HIGH RESOLUTION DATA PROCESSING AND TSUNAMI ASSESSMENT AND APPLICATIONS TO PORTS IN THE SEA OF MARMARA

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The vulnerable nature of ports requires detailed assessment, serious preparedness and strong mitigation strategies for significant reduction of the loss of life and property.

High resolution data processing and tsunami assessment for ports is very substantial solution to achieve these objectives.

High resolution data processing and tsunami assessment for ports is performed by using tsunami simulation and visualization code NAMIDANCE to two different ports in the Sea of Marmara.





When it comes to tsunami hazard and tsunami hazard assessment, there are several critical structures in the Sea of Marmara. Two of them are Haydarpasa and Yenikapi Ports.

Both ports are located in Istanbul at the Southern entrance to the Bosphorus. The ports serve the hinterland which is the most industrialized area of Turkey.

Especially, Haydarpasa Port has a great importance due to being a gateway to the biggest container port in the Marmara Region.



Bathymetric and Shoreline Data

The bathymetric data is acquired from General Bathymetric Chart of the Oceans (GEBCO) of the British Oceanographic Data Centre.

Nevertheless, the dataset obtained from Navigation Charts is added to improve bathymetric data in high-resolution maps since GEBCO is insufficient in shallow water regions, especially inside the port areas due to its resolution.

The cross-section of breakwaters of Haydarpasa Port are also acquired from the original plots of design stage of the ports.

Besides, images from Google Earth are used to define a better shoreline and location of the breakwaters in the chosen domains.

Topographic Data

The topographical data purchased from Directorate of Cartography underneath of Department of Housing and Urban Development of Istanbul Metropolitan Municipality (IMM) to be able to create higher resolution topographic models.

In general, the purchased data from IMM has two parts: one is the raster data of digital elevation models that covers all districts in Istanbul and second is different vector data (points, lines and polygons) related to all type of structures in all districts in Istanbul.

DATA PROCESSING – Haydarpasa Port

For higher resolution numerical modeling, data set are obtained from Istanbul Metropolitan Municipality. This data set includes:

Digital Elevation Maps for all regions in Istanbul (for both in European and Anatolian Sites)





High : 263.37

Example Study:

Obtained contour map with 5 meters interval by using DEMs for Uskudar on top) and Kadikoy (at the bottom)

Example Study:

DEMs for two different regions in Istanbul where Domain D is in:

Uskudar and Kadikoy

DATA PROCESSING – Haydarpasa Port

For higher resolution numerical modeling, data set are obtained from Istanbul Metropolitan Municipality. This data set includes:

Elevation and coordinates of all structures (as polygons, lines and points) for all regions in Istanbul (for both in European and Anatolian Sites)



Example Study:

Representing all lipolygon features in Kadiikoy and Uskudar such as solads)ls, pidble boldingsasseligjens waijslingsk factorlicetoad carrying platfoms, factory chimneys, greenhouses, pools, closed bus stops etc.

DATA PROCESSING – Haydarpasa Port



Example Study:

For a better view of given data, representing all structures (polygons and lines) in Domain D by using UTM coordinates.

CREATED BATHYMETRIC AND TOPOGRAPHIC MAPS – Haydarpasa Port



| 28.995 | 29 | 29.005 | 29.01 | 29.015 | 29.02 | 29.025 |
|--------|----|--------|-------|--------|-------|--------|
| | | | | | | |

| Domain Name | Grid Size (m) | Coordinates of the | | |
|-------------|---------------|---------------------|--|--|
| | | Domains | | |
| С | 3 | 40.98° – 41.0165° N | | |
| | | 28.973° – 29.030° E | | |
| D | 1 | 40.987° – 41.015° N | | |
| | | 28.995° – 29.025° E | | |



| 12 | 2.4.9 | 21.0 | 24.9 | | 1 | |
|-----|-------|-------|------|--------|---|--------|
| 0 m | 250 m | 500 m | | 1000 m | | 1500 m |

