the area is affected by the **uncontrolled waste disposals** from the yachts, the **circulation pattern** and **ecological characteristics** of the area.

The seawater pollution level in Göcek Bay are[illegible] and bilge water characteristics of the yachts were evaluated at several locations

- **FC** concentrations are high above the guide values according to **Bathing Water Directive** .

- **Untreated and uncontrolled** bilge water discharged from yachts threatens the **biological and chemical integrity of seawater** in Göcek Bay area because of high concentrations of **Chemical Oxygen Demand, Oil and Grease and hydrocarbons**

TSS and Chll-a concentrations measured in seawater indicate that highest concentrations are observed in the marina as well as in the bays where yachts visit frequently



EGU, 22-27 April 2012, Vienna: poster # EGU2012-11588

Field survey of the coastal impact of the March 11, 2011 great East Japan tsunami

A. Yalciner[1], F. Imamura[2], E. Mas[2], I. Necmioglu[3], C. Ozer[1], A. Zaytsev[4], S. Takahashi[5], T. Tomita[5], G. Yon[5], N. Kalligeris[6], H. Fritz[7], V. Skanavis[6], C. Synolakis[6,8,9], N. Meral Ozel[4]

1. Middle East Technical University (METU), Ankara, Turkey.
2. Tohoku University, Sendai Japan.
3. Bogazici University, Istanbul, Turkey.
4. Special Research Bureau for Automation of Marine Research, Yuzhno-Sakhalinsk, Russia.
5. Port and Airport Research Institute (PARI), Yokosuka, Japan.
6. Technical University of Crete, Chanea, Greece.
7. Georgia Institute of Technology, Savannah, Georgia, USA.
8. University of Southern California, Los Angeles, California, USA.
9. Hellenic Center for Marine Research (HCMR), Anavyssos, Greece.

Abstract

We performed a field survey in the tsunami hit areas of Great East Japan Tsunami. We report our findings from Sendai Airport, Yuriage, Natori, Sendai port, Taro, Miyako, Yamada, Kamaishi, Rikuzentakata, Ofunato and Kesennuma. We also present simulations of tsunami inundation and compute near shore tsunami parameters and different characteristics of the incoming tsunami. We present an assessment of the performance of coastal structures (tsunami walls, breakwaters, port structures, quays and defence structures), countermeasures, building damage, possible reasons of building damage. Furthermore, the tsunami impact, building response and tsunami mitigation strategies are briefly discussed.

Tsunamis that affected Sanriku coast in the past

The Sanriku coast extends northward from Sendai to Aomori. It is an indented coast with a shoreline longer than 600 km. The following tsunami events have affected it in the past:

Year (A.D.)	Estimated	Runup (m)
869	M~8.6	n/a
1611	M~8.1	n/a
1896	M~8.5	37,2
1933	M~8.1	28

Figure 1. Signs indicating past tsunami runup inTaro (15m in 1896 and 10m in 1933).

Before 2011, the possibility of a Miyagi-oki earthquake occurring had been estimated as 99% within 30 years, the highest earthquake risk in Japan. Along this coast, tsunami countermeasures had been extensively explored and were materialised as hard structures (Abe and Imamura, 2010).

Field survey of tsunami-hit areas

The field survey was held between 29th of May and 4th of June 2011. The field survey consisted of two parts, covering Sendai area, Miyagi Prefecture in the first part and Sanriku coast along Iwate and Miyagi Prefecture from Taro to Onagawa in the second part of the survey, as shown in Figure 2.

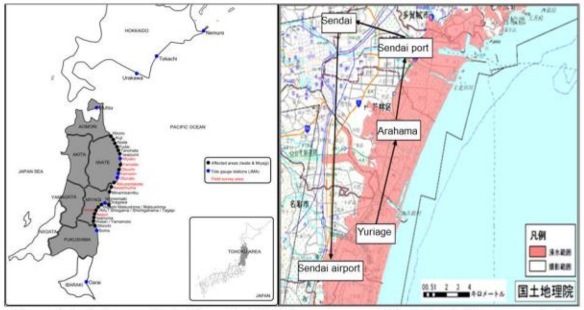


Figure 2. Left, Areas affected from the 2011 Japan tsunami (black dots), tide gauge station locations (blue dots) and areas covered in the field survey (red text); Right, locations visited around Sendai area.

Numerical Modelling

The ground deformation models developed by Fujii *et al.* (2011) and Imamura *et al.* (2011) are shown in Figure 3. A GPS buoy operated by the Independent Administrative Institute Port and Airport Research Institute (PARI), located 24km off Kamaishi, recorded the tsunami (Figure 4a). The first crest was 6.7m and occurred 26 minutes after the earthquake. The initial conditions for tsunami generation of Figure 3 were used to compute water heights using GEBCO 30arcsec bathymetry data. The comparison with the GPS buoy record and maximum water elevation using the Imamura et al. (2011) source modes are given in Figure 4.

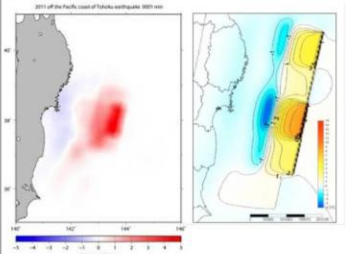


Figure 3. Source models for the 2011 Great East Japan Earthquake. Left, the Fujii-Satake Source (Fujii et al, 2011); Right, the Tohoku University-Imamura Source (Imamura et al (2011).

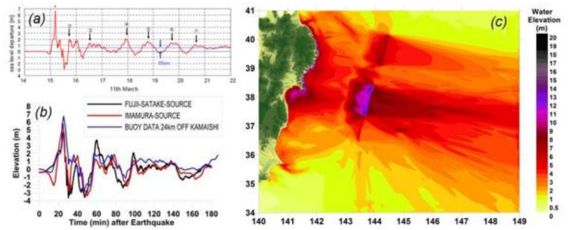


Figure 4. (a)The wave record 24 km off Kamaishi by PARI Japan, (b) comparison of the measured data and the computed data using both the Fujii-Satake and Imamura sources of Figure 2 and (c) distribution of maximum water elevation over the entire computation area using Imamura source as initial conditions.

To assess the wave attenuation induced by the Kamaishi breakwaters on March 11, 2011, we performed numerical simulations with and without the breakwaters in place, using a 10m cell-size DEM.

The comparison of model predictions using the Imamura *et al.* (2011) source model are shown in Figure 5. For five chosen locations behind the breakwaters in Kamaishi bay, the breakwaters are seen to only have reduced the tsunami height by 10-20%.

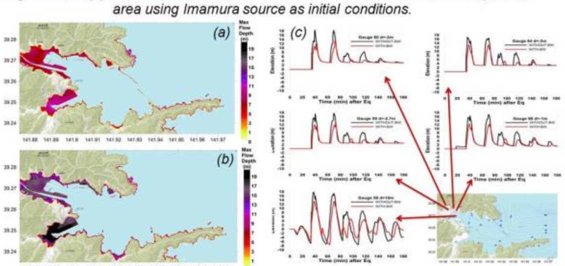


Figure 5. The distribution of maximum flow depths computed for Kamaishi area with breakwaters (a) and without breakwater (b); (c) Comparison of the time histories of water level change at some locations in Kamaishi bay according to the simulations with and without the breakwater included in the bathymetry.

