Project N. 037110

Project Acronym: NEAREST

Project title: Integrated observations from NEAR shore sourcES of Tsunamis: towards an early warning system

Instrument: STREP

Thematic priority: 1.1.6.3 GOCE (Global Change and Ecosystems)

Deliverable n 26

Simulation of the 1755 tsunami in the Boca de Rio area

Due date of deliverable: 28 February 2009
Actual submission date: 28 February 2009

Start date of the project: 01/10/2006 Duration 36 months + 6 months

Organisation name of the lead contractor for this deliverable: FFCUL

Final release

Project Co founded By the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination level		
PU	Public	
PP	Restricted to other programme participants (including Commission Services)	
RE	Restricted to a gruop specified by the Consortium (including Commission Services	
CO	Confidential, only for members of the Consortium (including Commission Services)	**CO**

1 NEAREST

NEAREST is addressed to the identification and characterization of large potential tsunami
sources located near shore in the Gulf of Cadiz; the improvement of near real-time detection of signals by a multiparameter seafloor observatory for the characterization of potential tsunamigenic sources to be used in the development of an Early Warning System (EWS) Prototype; the improvement of integrated numerical models enabling more accurate scenarios of tsunami impact and the production of accurate inundation maps in selected areas of the Algarve (SW Portugal), highly hit by the 1755 tsunamis. In this area, highly populated and prone to devastating earthquakes and tsunamis, excellent geological/geophysical knowledge has already been acquired in the last decade.

2 DESCRIPTION OF OBJECTIVES

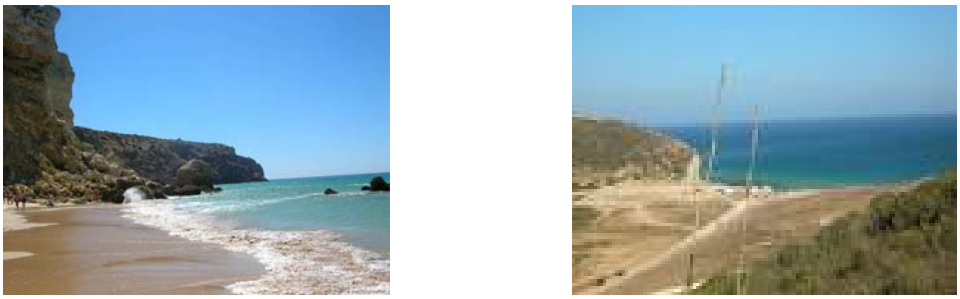
To prepare the first inundation maps covering a portion of Algarve coast based on potential off-shore tsunami sources and a new collation of high resolution bathymetric, topographic and construction areas close to the coast. Mapped inundation line will be based on run-up computations for the worst case scenario. In the framework of the cooperation between NEAREST and TRANSFER, model validation will be made to support risk assessment and emergency planning in south Portugal.

Deliverable 26 Simulation of the 1755 tsunami in the Boca de Rio area

Results of the numerical simulations for an event similar to the 1755 earthquake and tsunami are discussed in terms of wave heights and flow depth.

The valley of Boca do Rio is a small lowland located within an otherwise coiffed coastal segment of the Algarve coast…the lowland consists of a flat –flood valley, surrounded by steep slopes, that corresponds to a with a N-S trending fault along the western side. The lowland area consists of a supratidal floodplain that is periodically subject to extensive river flooding. The area is separated from the sea by a storm beach ridge and a rock spur that together present a barrier to wave overtopping during storms. Whelan & Kelletat (2005) report run up heights at Boca do Rio of 11-13 m.

Figure 1. Location of Boca do Rio and Martinhal beaches



Boca do Rio - beach Boca do Rio - Valley

Figure 2. View of beach (right) and Boca do Rio valley (left)

Martinhal beach is located 5 km to the east of Sagres. At Martinhal (“Mortinhal) the sea run in half league; the crops were destroyed; Fishes were left in dry land and heavy boulders, one of them with 300 “arrobas” (4.5T).

