Building a unified GIS database for integrating and disseminating tsunami-related data in Europe: a TRANSFER project experience

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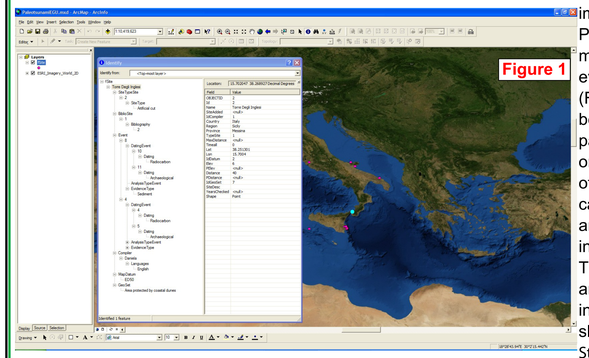
INTRODUCTION

TRANSFER, an acronym standing for "Tsunami Risk And Strategies For the European Region", is a EU-funded research project coordinated by the Department of Physics of the University of Bologna, Italy. The project involves 29 partners covering almost all the Euro-Mediterranean coastal areas. The main project objectives are: 1) improving our understanding of tsunami processes in the Euro-Mediterranean region, 2) contributing to the tsunami hazard, vulnerability and risk assessment, 3) identifying the best strategies for reduction of tsunami risk, 4) focussing on the gaps and needs for the implementation of an efficient tsunami early warning system (TEWS) in the Euro-Mediterranean area. A key aspect is represented by the dissemination of the project data and results to the largest possible public. The two privileged means are and will be the project web site (http://www.transferproject.eu) and a web-based GIS database. This contribution focuses on this second tool. The GIS database is intended to support the general project goals by integrating existing data and storing new project data.

From the technical point of view, the geodatabase is being built using Esri ArcGIS version 9.2, which represents a de facto standard in GIS development.

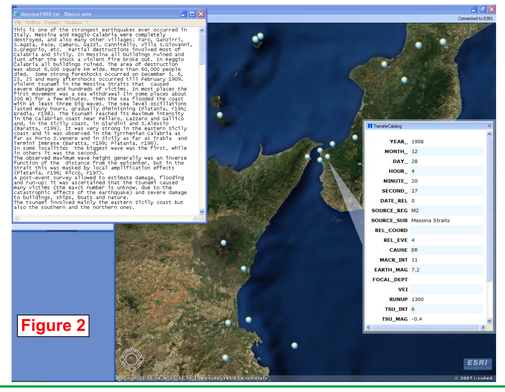
Here we show some examples of a prototype database that is being built through cooperation of different partners in TRANSFER. The examples illustrate some of the different fields of research covered in the project.

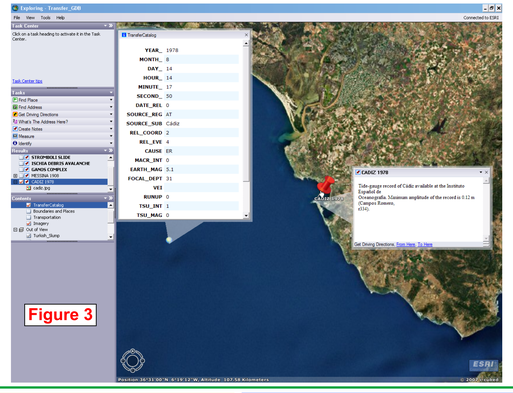
TSUNAMI CATALOGUE



The updating and revision of the European Tsunami Catalogue and its implementation into a GIS platform is the main goal of TRANSFER Work Package (WP) 1. The examples shown in this panel refer to two of the main tasks involved in this WP. The first regards the inclusion of new events and the updating of existing events through paleotsunami studies (Figure 1). Evidence of paleotsunamis is derived from coastal stratigraphy because of the presence of peculiar sediments or boulders. Dating of the paleotsunami deposits helps in correlating events with historical tsunamis or previous ones. The database provides mainly two types of information of use for developing tsunami scenarios and time dependent hazard calculations: locations of past inundations and their frequency. Figure 1 is an ArcMap snapshot illustrating the location of a number of surveyed sites in southern Italy and the type information retrievable for each of them.

