Advanced Engineering Days

aed.mersin.edu.tr

Simulation with the Mirone application for the construction of marine mechanical waves generated by possible seismic events in the territory of the Adriatic and Ionian seas

Adisa Daberdini [*1], **Fatmir Basholli** [2], **Novrus Metaj** [3]

[1]*University Aleksander Xhuvani, Department of Informatics, Elbasan, Albania, adisa.daberdini@uniel.edu.al*
[2]*Albanian University, Department of Engineering, Tirana, Albania, fatmir.basholli@albanianuniversity.edu.al*
[3]*Polytechnic University of Tirana, Department of Physical Engineering, Albania, novimetaj@gmail.com*

Cite this study: Daberdini, A., Basholli, F. & Metaj, N. (2022). Simulation with the Mirone application for the construction of marine mechanical waves generated by possible seismic events in the territory of the Adriatic and Ionian seas. 5th Advanced Engineering Days, 84-87

Keywords
Seismic Simulation
Wave
Tsunamis
Applications

Abstract

In this study, we will present the practical development of some simulations that we have done with the Mirone program for the generation of tsunami waves. These simulations are taken into account for real seismic events that have occurred in the Adriatic and Ionian seas throughout history and the data that have been reported for certain areas. In practical simulations with applications, we have the opportunity to see what is actually expected to happen in such events. We have presented several scenarios and we have also analyzed all the results that we have derived from the calculations and simulations made. We have taken risk assessment scenarios in both our seas and we have also given the effects they will have on the ecology of coastal areas and underwater ecology. In the tectonic origin risk assessment scenario in the Adriatic and Ionian seas, we study the tsunami risk generated by faults. Despite the fact that most of the seismic tsunamis are generated in the oceans as well as in the basins of small seas such as the Adriatic and the Ionian, where these phenomena can occur. A scenario-based method was used to provide a tsunami hazard assessment for the first time in this region.

Introduction

Real seismic sources with tsunami potential are found to model the expected coseismic deformation, which is directly related to the water surface and is used as an initial condition for tsunami propagation. Seismic results show examined sources and only presents very high threat causing wave amplitude up to 4m, one high, two intermediate and three low waves causing amplitude smaller than 4 m in some of the tourist resorts along the Ionian coast -Adriatic.

The Ionian-Adriatic region has experienced a sudden economic and tourism boom with an increase in the coastal population and the development of large free time zones in recent years and more so in parts of coastal cities that are only a few meters above sea level. sea making them future targets of a large-scale disaster, even if the height of the tsunami wave is moderate.

Large tsunami events require the presence of a thick layer of water that can only be found in oceanic domains, but they can also occur in small basins such as the Ionian and Adriatic seas in which many tsunamis have been reported during historical periods.

Numerical modeling of the tsunami, mainly those made by Bousinesq and Green's models, are the basis for the construction and coding of the programs used for the simulations [1]. These numerical models and the algorithms built from them are integrated into the Mirone, Geowave programs that contain both numerical models. Both of

these programs are Matlab based. We have also presented the data we have collected through the Surfer and Wiz-map programs that serve for the visual and three-dimensional construction of the structures and for merging these data with the maps we have. As input parameters of the program, we put the data of our coast longitude and latitude and the depths [2].

Mirone is a matlab-based program that allows the display and manipulation of a large number of grid formats through its interface with the GDAL library. Its main purpose is to provide users with an easier use of graphics compared to the more frequently used programs of the GMT package [3].

In addition, it offers a large number of tools that are focused in particular on the field of geophysics and earth sciences [4]. Among them the user can find tools to do multibeam planning, elastic deformation studies, tsunami propagation modeling, IGRF calculation and Parker magnetic inversion, Euler rotations and Euler pole calculation, plate tectonic reconstructions, seismicity analysis and mechanisms of hearth, advanced image processing tools. Mirone is written using the Matlab programming language a separate version is also provided to run under the Windows operating system [5].