The descriptions found in Pereira de Sousa (1919) and Silva Lopes (1841) report:

“... the sea surged out of its limits, ejecting sand from a nearby beach located close to a narrow opening (INLET) that allows the tide to rush in...it uncovered foundations of a large settlement that extended farther seawards...today this place is again covered with sand as it was before...At the coast...is located the Almadena fort, built under King Filipe III...the sea invaded the fresh water creek that outlets there into the sea, for more than 1/2 league (CIRCA 2500-3000m) with a water height of 10-12 "varas" (CIRCA 11-13m) destroying some large "medôes" (FOREDUNES) and carrying along 50 of the heaviest anchors more than 1/4 league inland.

The backwash uncovered great and noble buildings of which no memory existed...The sea left behind a large lake whose depth was not investigated but is not disturbed neither by the flood nor by the ebb. Immediately to the east the fort of Almadena was not significantly damaged.

The sea flooded a beach called “Mortinhal”, facing eastward, by about 1/2 league (CIRCA 2km) ripping off vineyards and leaving the land as if it was a beach, covered with several types of fish and big "penedias" (LARGE BOULDERS) of which one, weighting more than 300 "arrobas" (CIRCA 4500kg) showed many shellfish stuck on its surface. Three times the sea struck and withdrew, the first wave being the largest.” (Pereira de Sousa, 1919)

Martinhal beach

Aerial View of Martinhal

These descriptions can be summarized in the following table:

Inundation Parameters	Inundation Parameters Inferred from the historical reports	Synthetic Inundation Parameters
Run up	11- 13 m	10 m
Maximum Inundation Distance	2500 m	2000 m

Table 1: Historical and Computed Inundation Parameters

For the Algarve test areas only source C (Baptista et al., 1998 in DEFRA, 2006) with the following fault parameters: Length 210 km, Width – 75 km; Slip – 13 m; Dip 45^0, Strike – 340^0 and Strike – 90^0.

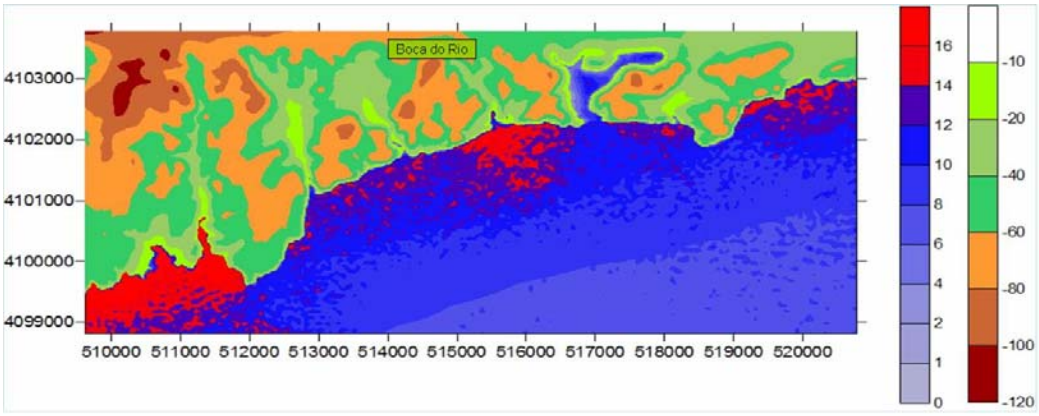


Figure 3. Maximum wave height (in meters) at Boca does Rio due to a tsunami generated by an earthquake like the 1755.11.01. The color scale on the left refers to wave height and the one on the right refers to topography (meters).

The model results show a great amount of energy heading to the southwest part of Algarve and high wave heights along the coast (Figure 3). At Boca do Rio wave heights between 8 and 14 meters are predominant (Figure 4), which is in agreement with historical data, that refers heights of about 11 – 13 meters (see section 4, for historical data).