Conclusions

The 11 March 2011 event provided an unfortunate opportunity to observe a world class warning system in action, and observe tsunami effects in the possibly most sophisticated nation in the world in terms of tsunami preparedness.

Coastal forestation was one of Japan's tsunami mitigation strategies. From the 4000 pine trees planted in Rikuzentakata city, a single pine tree survived and 20% of residents of this city lost their lives.

The period of the waves is estimated at about 50 minutes. As the tsunami waves shoaled in shallow and narrow bays, they caused massive flooding that lasted for up to 25min. The field survey revealed that the flow reached supercritical conditions in most areas causing significant damage.

In our survey, we observed flow depths almost twice as large as those from the 1896 Great Meiji tsunami. The death toll from the 2011 tsunami is much lower in relative terms compared to the population size. Hence the tsunami protection and mitigation measures and public education were effective in reducing loss of life.

Acknowledgments

The authors thank Professor Nobuo Shuto for his long leadership in tsunami studies worldwide, and also for invaluable contributions to this study. The field survey was supported by Turkish Chamber of Civil Engineers, Yuksel Project Int. Co., Kiska Commandite Co., Dolsar Ltd. Co, Cesas Ltd. Co. Turkey. This study was partly supported by TUBITAK (Turkey)-RFBR (Russia) Joint Research Grant (MORAT, Project No: TUBITAK 108Y227), DPT2010K140200 and DPT2011K140210 Projets, a RAPID grant from the National Science Foundation of the US, and Willis Research Network (WRN) under the pan Asian/Oceanian tsunami risk modeling and mapping project, METU and Bogazici University KOERI Turkey, HCMR Greece, Tohoku University Japan. Dr. Masahiro Yamamoto, the anonymous contributors to the series of IOC/UNESCO, Dr. Laura Kong, Prof. Shunichi Koshimura, Aykut Ayca, and PARI, Japan are also acknowledged.

A Complete Study on the Determination of Yacht Carrying Capacities in Gocek and Foca Bays (Special Environment Protection Areas)

FOCA

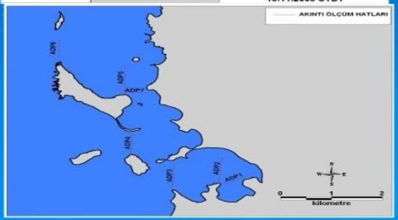
GOCEK

Carrying Capacity of Marine Vehicles:
Determination of the number of marine vehicles using the Marine Environmental Protected Areas (EPASs) by considering the sustainability of the physical, economical, social., natural and cultural values and also the pleasure and satisfaction of the local people and guests in EPASs.

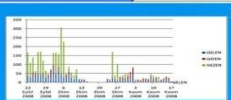
Stages:
- Determination of restrictions
- Marine surveys and measurement programs on oceanographic and environmental parameters
- Monitoring boat trafic by video camera recordings and counting with software support
- Determination of berthing places, navigation routes and parking places of boats
- Determination of Carrying Capacity in coordination with the results of socio-economic investigations
- Development of recommendations and application to the practice by short and long term management plans

Navigation routes

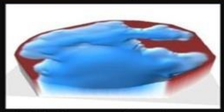
Location of video camera and view angle



Lines of

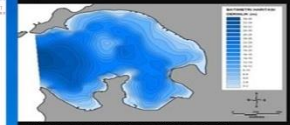


Counting of boat trafic

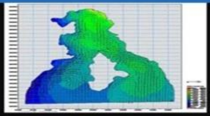


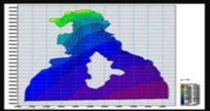
3-D Bathymetry of Foca Bay

Foca Bay

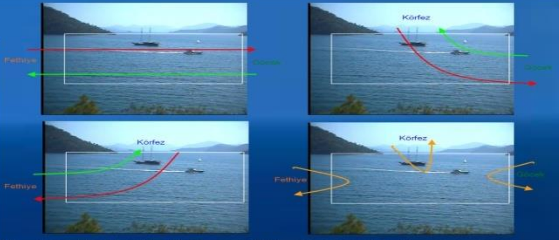


Bathymetric Map of Gocek Bay

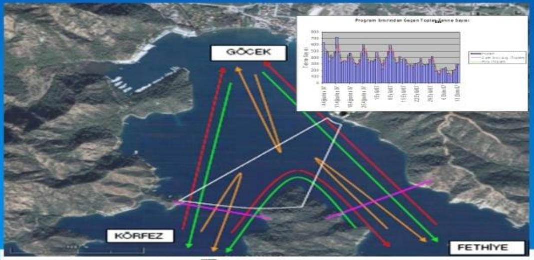


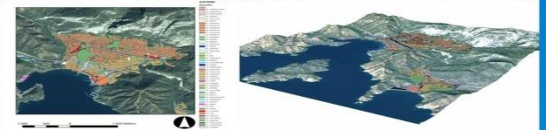


Göcek Bay, Circulation Modeling



Counting the boat trafic by specially developed software support





3D views of basement plans layered on the satellite image

Main reasons of marine pollutions are land and marine use by human .

The level of pollution by the boats are directly proportional to the number of human using the vehicles.

In order to diminish the effects of the solid and liquid wastes from the boats to the marine environment, the collection system and treatment plants of all wastes must be established and operated in highest efficiency.

In order not to give any damage to marine biotopes, mooring systems should be developed at the densely anchoring sites, and maritime traffic should be controlled in the sensitive marine zones in SEPAs

Proper controlling mechanisms by considering the pleasure and satisfaction of the users must be performed.

The awareness of the users and all involved sectors in the sensitivity of the environmental issues must be kept in highest priority.

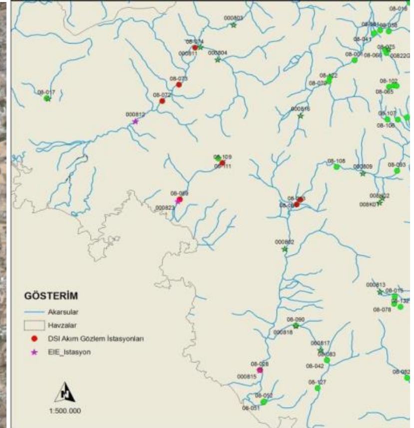
The management plans considering the protection of the environment and long term sustainable use of marine protected areas must be developed in collaboration with the involved sectors and strictly be followed by all sectors in the region

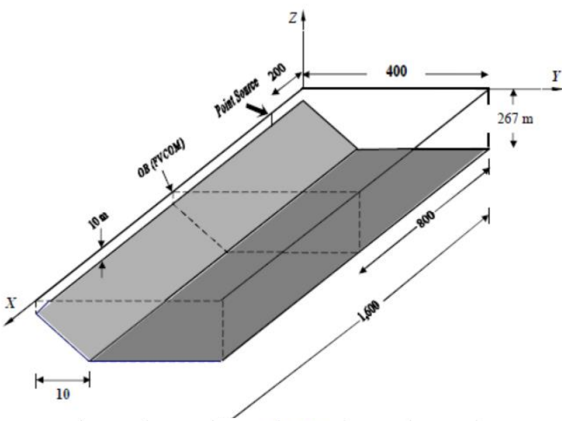
Acknowledgements:
The results of surveys and investigations given in this paper are based on the studies supported by EPASA and performed by Dokuz Eylül University, Institute of Marine Sciences and Technologies, Derinsu Underwater Engineering and Consultancy Co.; Middle East Technical University, Civil Engineering Department, Ocean Engineering Research Center, Underwater Research Society and Yıldız Technical University. The projects are supported by EPASA. The coordination and supports by Göcek and Foça Municipalities and EU funded TRANSFER Project are acknowledged.