Details of Domain D

DETERMINATION OF POSSIBLE TSUNAMI SOURCE- Haydarpasa Port

- 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):



| | Lon. | Lat. | Depth | Strike | Dip | Rake | Length | Width | Vertical Disp. |
|-----|----------|----------|-------|--------|-----|------|--------|-------|----------------|
| | (°) | (°) | (m) | (°) | (°) | (°) | (m) | (m) | (m) |
| | 29.47103 | 40.72115 | 1978 | 257.96 | 70 | 195 | 7058 | 17027 | 5 |
| | 29.38946 | 40.70850 | 1960 | 261.14 | 70 | 195 | 6873 | 17027 | 5 |
| | 29.30920 | 40.69851 | 1823 | 260.98 | 70 | 195 | 10952 | 17027 | 5 |
| VAN | 29.18143 | 40.68121 | 1681 | 262.35 | 70 | 270 | 4448 | 17027 | 5 |
| YAN | 29.12936 | 40.67650 | 1557 | 273.96 | 70 | 270 | 4562 | 17027 | 5 |
| | 29.07651 | 40.67891 | 1252 | 283.78 | 70 | 270 | 10021 | 17027 | 5 |
| | 28.96007 | 40.69843 | 1219 | 294.84 | 70 | 270 | 3154 | 17027 | 5 |
| | 28.96202 | 40.71005 | 1178 | 284.90 | 70 | 270 | 14043 | 17027 | 5 |

TSUNAMI ANALYSIS RESULTS – Haydarpasa Port

U -10 -50 -50 -80 -100 -500 -500 -800 -1200 -1600 40.5 2002

-1600 -2000 -2400 -2800 -3200 -3600 -4000

0

0 -10 -30 -50 -80 4 -100 -300 -500 -800 -1200 -1600 40.5 2000

-1600 -2000 -2400 -2800 -3200 -3600 -4000

0 -10 -30 -50 -80 -100 -300 -500 -800 -1200

-1200 -1600 4 -2000 -2400 -2800 -3200 -3600



0 -0.3 -0.5

-0.8 -1

-1.6 -2 -2.4

-3 -3.5

-4 -4.5 -5

-5.5 -6 -6.6 -7 -7.4

CREATED MAP AND SELECTED TSUNAMI SOURCE- Yenikapi Port

41.005

41

40.995



TSUNAMI ANALYSIS RESULTS – Yenikapi Port







Distributions of maximum sea surface elevation amplitude in Domain D (m)

Distributions of minimum sea surface elevation amplitude in Domain D (m)



Distributions of maximum flow depth on land in Domain D (m)

SIMULATIONS

Summary of the results are obtained for each port. 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. According to these results:

- 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 both Haydarpasa and Yenikapi Ports should be expected.

| Name of gauge pt. | Depth of gauge pt. (m) | Longitude | Latitude | Arrival time of initial wave (min) | Arrival time of max.wave (min) | Maximum (+)ve amp. (m) | Maximum (-)ve amp. (m) |
|-------------------|---------------------------------|-----------|----------|---|---|------------------------------|------------------------------|
| hp35 | -2.6 | 29.0236 | 40.9965 | 21 | 22 | 3.5 | 0.0 |
| hp51 | 13.6 | 29.012 | 41.0031 | 3 | 37 | 3.5 | -3.6 |
| hp55 | -2.8 | 29.0146 | 41.0031 | 23 | 38 | 3.2 | 0.0 |
| hp76 | 4.0 | 29.0096 | 40.9979 | 2 | 20 | 4.8 | -2.9 |
| p13 | 7.2 | 29.0171 | 40.9982 | 3 | 39 | 2.5 | -3.2 |
| p35 | 8.8 | 29.0094 | 41.0078 | 3 | 22 | 5.0 | -5.0 |
| p52 | 11.6 | 29.009 | 41.0013 | 3 | 37 | 2.4 | -2.8 |
| p55 | 5.3 | 29.0164 | 40.9966 | 3 | 38 | 2.6 | -3.2 |

Example Summary Sheet of Main Tsunami Parameters at Selected Gauges for Haydarpasa Port



THANK YOU FOR YOUR KIND ATTENTION

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