The second main task concerns the inclusion of new events and the updating of existing events of historical (pre-instrumental and instrumental) times. Figures 2 and 3 are ArcGIS Explorer snapshots showing the database interrogation on two historical tsunamis (Messina Straits, Italy, 28 December 1908 and Cadiz, Spain, 1978).





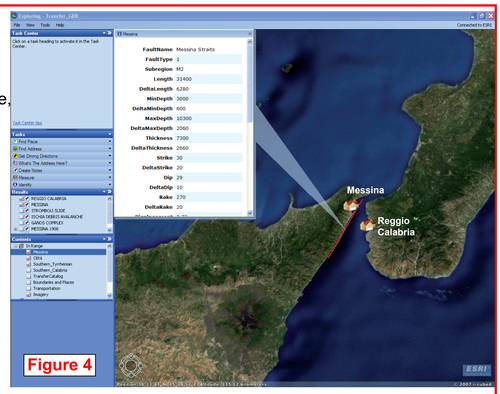
TSUNAMIGENIC SEISMIC SOURCES

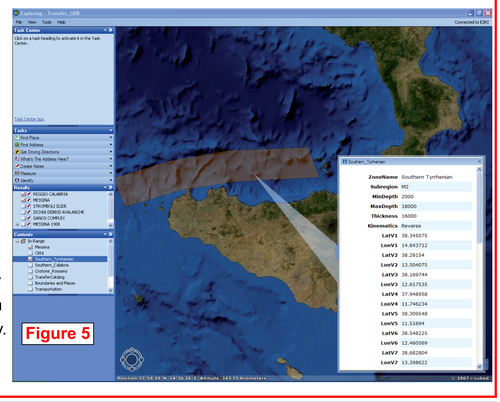
The inventory and characterization of tsunamigenic seismic sources in the Euro-Mediterranean area, and their inclusion in a GIS database, is covered in WP2. The TRANSFER Consortium, with main contributions from the Istituto Nazionale di Geofisica e Vulcanologia (INGV, Italy) and the National Observatory of Athens (Greece), decided that the database will be composed of three different source categories, depending on the level of knowledge: (1) individual sources that have produced a tsunami in the past, (2) faults that are considered potential sources for future tsunamis, (3) zones that may contain tsunami sources.

The Category/layer 1 (named "INDIVIDUAL SOURCES") contains sources with the highest reliability (because they actually produced a tsunami), although only a few of them are recognized to be directly related to a known fault. They are represented by an ellipse centered on the area where the source is expected to be located. The major axis of the ellipse coincides with the length and strike of the fault, while the length of the minor axis is representative of the fault dip.

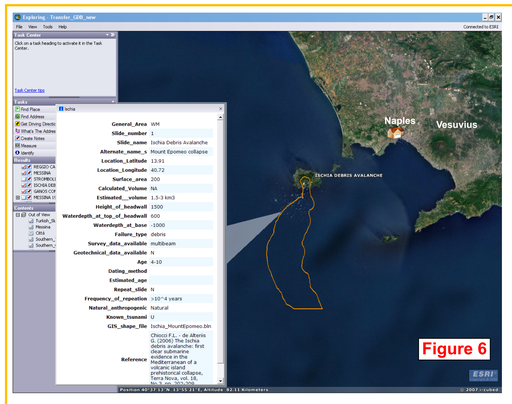
Figure 4 shows an example of the sources belonging to Category/layer 2 (named "COASTAL AND OFFSHORE FAULTS"). They are represented as lines (representing fault strike and length) with symbols (ticks, triangles and arrows) indicating their kinematics. A field with the date of a possible historical tsunami produced by that source is added. Modelers can use some of these sources to elaborate scenarios.