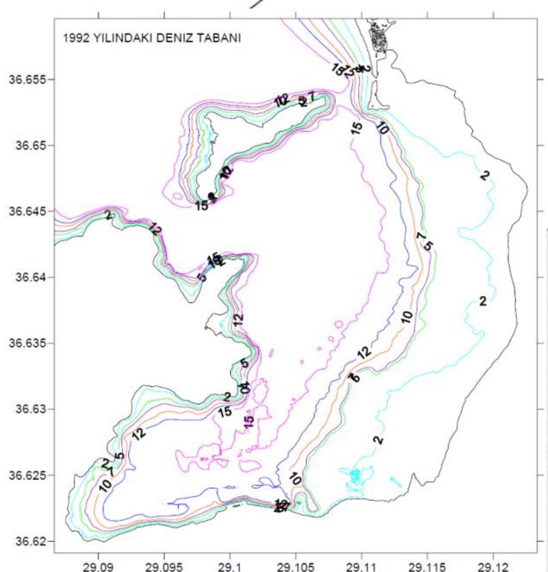
UNDERWATER RESEARCH SOCIETY

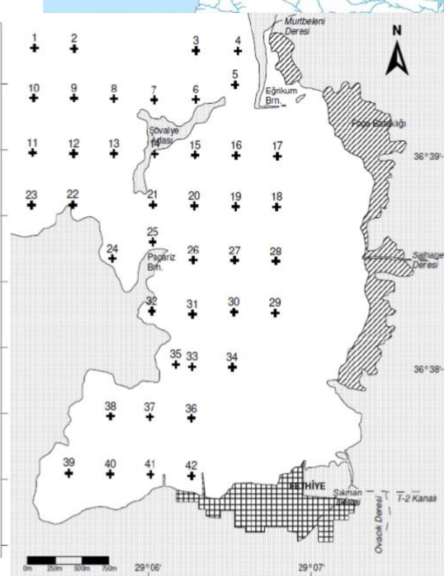
REPUBLIC OF TURKEY MINISTRY OF ENVIRONMENT AND FORESTRY
ENVIRONMENTAL PROTECTION AGENCY FOR SPECIAL AREAS

MIDDLE EAST TECHNICAL UNIVERSITY
DEPARTMENT OF CIVIL ENGINEERING
OCEAN ENGINEERING RESEARCH CENTER



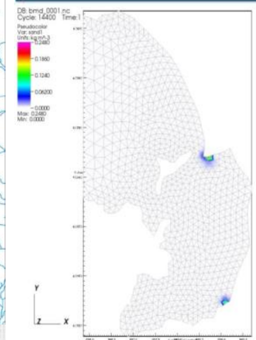


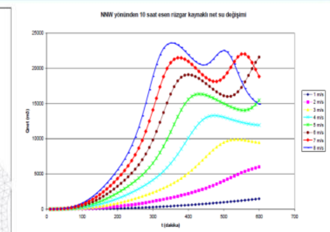


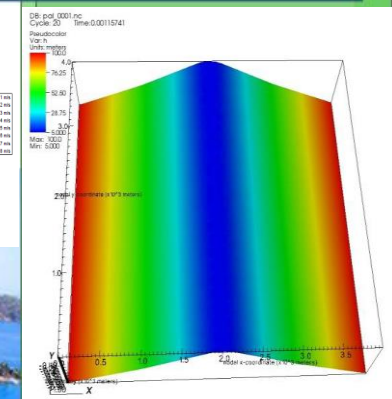


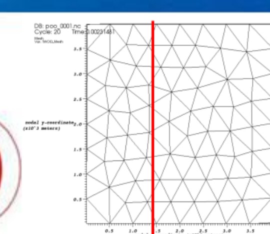
FETHİYE GÖCEK ÖZEL ÇEVRE KORUMA BÖLGESİ FETHİYE KÖRFEZİ YAT TAŞIMA KAPASİTESİNİN BELİRLENMESİ PROJESİ

Sonuç Raporu









Deniz Mühendisliği Araştırma Merkezi

İnşaat Mühendisliği Bölümü

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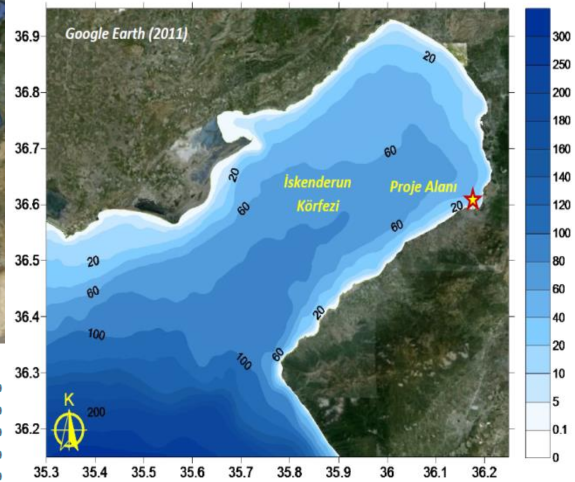
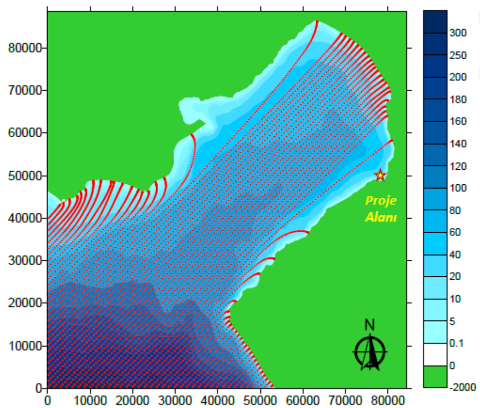
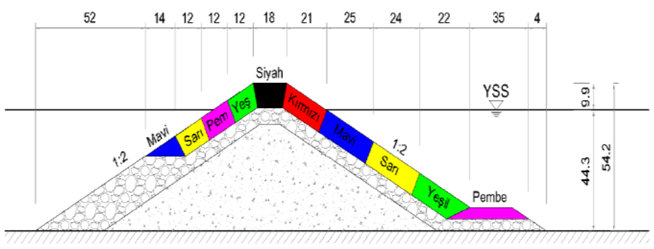
Nisan 2012







