

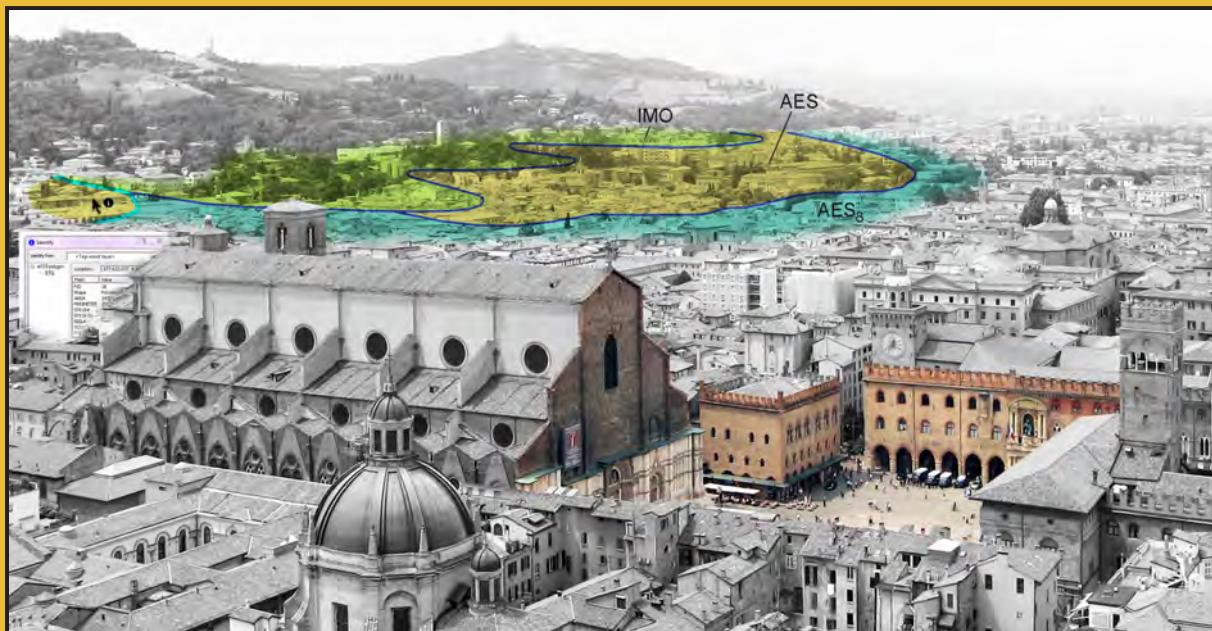
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Bologna, 13-15 Giugno 2012



NOTE BREVI E RIASSUNTI

A cura di: Chiara D'Ambrogi



ROMA
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2012
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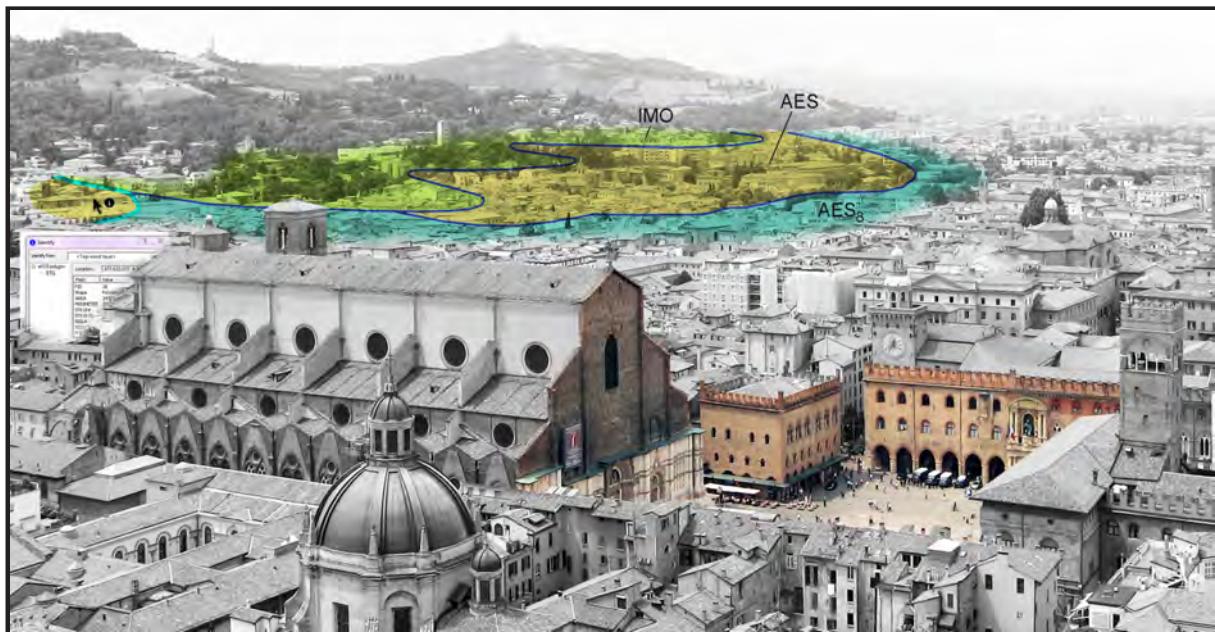
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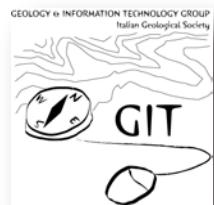