Material and Method

For the study and development of the simulations, we have taken into account the bathymetry of the Adriatic and Ionian seas and also the earthquake events that have occurred in these areas. Materials for this study we used different software, while for the construction of simulations one of the software's is Mirone. Below are the bathymetry data and also the profiles that were taken into consideration for the development of the simulations. [6]. The profiles are obtained as follows: the first coordinate is taken on our coast and the second coordinate is taken on the nearest neighboring coast. We will have a very accurate presentation of the profile and the distance of each of the two points. The profiles are almost parallel to each other and have different distances starting from the geometry of the coast and the bathometric data that we had available from the institute. Also, in the construction of bathymetry we have used another program Surfer that we have built the coastal basin using the dates obtained from the depths of the profiles [7].

Each of these profiles we have obtained has a very special structure and what we expect is that an earthquake occurring in different areas of these profiles will affect in different ways [8].

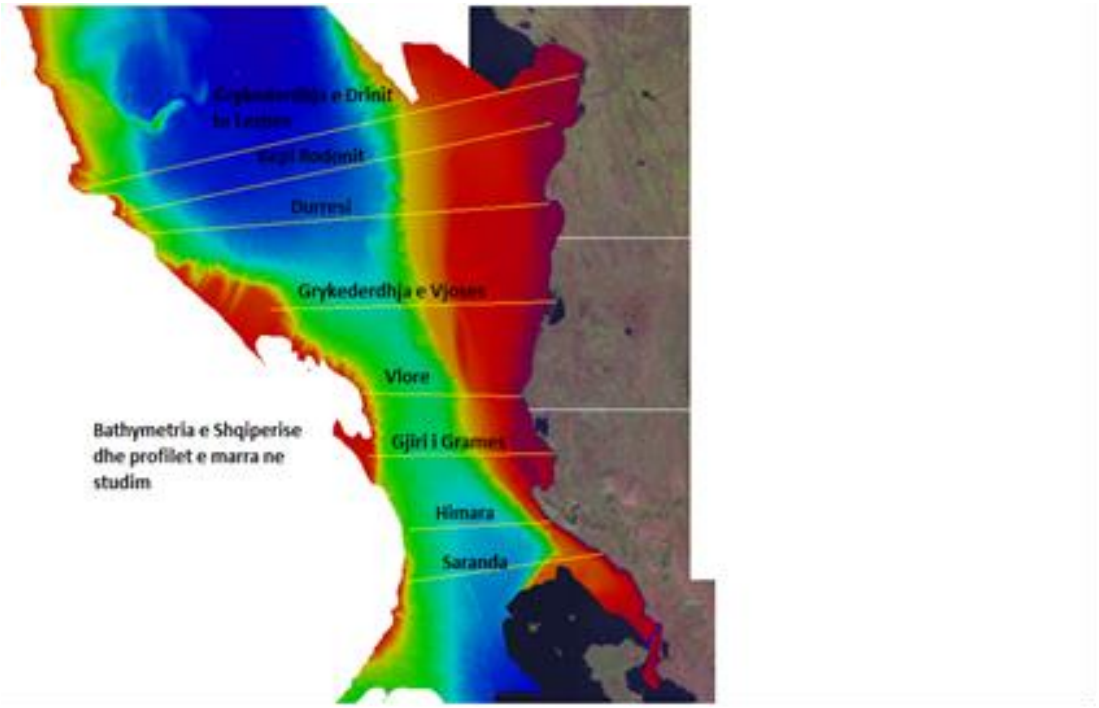

Figure 1. Bathymetry of Adriatic and Ionian Seas build with Caris Base Edition 4.1.

This menu has options to display data related to earthquakes and the mechanisms and elastic deformations that generate the earthquake. Below we also have the tool that allows us to simulate the spread of the tsunami. Figure 2 give us the simulations with the data used.