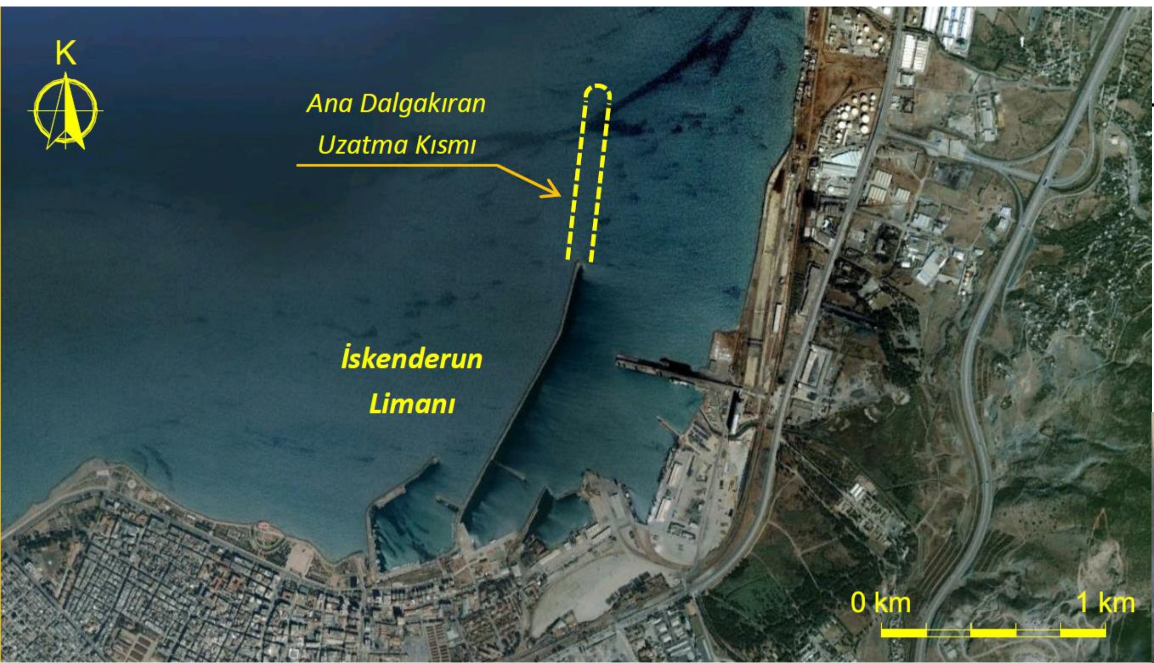
İSKEDERUN LİMANI DALGAKIRAN DENGE DURUMLARININ DENEYLER YAPILARAK ARAŞTIRILMASI PROJESİ

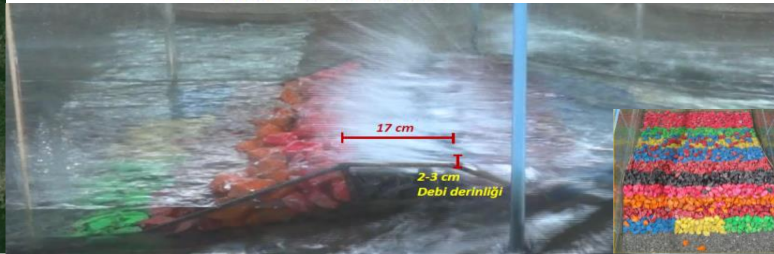
SONUÇ RAPORU

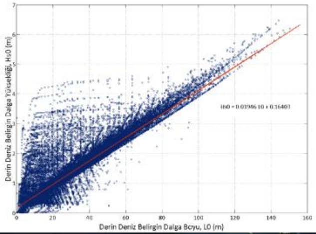
Prof. Dr. Ayşen Ergin, Prof. Dr. Ahmet Cevdet Yalçıner
Mustafa Esen (İnş. Y. Müh.), Cüneyt Baykal (İnş. Y. Müh.)
Ayşe Karancı (İnş. Y. Müh.), Dr. Gülizar Özyurt

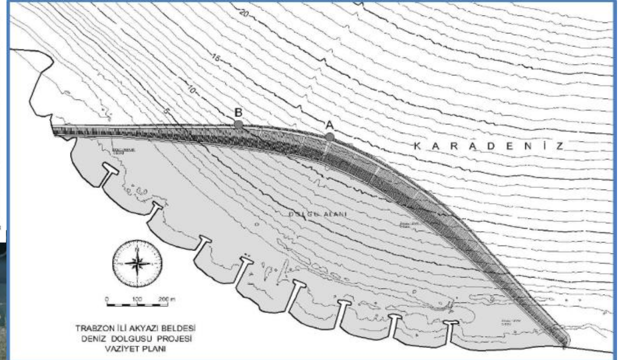
ORTA DOĞU TEKNİK ÜNİVERSİTESİ
İnşaat Mühendisliği Bölümü
Deniz Mühendisliği Araştırma Merkezi

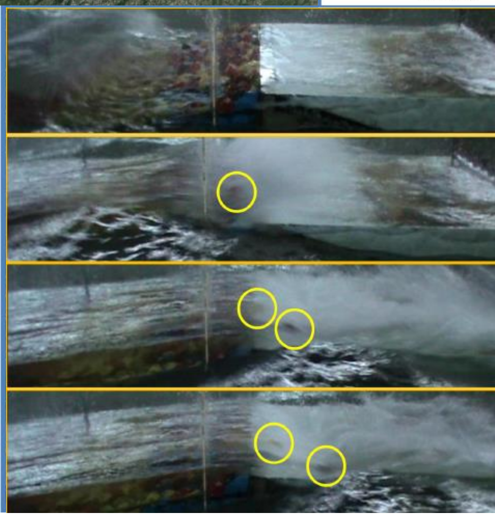
ANKARA – 08 Temmuz 2011

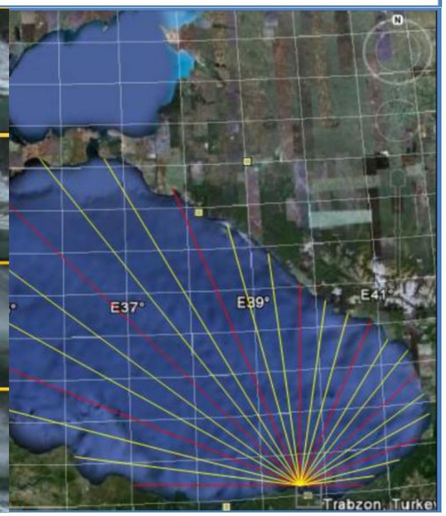


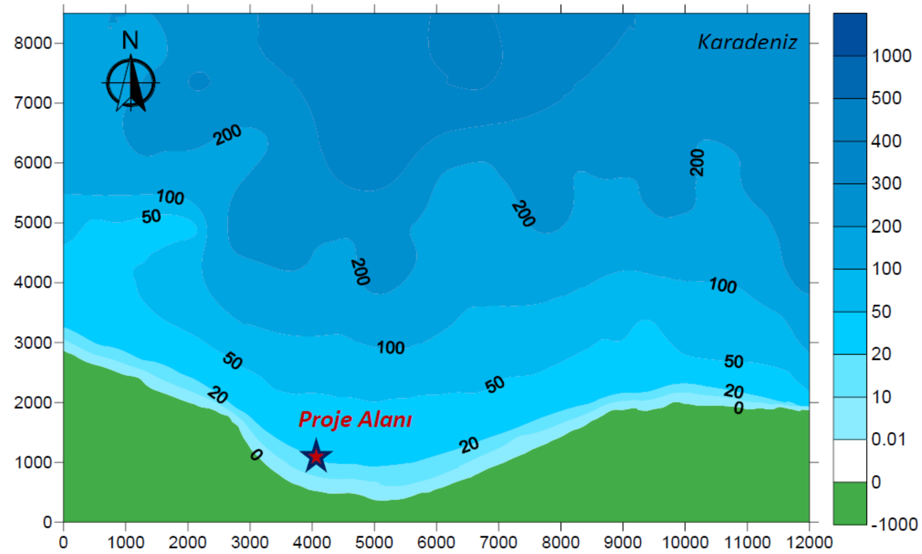












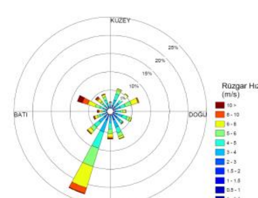
TRABZON İLİ AKYAZI BELDESİ DOLGU PROJESİ KORUMA YAPISI FİZİKSEL MODEL ÇALIŞMALARI