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MultiRISK: a platform for Multi-Hazard Risk Modelling and Visualisation

SIMONE FRIGERIO (*), MELANIE S. KAPPES (**), THOMAS GLADE (***) & JEAN-PHILIPPE MALET (°)

ABSTRACT

Il lavoro proposto rientra tra le attività svolte all'interno del Progetto Marie Curie Mountain Risks (Contract number MCRTN03598). L'attività ha considerato la crescente interferenza e sovrapposizione di eventi naturali sia come fattori innescanti sia per le conseguenze a effetto domino. Le classiche metodologie di analisi modellistica per singola tipologia di processo vengono integrate sempre più frequentemente in sistemi Multi-Hazard, dove i fenomeni non sono semplicemente sovrapposti ma vengono considerati per diverse potenziali nuove interazioni. Il sistema di validazione ne risulta conseguentemente modificato. L'attività ha portato alla realizzazione di un prototipo di piattaforma MultiRISK, basata su un modulo *Modelling*, di modellazione integrata, e un modulo *Visualization*, per una concreta analisi da parte di esperti dei risultati proposti, mediante semplici servizi web. Gli *step* operativi hanno dunque come obiettivo quello di offrire un completo sistema di modellazione ma allo stesso tempo una chiara strategia di comprensione e utilizzo del dato prodotto.

KEY WORDS: *Multi-hazard Risk analyses, MultiRISK - Modelling Tool, MultiRISK - Visualization Tool, Web Service.*

INTRODUCTION

Multi-hazard risk studies became important topic in the scientific community considering the increasing number of

related events like earthquake/landslides (CUI *et alii* 2011, HUANG AND JIANG 2010), or landslides/flooding (CAO *et alii* 2011).

Multi-hazard risk analyses (MHRA) are the first step of comprehensive risk management for overall risk reduction. Herein, all relevant hazards in an area of interest have to be considered. However, MHRA raise a number of challenges in comparison to single-hazard risk analyses including comparability and differences in hazard/vulnerability modelling or interactions between processes (GLADE AND VAN ELVERFELDT 2005, GLADE *et alii* 2012). MultiRISK is multi-module platform combining modelling of hazards and exposure of elements at risk in mountain areas, including a validation step and a final web visualisation. The platform offers a coherent analysis scheme coping with methodological rules and consequent development framework as partially tackled by HAZUS (FEMA 2007) and RISKSCAPE (SCHMIDT *et alii* 2011).

A modelling and a visualization platform tools are separately designed and maintained but synchronized by user-friendly tools. MultiRISK platform targets the following objectives: 1) Modelling of multiple hazards in a comprehensive way 2) Output validation 3) Exposure analysis of elements at risk 4) Provide a web-based visualization.

