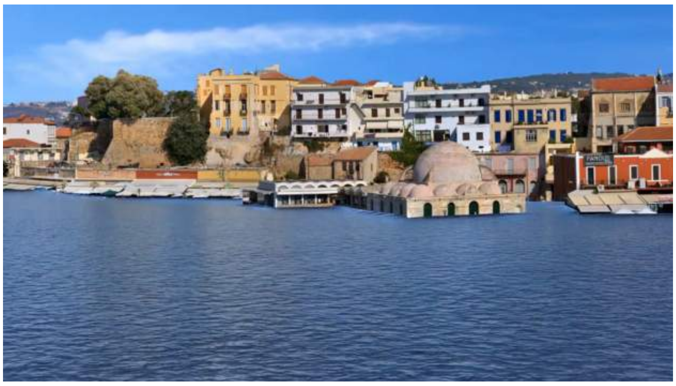
# photo-realistic simulation of tsunami impacts using foss gis tools and blender



Alex Giannakidis, orbitlab
Giorgos Papadakis, orbitlab
Nikos Kalligeris, Technical University of Crete
Giannis Giakoumidakis, Technical University of Crete

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At this project a work flow is proposed for photo-realistic tsunami visualization based on scientific data. The goal of this work is to quickly and efficiently visualize tsunami impact on exposed coastal zones. All parts have been thoroughly tested and applied to a first animation prototype visualizing a historical tsunami at the old port of Chania – Greece, by using the ArcGIS suite and Blender. After that, focus was shifted to utilize foss GIS tools and automatize the process using a script in Blender. The scenario was a depetition of the 365AD tsunami [1]. The final objective was to use the animation to train civil defence in Crete, in the context of the first ever field exercise on tsunami preparedness in Europe, funded by the EU [2]. This exercise took place on October 23-24 in Heraklion and Chania.

The tsunami is visualized in 3D as an isometric grid [3] representing the sea surface. This subdivided plane is sequentially transformed by a time-array of a simulated waveheight map from the MOST (Method of Splitting Tsunami)* model [4], the standard numerical model for tsunami simulation used at the NOAA (National Oceanic and Atmospheric Administration, U.S.A.).

* The **MOST Model** is a suite of numerical simulation codes capable of simulating three processes of tsunami evolution: generation, propagation, and inundation (eg. flooding) of dry land. It outputs wave height and speed in a time array of georeferenced waveheight maps.

The animation of the isometric grid is realized making use of shape keys in Blender. A Python script (for Blender 2.5) fully automatizes the process of setting up the shape keys and the animation.

For the needs of the visualization a 3D model of the wider old-port area is constructed based on GIS data from the Municipality of Chania. It contains the topography (land & sea bottom), the jetty, the buildings, the remaining venetian walls and the lighthouse. All topographical data are correctly projected in the GIS software (ArcGIS , QuantumGIS or GrassGIS) as separate layers and then exported to Blender for further processing.

Currently GrassGIS has poor 3D capabilities so the export is limited to the bounding boxes of the GIS layers and the 3D geometry is developed later on in Blender. ArcGIS can create the needed 3D geometry and export the entire scene in VRML format.

Below is a brief description of the proposed work flow :

1. Gathering and projecting necessary data in GIS (correct alignment is of crucial importance for this work flow)
2. Exporting necessary information to Blender, including
   a) Direct export of 3D geometry, when using ArcGIS
   b) Export of aligned bounding boxes, when using GrassGIS
3. Animating the isometric grid (subdivided plane in Blender)
   a) Setting up shapekeys for every waveheight map of the array
   b) Setting up shapekeys for every waveheight map of the array
4. Compositing, photo-realistic rendering

Part 3 of the work flow is the most demanding in terms of time needed but fortunately it is completely executed with a python script inside

Blender. The script does the following :

*create texture mytex*
*for every waveheight map in specified folder do :*
    *assign waveheight map to mytex*
    *add displace modifier to active object*
    *assign mytex to displace modifier*
    *apply displace modifier as shape*
    *edit displace modifier properties*
    *set keyframes for newly created shapekey*

Photo-realism makes the animation more accessible for the public. A number of different techniques can be applied to the final scene in order to achieve photo-realism. For our prototype animation we applied the following :

*sea surface* : mirror material, animated procedural textures, surface tension on mesh intersections

*environment* : blue ambient color to reflect on the mirrored sea surface, 16384 X 16984 photographic angmap of old port area, time-lapse footage of sky (moving clouds), geometry above sea level is rendered transparent, buildings are just placeholders

This work is in progress and many of its aspects will be improved in the final version.

## Acknowledgements

The first milestone of this project was financed by a Civil Defence Grant to Prof. C.E. Synolakis.

Currently a computer engineering student (Giannis Giakoumidakis) is writing his thesis on this subject by applying and improving the work flow (utilizing only foss GIS tools) for the visualization of the same tsunami at the Port of Heraklion - Crete.

## References

[1] C. E. Synolakis, N. Kalligeris, E. Flouri, G. Alexandrakis, N. Kampanis, The Great Cretan Splashup - A Coastal Disaster Preparedness Exercise in Greece, Solutions to Coastal Disasters 2011, Anchorage, Alaska, June 26-29, 2011

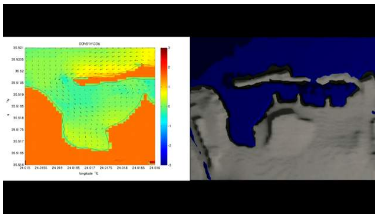
[2] POSEIDON, Earthquake followed by Tsunami in the Mediterranean Sea, Simulation Exercises in the field of the Community Civil Protection Mechanism, European Union, 2009-2011.

[3] A Heightfield on an Isometric Grid, Morgan McGuire and Peter Sibley, SIGGRAPH 2004

[4] Titov, V. V. and Synolakis, C. E., (1998), Numerical modeling of tidal wave runup, Journal of Waterways, Port, Coastal and Ocean Engineering, ASCE, 124, 157-171.

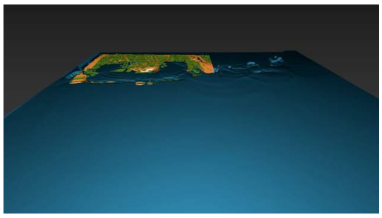
## Animations :

a.



side by side comparison of MOST Model and 3d Visualization in Blender (2 hours compressed in 4 min, 480 heightmaps)
http://vimeo.com/31594155

b.



heightgid & topography (extended view)
http://vimeo.com/24609316

c.

close up view of the old port 3d model
http://vimeo.com/24609424

d.

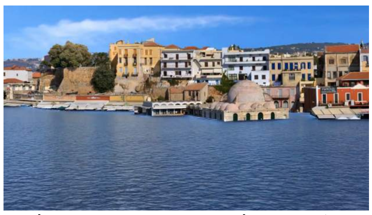


Photo-realistic composite visualization (prototype)
http://vimeo.com/24608769