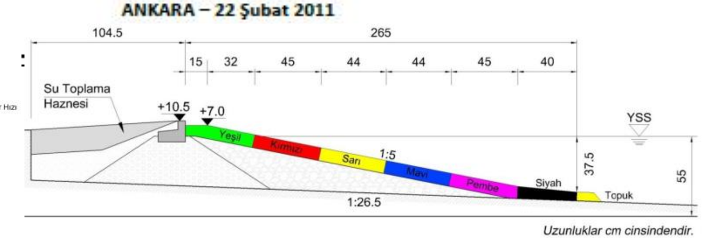
SONUÇ RAPORU

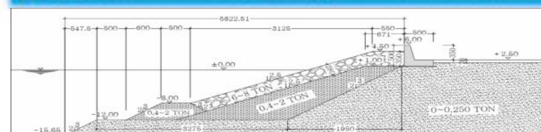
Prof. Dr. Ayşen Ergin
Prof. Dr. Ahmet Cevdet Yalçıner
Cüneyt Baykal (İnş. Y. Müh.), Mustafa Esen (İnş. Y. Müh.)
Kemal Cihan Şimşek (İnş. Müh.)

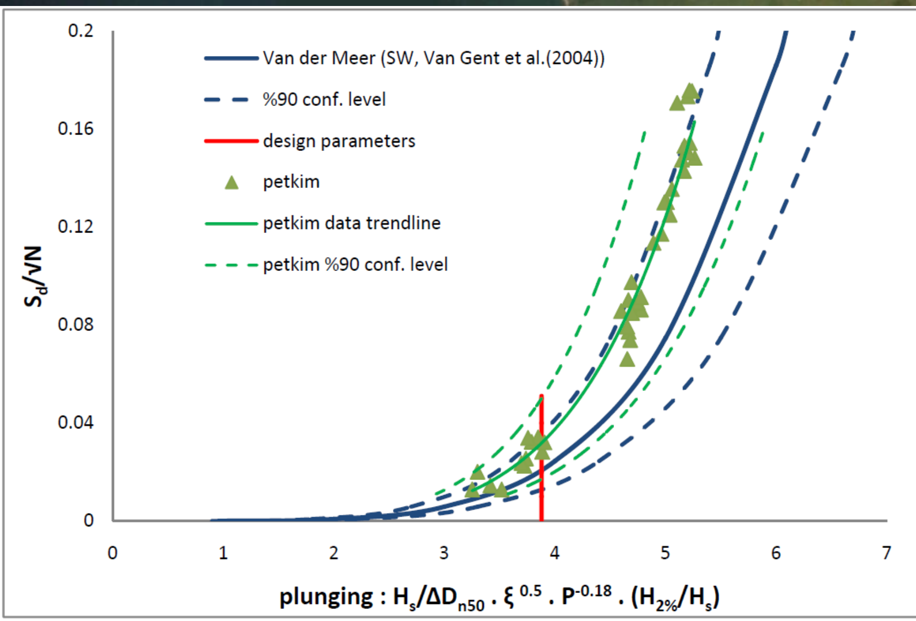
ORTA DOĞU TEKNİK ÜNİVERSİTESİ
İnşaat Mühendisliği Bölümü
Deniz Mühendisliği Araştırma Merkezi

ANKARA – 22 Şubat 2011





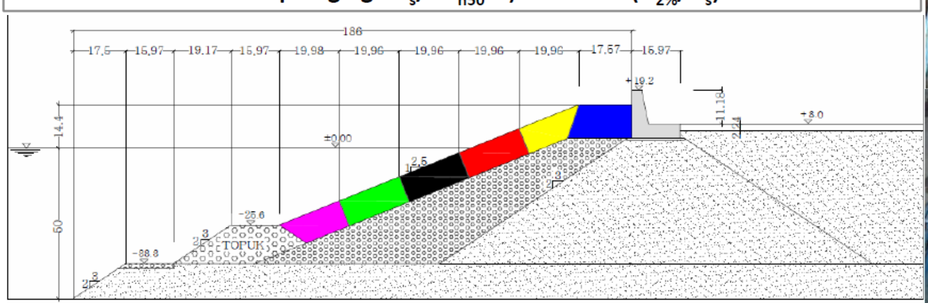




PETKİM LİMANI DALGAKIRAN DENGE DURUMLARININ DENEYLER YAPILARAK ARAŞTIRILMASI PROJESİ

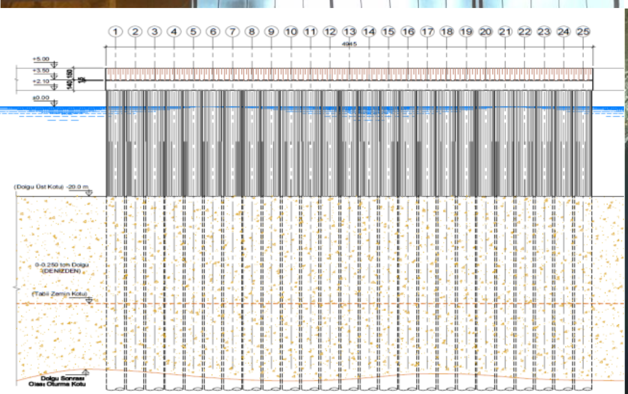
SONUÇ RAPORU

Prof. Dr. Ayşen Ergin, Prof. Dr. Ahmet Cevdet Yalçıner
Cüneyt Baykal (İnş. Y. Müh.), Kemal Cihan Şimşek (İnş. Y. Müh.)
Aysim Damla Atalay (İnş. Müh.)



ORTA DOĞU TEKNİK ÜNİVERSİTESİ
İnşaat Mühendisliği Bölümü
Deniz Mühendisliği Araştırma Merkezi

ANKARA – 9 Şubat2012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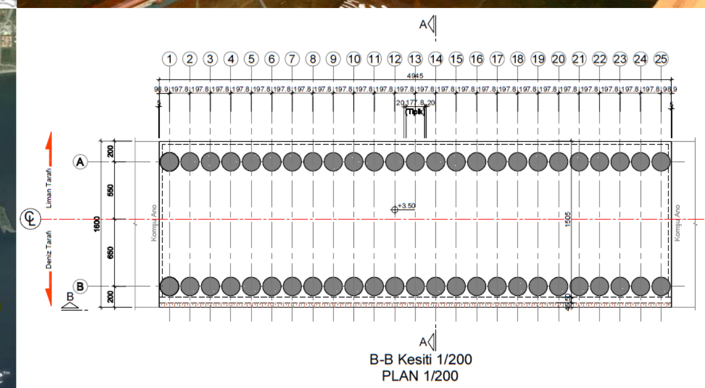
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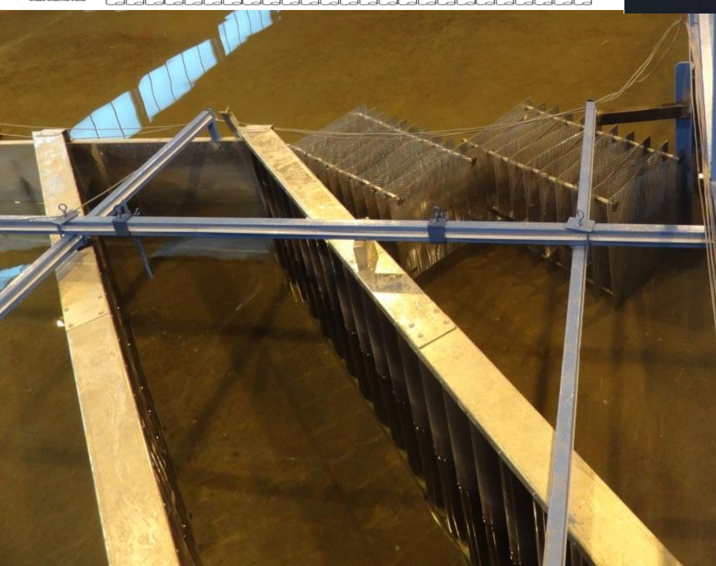