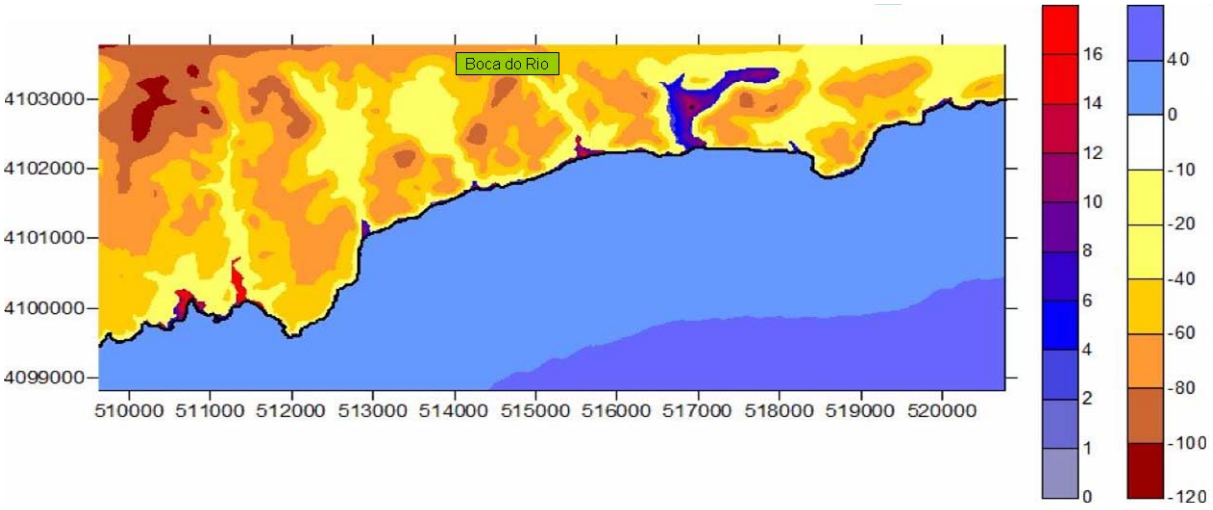


Figure 4. Inundation at Boca does Rio. The color scale on the left refers to inundation and the one on the right refers to topography and bathymetry (meters).