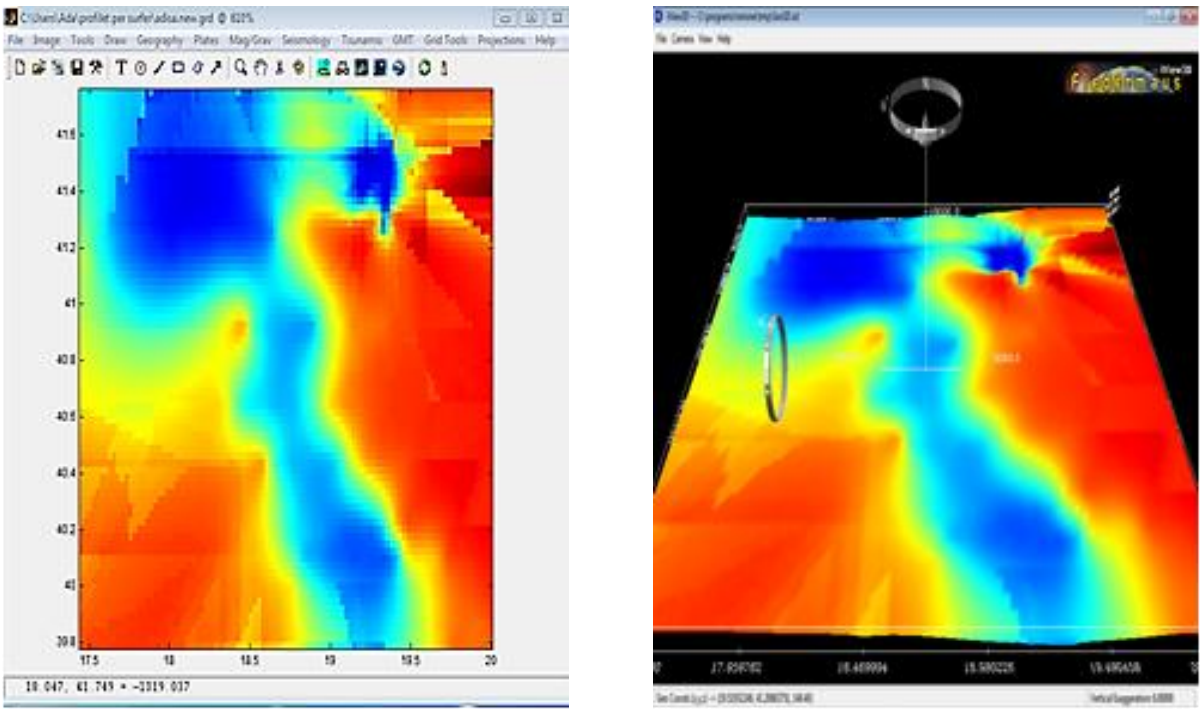

Figure 2. Bathymetry of our 3D coasts taken in Mirone

Results

First, the results of this study show how to build an approximate model for the structuring of the Adriatic and Ionian seas if the Adriatic and Ionian seas were to undergo a seismic activity and if in these cases a tsunami would develop in marine dimensions.

Secondly the physical structure can be damaged by the force of the wave itself, the physical removal of flora and fauna and the growth of sediments which can kill species that are sensitive to sediments and the disturbance of underwater vegetation [9].

Discussion

First in the north at the Drini estuary the tsunami wave has a high probability that if it occurs in a position close to the coast as a wave of a tsunami of the V degree with a height of 1 m and a tsunami of the VI degree with a tsunami wave of a height of 2 m there are many opportunities for wide spread on the coast and in the surroundings and in the villages and even on the streets. Normally, a tsunami wave with a height of 2 m will be more damaging. Secondly, in Sarandë, the tsunami occurring near the coast will have an impact only on the parts very close to the coast due to the high profile of the coast.