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ULAŞTIRMA BAKANLIĞI
DEMİRYOLLAR, LİMANLAR VE HAVA MEYDANLARI İNŞAATI
GENEL MÜDÜRLÜĞÜ
İŞİN ADI
ÇANDARLI LİMANI DALGAKIRAN İNŞAATI
YÜKLENİCİ
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YÜKLENİCİ
KONTROL MÜHENDİSİ
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BAŞ MÜHENDİS
BÖLGE MÜDÜR YARDIMCISI
BÖLGE MÜDÜRÜ
ŞUBE MÜDÜRÜ
DAİRE BAŞKANI
GENEL MÜDÜR
ONAY

ITS, 25-28 September 2013

Database Development for Tsunami Modeling and Assessment in Didim Peninsula and Gulluk Bay, Turkey

S. Acar[1]
B. Aytore[1]
Dr. A. Zaytsev[2]
Prof. Dr. A. C. Yalciner[3]

1.Middle East Technical University (METU), Ankara, Turkey.
2.Special Research Bureau for Automation of Marine Researches, Far Eastern Branch of Russian Academy of Sciences, Russia.
3.Middle East Technical University (METU), Ankara, Turkey.

Abstract

Gulluk Bay is formed basically by four large natural coves and many small bays and inlets. Local industries are mainly based on fish farming for sea bass and bream, and the export of bauxite from the recently relocated harbour on the outskirts of Gulluk. Furthermore, Gulluk Bay is one of the seven largest gulfs and bays on the west coast of Turkey and contributes about 80% of countries' aquaculture production.

Didim, is a small town, and district of Aydın Province on the Aegean coast of western Turkey, 123 km from the city of Aydın and is located on the north shore of the gulf of Güllük opposite the Bodrum peninsula villages.

The fish farms are vulnerable against external effects mainly against storm and long wave action. Therefore, a low level tsunami may even be destructive to plants and fishes in the nets of the farms. The area is subjected to tsunamis generated by local seismic sources and far filed sources at Helenic Arc and Santorini. Since the tsunami and Aquaculture has not been studied previously (only partly in Japan), and the risk level for the aqua cultural environment for Gulluk Bay under a tsunami motion has not been studied in any researches so far. Within the scope of the study, the tsunami effects mainly on the aquaculture industry and partly on coastal structures and settlements shall be studied.

Tsunamis that affected Gulluk bay in the past

- Tsunami by Santorini Eruption 1600 BC and 1956 Southern Aegean Tsunami,
- Seismic sources along Hellenic Arc from East of Crete to Rhodes island,
- Local seismic sources in Southern Aegean sea.

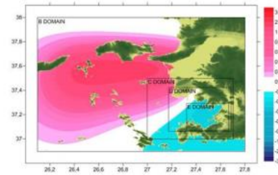
Fish Farming and Aquaculture Plants along the Gulluk Bay

Figure 1: Satellite Image of Gulluk Bay; Fish Farms located in the bay, Courtesy to: FAO and EUROFISH Regional Workshop on WTO and Fisheries: An update on WTO and Market Access Issues in Fisheries and Aquaculture, 8-10 November 2011, Istanbul, TURKEY, Hayri DENİZ – National Coordinator

Numerical Modelling

Source Properties: Source were taken from historical eartquakes in Aegean Sea. Source properties are given as:

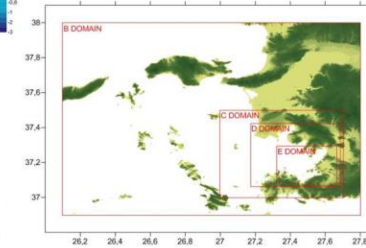
Name: s18-Z22
Type: Normal
Epicenter: 26.36E, 37.64N
Dip Angle: 45°
Rake Angle: 45°
Strike Angle: 95°
Depth (km): 20
Maximum (+) wave amplitude (m): 1.80
Maximum (-) wave amplitude (m): -0.30
L (km): 95
W (km): 30
U (m): 8



Source for Gulluk Bay (s18-Z22)

Table 1 Boundary Coordinates of B, C, D and E Domains in Gulluk Bay

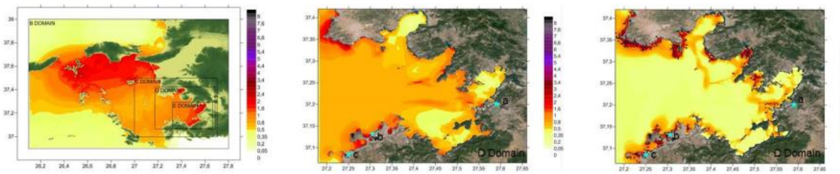
Domain name	Left Longitude (°)	Right Longitude (°)	Bottom Latitude (°)	Bottom Latitude (°)	Resolution (m)
B	26.1 E	27.8 E	36.9 N	38.0 N	270
C	27 E	27.7 E	37 N	37.5 N	90
D	27.18 E	27.66 E	37.065 N	37.42 N	30
E	27.323 E	27.667 E	37.068 N	37.294 N	10

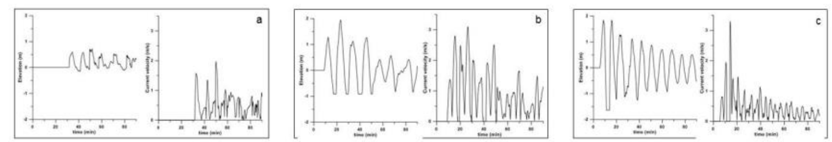


As first approach, s18-Z22 source used to define the wave parameters and effects on Gulluk Bay.

In the case study the tsunami simulation and visualization code NAMI DANCE is used. The code has the capability of solving nonlinear form of shallow water equations with friction and dispersion with variable mesh. The model computes time histories of all necessary tsunami parameters (water level, current velocities, flow depth, inundation length and height, and maximum water level at land) in the study domain. The model is utilized in highest resolution and the simulation results are used for assessment of the effects of a selected tsunami in Gulluk bay.

Following figures show the simulation results which were obtained from NAMI DANCE.