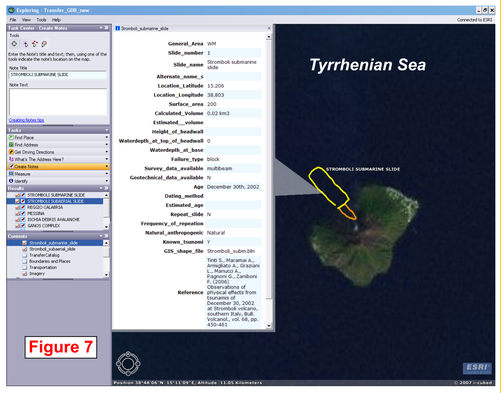
Figure 5 illustrates Category/layer 3 (named "TSUNAMI ZONES"). Tsunami zones are represented as polygons (up to 8 vertexes). They mainly show where there is the possibility that tsunamis may occur in the future but individual faults/sources cannot be drawn with certainty. These zones may also enclose elements from either category 1 or 2.





TSUNAMIGENIC NON-SEISMIC SOURCES

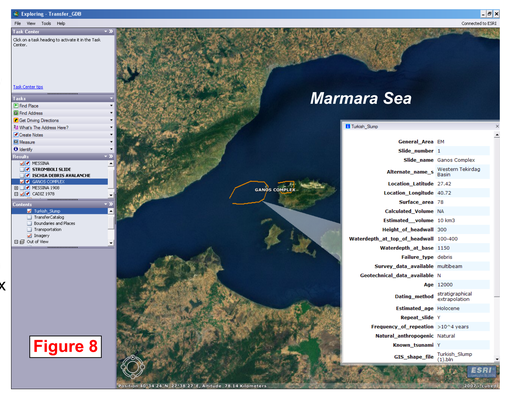




Tsunamis can be generated not only by earthquakes but also by landslides, slumps, volcanic eruptions and also by more unusual events such as mud volcanoes or rapid erosion induced by jökulhlaups. In TRANSFER we indicate these as "non-seismic sources", and their classification, characterization and inclusion in a suitable GIS database is one task of WP3. Five main categories/layers have been established for the database classification: 1) slides, including mapped/known submarine landslides/slumps; 2) coastal failures, comprising mapped/known coastal (subaerial) slides, rockfalls and debris flows; 3) volcanoes, both subaerial and submerged; 4) canyon-channels, seen as limited-size areas with the potential to trigger tsunamigenic mass movements; 5) wide failure areas known to have failed in the past or having the potential to trigger tsunamigenic mass movements in the future.

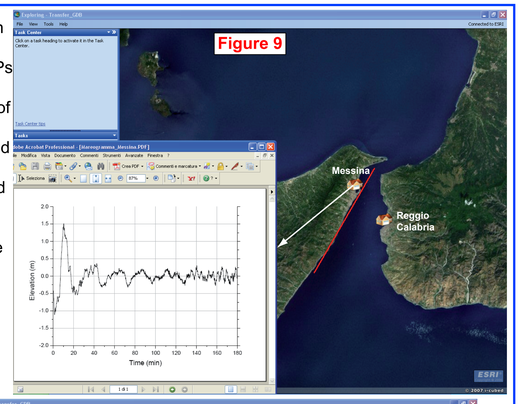
Each category is characterized in the database by means of a number of parameters describing the geographic, geometric and physical properties of the layer members. Whenever possible, reference to known past events and to possibly generated tsunamis are given.