Thirdly, in Vlora, Grykëderdhjen e Vjosa, Divjakë are the areas with the most risk because in these profiles due to the low height of the areas near the coast there is a risk that in the case of a tsunami the areas will be flooded and have a great impact on the beach period of holidays when these areas have a lot of population [10].

The figures below show the tsunami wave simulations for two of the main profiles we have in the study Rodon Cape and Durres. The dark blue indicates the depth zone, the yellow dot located on the first map indicates the source from which the earthquake will be taken, and then the blue areas on the side of the map show the areas that may be flooded [11]. The figure on the left shows the unimulated scheme and the points where the generations were taken, while on the right it shows after the simulation and the areas where the wave can propagate.

Conclusion

The mapping of the depths of the Adriatic Sea as well as the mapping of the depths and focal mechanisms of earthquakes of recent years has been calculated the maximum value of the wave that may have the tsunami generation in these areas [12].

If a thrust type earthquake with magnitude M> 6.5 Richter occurs in the area of Adriatic with with distance more than 25 km from the coast it can generate a tsunami on the coast at coordinates from Durres 41.292260, 19.503316 to Shengjin 41.809225, 19.597102 up to a height of 0.5-1m. problems can be shown even in the south of Adriatic near Divjaka with coordinates 40.832932, 19.368522.

In the recent earthquake events in addition to the damage to people and material damage we had, we can consider as something very positive the fact that the earthquakes occurred very close to the ground and there was no possibility of generating a tsunami wave.

References

1. Sh, A. (2000). Active fault zones in Albania. *XVII XXVII General assembly of the European seismological commission, book of abstracts and papers*, *74*.
2. Aliaj, S., Meço, S., Sh, A., & Turku, I. (2000). Neotectonics and seismicity in Albania. *Geology of Albania, edited by: Meco, S., Aliaj, S., and Turku, I., Beitr. Regional. Geol. Erde*, *28*, 135-178.
3. Ormeni, R., Kociu, S., Fundo, A., Daja, S., & Doda, V. (2013). Moderate earthquakes in Albania during 2009 and their associated seismogenic zones. *Italian Journal of Geosciences*, *132*(2), 203-212.
4. Ormeni, R. (2015, October). Mapping b-Value in the Seismogenic Zones of Albania Region. In *8th Congress of the Balkan Geophysical Society* (Vol. 2015, No. 1, pp. 1-5). European Association of Geoscientists & Engineers.
5. Daberdini, A., Rogozi, E., & Ormeni, R. (2015). The effect of earthquakes on marine ecosystems in adriatic sea. International Conference of Echology (ICE), Tirane.
6. Ormeni, R., & Fundo, A. (2011, October). The Seismoactive Layers of the Albanian Earth's Crust Seismogenic Zones. In *6th Congress of the Balkan Geophysical Society* (pp. cp-262). European Association of Geoscientists & Engineers.
7. Daberdini, A., & Ormeni, R. (2014). Mechanical wave earthquake/generated in Adriatic Sea. Alb-Shkenca International Conference, Kosovo.
8. Daberdini, A. (2016). Mechanical water waves generated by seismic vibrations in sea basins Adriatic and Ion. PHD Thesis.
9. Daberdini, A., & Ormeni, R. (2013). Generation of tsunami wave by earthquake in Adriatic Sea. Alb-Shkenca International Conference, Tirana.
10. Rrapo, O., Edmond, D., Astrit, S., Adisa, D., & Fatmir, B. (2013). Recent seismic activity of the Lezha-Ulqini seismogenic zone and its associated hazard.
11. Daberdini, A., Rogozi, E., & Ormeni, R. (2015). The effect of earthquakes on marine ecosystems in Adriatic Sea. International Conference of Echology (ICE), Tirane.
12. Aliaj, S., Sulstarova, E., Muço, B., & Kociu, S. (2000). Seismotectonic map of Albania, scale 1: 500.000. *Seismological Institute Tirana*, *5*, 297.