Conclusions

The possible tsunami sources in the Aegean Sea are evalauted in regard to tsunami influence in Didim Peninsula and Gulluk Bay where critical coastal plants (i.e. fish farms) are utilized. Available high quality bathymetry and topography data of Gulluk and Didim areas are collected and processed. The fine grid high resoluiton database is developed for tsunami modeling. One of the critical tsunami source is simulated using nested grid domains with the 30 m resolution. The critical regions in the bay artea where higher ampolitude and stronger current of tsunami occur are determined. According the simulated tsunami source (1.30 m amplitude) the highest water elevation goes to more than 3 m and strongest water velocities exceed 5 m/sec at some areas. Further assessments, simulations and discussions are necessary. Measurements are also necessary for further improvement of database and better accuracy.

More awareness of local community is necessary for the tsunami risk especially on the aquaculture industry. More willingness of local civil protection agencies and stake-holders are necessary for better development of risk prevention strategy and resilience.

Acknowledgments

This study is partly supported by EU TRANSFER Project, UDAP-Ç-12-14 project granted by Disaster Emergency Management Presidency of Turkey (AFAD), and 108Y227 project by TUBITAK and DPT 2011K140210 and RAPSODI (CONCERT_Dis-021) project in the framework of CONCERT-Japan, Research and Innovation Joint Call for connecting and cooperating European Research and Technology Development with Japan.

ITS, 25-28 September 2013, Gocek: Poster #42

Assessment of tsunami resilience of ports by high resolution numerical modeling: A case study for Haydarpasa Port in the Sea of Marmara

B. Aytore[1]
S. Acar[1]
A. Zaytsev[2]
A. Ayca[3]
A. Yalciner[1]

1.Middle East Technical University (METU), Ankara, Turkey.
2.Special Research Bureau for Automation of Marine Research, Yuzhno-Sakhalinsk, Russia.
3.University of Southern California , Los Angeles, California, USA.

Abstract

Ports and harbors are critical structures and vulnerable against tsunamis. Those must be resilient against natural hazards in order to facilitate recovery operations. The Sea of Marmara is located at the western part of the North Anatolian Fault (NAF) zone which caused earthquakes and tsunamis. 35 tsunamis have occurred in the region in last two millenniums. The characteristics of possible tsunami sources have already been estimated. However a complete tsunami inundation analysis using recent data processing and computational techniques are necessary for better analysis of the effects of different levels of tsunamis on specific critical structures. Hence Haydapasa port is selected as a case study.

The port has components of handling and storing general cargo and container, serving ro-ro and passenger vessels. It has two breakwaters with the length of 3km total so as to protect the vessels and harbor operations.

The numerical methods from data collection and processing to tsunami modeling by considering non linearity, friction, dispersion, inundation and motion in the harbor basin are applied with highest confidence and accuracy to Haydarpasa Port in a domain 5kmx3km size with highest resolution. The aim is to evaluate the possible effects of different sizes of tsunamis on the port and its structures as well as the level of resilience after tsunami for the efficient recovery operations.

The tsunami simulation and visualization code NAMI DANCE is used with friction and dispersion in variable mesh. The simulation results are used with animations for assessment of tsunami effects on Haydarpasa port. Finally the structural performance of the port components is discussed for better resilience.

Test Site Desciption

The major characteristics of NAF zone is strike slip and it has two branched in the Sea of Marmara. Numerous investigations till now have provided sufficient information about the distribution different faults with their possible rupture characteristics in Marmara. Furthermore the possible landslide prone areas have also been determined in some of those studies. Therefore the characteristics of possible tsunami sources have already been obtained for the region.

In the Sea of Marmara there are several critical structures. One of them is the port of Haydarpaşa located in Haydarpaşa district in Istanbul at the Southern entrance to the Bosphorus , as shown in Figure 1. The port serves the hinterland which is the most industrialized area of Turkey. It has a great importance due to being a gateway to the biggest container port in the Marmara Region.

Figure 1. The location and a view of the port of Haydarpasa

Study Domains

The grid size of largest domain named Domain B was chosen as 90m. The grid sizes of Domains C and D are 30m and 10m respectively. The general views of selected domains are given in Figure 2. The modeling will focus on the port area and its environs where the high density of coastal population and activities are existent.

Selected Source

When the results of six different tsunami scenario simulations, namely Prince's Islands (PI), Prince's Islands Normal (PIN), Ganos Fault (GA), Yalova Fault Normal (YAN), Central Marmara Fault Normal (CMN), and Prince's Island and Ganos Fault (PI+GA) from previous studies were compared, it is found that the tsunami generated by the sources PI, PIN and YAN cause higher water level, flow depth and stronger current velocities near the port of Haydarpasa. When these three sources are carefully investigated, the scenario YAN is found as the most critical one for the port (OYO Int. Co., 2007; Ayca, 2012).

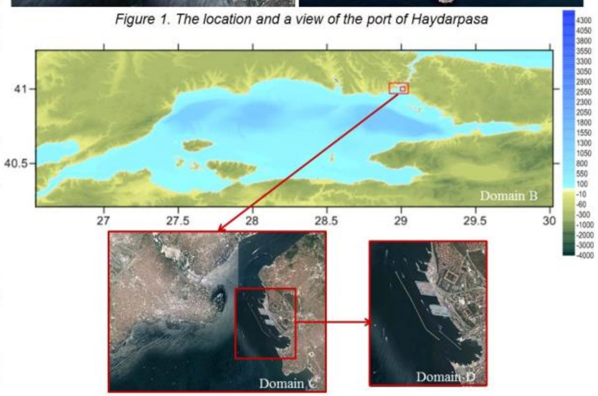


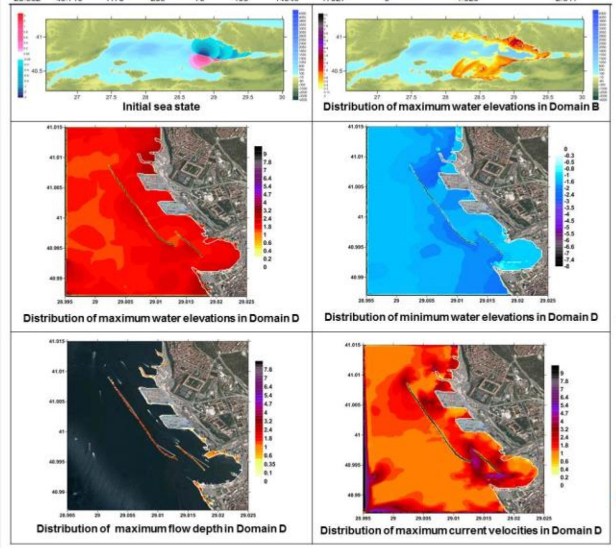
Figure 2. Nested study Domains B, C and D used in the simulations of the port of Haydarpasa

Numerical Modeling

The parameters of each segment, the results obtained after 45 minutes of simulation time are in Table 1. The fluctuations during simulation time at some of the selected gauges are in Figure 3 and a view from NAMI DANCE is in Figure 4.