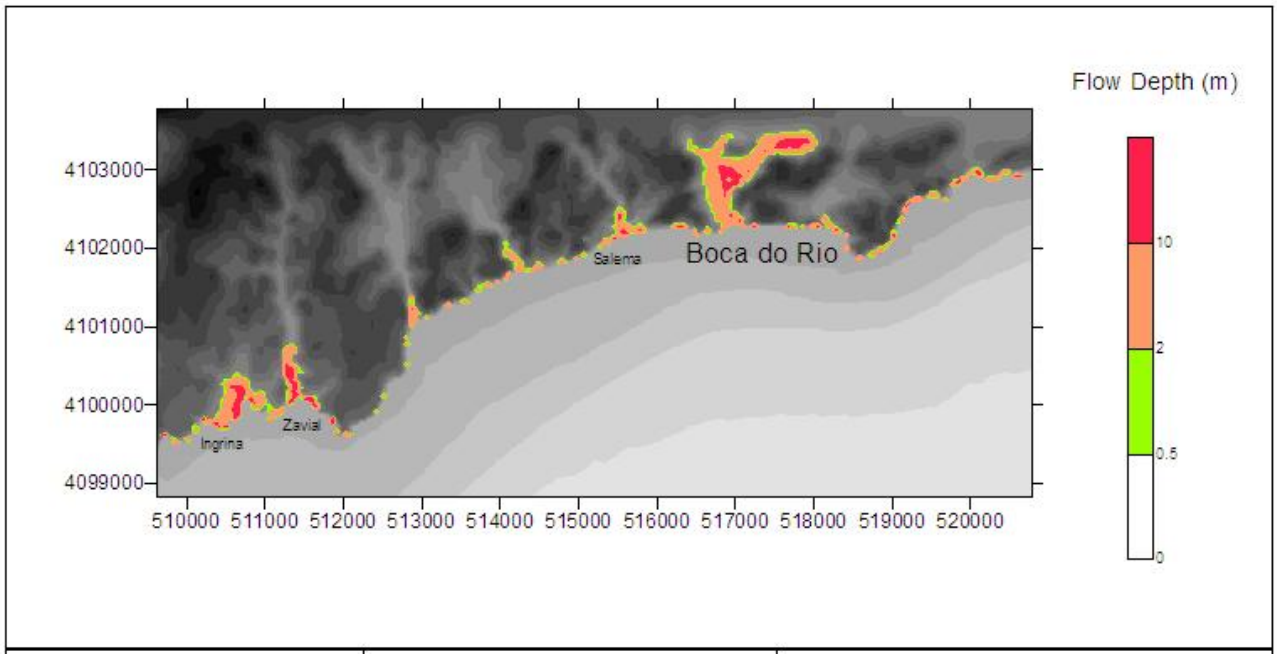


Figure 5. Tsunami inundation map for Boca do Rio – Martinhal área

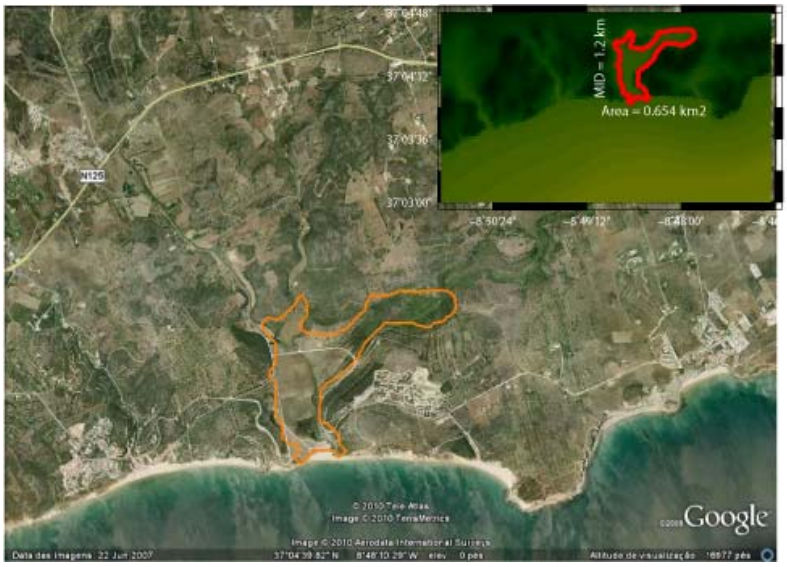


Figure 6 . Inundation limit – orange contour; inset (right top corner): area and maximum inundation distance MID

Tsunami inundation is observed along Boca do Rio (Figure 5) on an extension of approximately 1 km inland. Tsunami flow depths estimates vary from about 2 to 8 meters in Boca do Rio valley, reaching a maximum flow depth of about 10 meters. There are no historical records about the flow depth at this site but lithostratigraphic investigations were carried out pointing for 1km of run-in (Dawson et al., 1995), which is in agreement with our preliminary results.

5. CONCUSIONS

The model performs well and results for the test area agree with historical data. In case of 1755 like event this area along the South Portuguese Coast will be flooded about 1 km inland. The run up height reproduced correlates well with historical data and the maximum run up is compatible with the value of the slip of the rupture mechanism.

6 – References

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7-International Conferences and Scientific papers

7.1 International Conferences

7.1.1 Miranda J M, Baptista M A, Terrinha P, Matias L., (2008). Tsunamigenic Source Areas For Portugal Mainland, Iberia. 31 Gen. Ass. European Seismological Commission, Crete, Greece

7.1.2 Omira R., Baptista M A, Catita M C., Matias L. (2008). Design of a Tsunami Detection Network for the Gulf of Cadiz. 31 Gen. Ass. European Seismological Commission, Crete, Greece

7.2 ISI Papers

7.2.1 R. Omira , M. A. Baptista , J. M. Miranda , E. Toto, C. Catita TSUNAMI VULNERABILITY ASSESSMENT OF CASABLANCA-MOROCCO USING NUMERICAL MODELING AND GIS TOOLS. Submitted to Natural Hazards (submitted may 2008, under revision)

7.2.2 Baptista, M.A., Miranda J.M., (2009). Revision of the Portuguese Catalog of Tsunamis. Natural Hazards and Earth Systems Sciences, 9, 25-42.