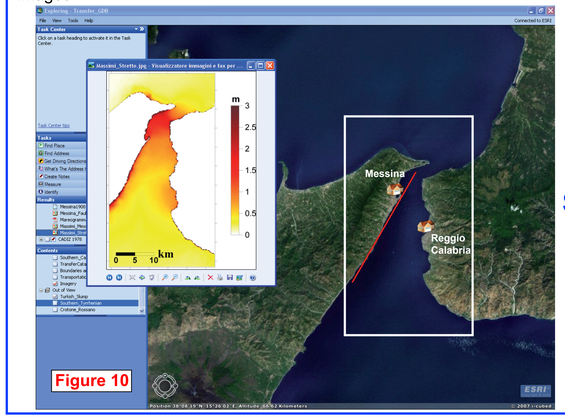
Examples of non-seismic sources in the Ischia and Stromboli volcanic islands (Tyrrhenian sea, Italy) are shown in Figures 6 and 7, respectively, while Figure 8 illustrates the shape of the Ganos complex and of the Marmara Island debris flow in the Marmara Sea. The Ischia Debris Avalanche (Figure 6), the tsunamigenic submarine landslide occurred along the NW flank of the Stromboli island on 30 December 2002 (Figure 7) and the Ganos complex (Figure 8) can be counted in category 1, while the 30 December 2002 tsunamigenic subaerial landslide in Stromboli and the Marmara island debris flow are members of category 2.

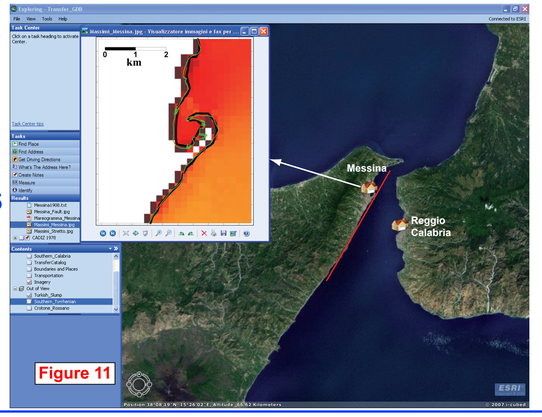


TSUNAMI SIMULATIONS

The knowledge on the pre-historical and historical events, and the inventory and characterization of known and potential tsunamigenic sources/zones, are not only relevant per se, but represent a key tool and a primary source of data for modelers. Numerical tsunami simulations are treated mainly in three distinct WPs in TRANSFER. While WP5 is specifically devoted to the improvement of existing, and the possible development of new, tsunami numerical models, the production of inundation maps and the development of worst-case scenarios of tsunami impact for risk assessment and reduction are faced in WP7 and WP8, respectively. The TRANSFER Consortium has selected eight test areas in different countries, that WP7 and WP8 will especially focus on. For each of the test areas, the ArcGIS database will provide the outputs of numerical simulations in terms of inundation maps, maxima and minima of water elevation in the basin and simulated tide-gauge records in selected coastal stations. One of these areas corresponds with the Messina Straits in southern Italy. Figures 9-11 refer to this test area and illustrate three examples of the outputs obtained by simulating the tsunami generated by one of the faults contained in the database of the tsunamigenic seismic sources (see Figure 4). The simulations were performed by the Tsunami Research Team at the University of Bologna, Italy, through the finite-difference code UBO-TSUFD. Figure 9 shows the synthetic tide-gauge record computed in Messina. Figure 10 represents the field of maximum positive water elevation in the Messina Straits, while Figure 11 is a close-up view showing the inundation map in the Messina harbour. In this prototype version of the database, the outputs open in separate windows, while in the final version of the database the relevant fields will be overlaid on the background satellite images.







TRANSFER is a STREP (Specific Targeted REsearch or innovation Project) funded by the European Commission in the Sixth Framework Programme, under the Priority 6.3.IV.2.2 "Assessment and Reduction of Tsunami Risk in Europe". The Project started on 1st October 2006 and has a foreseen duration of 30 months. The project web site is http://www.transferproject.eu/.

The authors are indebted to all partners in the Consortium, and in particular to the WP leaders, for helping preparing the database structure and for providing data to populate the database.