Table 1. The input and computed tsunami parameters generated by the source YAN

Lat. (deg.)	Lon. (deg.)	Depth (m)	Strike (deg.)	Dip (deg.)	Rake (deg.)	Length (m)	Width (m)	Vertical Disp. (m)	Max. Initial Wave Amp. (m)	Min. Initial Wave Amp. (m)
29.471	40.721	1978	258	70	195	7058	17027	5	0.272	-0.771
29.389	40.708	1960	261	70	195	6873	17027	5	0.269	-0.766
29.309	40.698	1823	261	70	195	10952	17027	5	0.335	-0.907
29.181	40.681	1681	262	70	195	4448	17027	5	0.474	-1.552
29.129	40.676	1557	274	70	195	4562	17027	5	0.559	-1.645
29.076	40.678	1252	284	70	195	10021	17027	5	0.917	-2.351
28.960	40.698	1219	295	70	195	3154	17027	5	0.518	-1.548
28.962	40.710	1178	285	70	195	14043	17027	5	1.029	-2.511



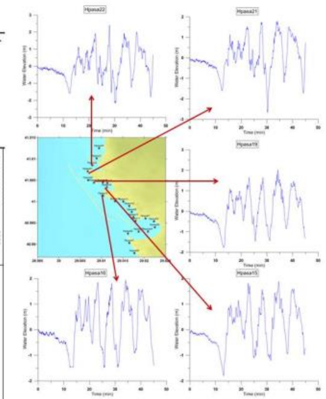


Figure 3. Time histories of water level fluctuations at selected gauge points

Figure 4. An aerial view of tsunami developed by NAMI DANCE

Conclusions

Table 2 gives the summary of main tsunami parameters computed at around port of Haydarpasa. The computed values does not cover the possible change of water level in long term (sea level rise) and short term during the storm and surge conditions if occur during tsunami.

Table 2. Summary Sheet of Main Tsunami Parameters at Selected Gauges for Source YAN

Name of gauge pt.	Depth of gauge pt.(m)	XCoord	YCoord	Arrival time of initial wave (min)	Arrival time of max.wave (min)	Maximum (+)ve amp. (m)	Maximum (-)ve amp. (m)
Hpasa22	2.15	29.0078	41.0085	0	28	2.41	-2.15
Hpasa21	3.80	29.0067	41.0071	0	34	1.80	-2.68
Hpasa19	4.90	29.0082	41.0044	0	34	2.02	-1.77
Hpasa16	1.46	29.0112	41.0034	0	34	1.95	-1.46
Hpasa15	8.71	29.0104	41.0014	0	35	1.88	-1.80

The simulation results (in Haydarpasa Port) using 90m grid resolution are in agreement in both this study and Ayca (2012) where Haydarpasa breakwater is not included. When fine grid nested domain (90m, 30m, 10m) simulation (in this study) is used, the wave motion and water level fluctuations inside the harbor could be computed realistically.

In regard to functions of the port of Haydarpasa, it is clear that, the water area inside the port will be agitated and water flow through both entrances will cause sea level rise and strong current inside the port. Damages and dragging of floating bodies due to strong currents and water level rise at the site should be expected.

Acknowledgments

This study is partly supported by EU TRANSFER Project, UDAP-Ç-12-14 project granted by Disaster Emergency Management Presidency of Turkey (AFAD), and 108Y227 project by TUBITAK and DPT 2011K140210 and RAPSODI (CONCERT_Dis-021) project in the framework of CONCERT-Japan, Research and Innovation Joint Call for connecting and cooperating European Research and Technology Development with Japan.

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Ayca A., (2012), Development of a Web Gis-based Tsunami Inundation Mapping Service; a Case Study for Marmara Sea Region, M. Sc. Thesis, METU, Dept of CE, Ocean Eng. Res. Cent.

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ONGOING PROJECTS

- **UDAP- Project under National Earthquake Research Program funded by Disaster Emergency Management Agency**
- **Turkey-Greece Joint Research Project (TUBITAK-GSRT)**
- **COCONET Coast to Coast Network for MPAs**
- **ASTARTE**
- **RAPSODI**
- **SATREPS Japan-Turkey (JICA-JST)**
  JAMSTEC-KOERI (Earthquake, sea bottom monitoring, tsunami source parameters)
  PARI-METU (Tsunami simulations, hazard assessment)

NOAA-UNESCO-USC-JRC-

METU CONTIBUTIONS TO RAPSODI

- ✓ **Numerical modelling of tsunamis from source to target,**
- ✓ **Experiments on the performance of selected rubble mound structures under the attack of long waves,**
- ✓ **High Resolution Modeling; tsunami parameters near shore and in the vicinity of structures and flow pattern,**
- ✓ **Resonance analysis and amplifications in semi closed basins (harbors and bays),**
- ✓ **Vulnerability, hazard, and risk analyses.**

STAGE 1 Evaluation of existing knowledge and comparisons of mitigation strategies

WP 1: Evaluation of existing tools, data, and mitigation strategies (**WP leader: METU**)

- - Review and evaluation of tools available for the numerical modelling, and the assessment of impact loads on structures, failure modes, and vulnerability,
- - Comparison of coastal structures and mitigation strategies in Europe and Japan,
- - Implementation of a database including data from post-tsunami field surveys (run up, flow depth, flow velocities, fluxes), damage data, and number of fatalities data,
- - Evaluation of the performance of structural and societal mitigation strategies from the 2011 event

STAGE 2 Numerical and experimental studies

WP 2: Numerical modelling of tsunamis (**WP leader: METU**)

- - Numerical modelling of spatial and temporal changes of tsunami parameters in high resolution geometries including structures for the assessment of damage (impact, scour, erosion) and flow conditions

- - Computation of coastal zone flow pattern due to different characteristics (direction, shape) of incident tsunami

- - Applications to selected coastal areas in Japan (e.g. Kamaishi, Oarai, Yamada) and a selected port in Europe (e.g. Haydarpasa port)

- - Recommendations on types/design of harbors and coastal structures for mitigation of tsunami impact

METU INVOLVEMENTS

will be involved in all work packages, and have the responsibilities for

- evaluation of existing tools, data, and mitigation strategies (WP1) and for the numerical modeling (WP2).

- updating the existing numerical model NAMI DANCE with new modules in collaboration with other partners to provide the necessary near shore and on land tsunami parameters (WP2) in relation to the hazard assessment and risk management (WP4).

- Cooperating with the other partners in experimental studies (WP3).

DELIVERABLES

D.1: Report on existing tools, data, and literature on tsunami impact, loads on structures, failure modes and vulnerability assessment (month 3, METU)

D.3: Report on the comparison of coastal structures in Europe and Japan (month 6 METU)

D.4: Report on comparison of mitigation strategies in Europe and Japan (month 12, METU)

D.5: Report on computed tsunami parameter values in shallow waters and around structures (month 16, METU)

D.6: Report on numerical modeling of tsunamis in harbors and bays (month 18, METU)

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Our Areas of Interests

Coastal Engineering, Coastal Zone Managemet, Marinas, Ocean Engineering and Underwater Operations, Design Of Sea Outfalls, Port Planning and Design, Wave Hydrodynamics, Statistical Analysis In Coastal Engineering, Modeling of Coastal Engineering Problems, Coastal Sedimentation, Coastal Pollution, Coastal and Harbour Structures Design, Wind and Wave Climate Statistics, Marine Hazards and Tsunamis

Our Ideas and Expertize

Baseline and identification collection of cultural and Socio Economical profiles, Strategical approach, Infrastructure tools development for applications, Applications for MPAs, Monitoring Evallauation and Dissemination, Management Strategies and Monitoring, Implementation

Prof.Dr. Ahmet Cevdet Yalciner
Middle East Tecnical University,
Department of Civil Engineering, Ocean Engineering Research Center
Phone: +90 312 210 54 38 E-mail: yalciner @metu.edu.tr
METU Department of Civil Engineering
Ocean Engineering Research Center
Ankara Turkey