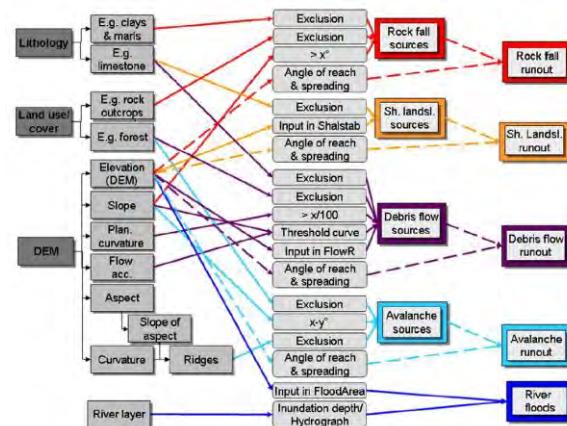


Fig. 1 – Analysis scheme for rock fall, shallow landslides, debris flows, avalanches and floods modelling (detailed in KAPPES *et alii*

(*) Research Institute for Hydrogeological Protection, Italian National Research Council, C.so Stati Uniti, 4, 35127 Padova, Italy.

(**) Disaster Risk Management Unit / Latin America and the Caribbean, The World Bank, 1818 H St. NW, Washington DC 20433, USA.

(***) Geomorphic Systems and Risk Research, Department of Geography and Regional Research, University of Vienna, Universitätsstraße 7, 1010 Vienna, Austria.

(°) Institut de Physique du Globe de Strasbourg, IPGS, UMR 7516 CNRS. University of Strasbourg. 5 rue Descartes. F-67084

METHODOLOGY

Similar data available for all different natural hazards shall form the basis for the hazard analyses. This criteria offers the scheme to develop the MultiRISK platform, but allowing further linkages between these hazards (Fig. 1)

A regional multi-hazard exposure computation procedure was designed including 1) a digital elevation model (DEM) and derived features as well as 2) land use/cover and lithological information. The multi-hazard modelling scheme includes debris flows, rock falls, shallow landslides, snow avalanches and floods and single empirical models were chosen for every process (GLADE *et alii* 2012, KAPPES *et alii* 2012).

A confusion matrix crossing historical events dataset with modelling output was built to offer a validation step, able to assess the models' quality (BEGUERIA 2006). Furthermore the overlay of resulted susceptibility zones with elements at risk was advanced as requirement of an exposure analysis.

The analysis scheme was implemented in the *MultiRISK - Modelling Tool*. It offers a fast and coherent multi-hazard exposure toolbox. The software is compiled in the programming language *Python* (dynamic and object-oriented) and based on *ArcGIS 9.3* tools (libraries of new versions are strongly python-oriented to offer an easy user-oriented

```

1  #!/usr/bin/env python
2  # -*- coding: iso-8859-15 -*-
3
4  #####
5  # MultiRISK.py
6  # Description:
7  #   MultiRISK - Analysis Platform
8  # Requirements: wxPython, ArcGIS, FloodArea, FloodArea Toolbox, slopearea, FlowR, shalstab
9  #               ArcInfo license and ArcInfo Workstation
10 # Author: Klemens
11 # Date: Aug 30, 2010
12 #####
13
14 #####
15 # TOOLBOXES and other important paths
16 #
17 ArcToolbox = "C:/Programme/ArcGIS/ArcToolbox/Toolboxes"
18 FloodAreatbx = "C:/FloodArea/FloodArea.tbx"
19 viewPlatform = "C:/MultiRISK/rev_visa"
20 #####
21
22
23
24 import wx, string, sys, os, shutil, tempfile, arcgisscripting, os.path, time, wx.grid
25 import xml.dom.minidom
26
27 #####
28 # classes with the main information about the hazards and paths
29 #####

```

- Requirements
- Setup for modelling path and toolbox

- Single process setup (directory and parameters)

s DEM also the derivations (slope, ...) are "old")

```

class Rockfall:
    """Rock fall parameters"""
    #lowest Slope for Rockfall
    low_SlopeAngle = 0
    #this landtypes arent dangerous for rockfall (user defined)
    not_danger_lands = []
    #this geotypes arent dangerous for rockfall (user defined)
    not_danger_geo = []
    # spreading of runout
    spreading = 0
    #frictionloss of runout
    frictionloss = 0
    #optional to the source parameter an pre defined Source file
    predefSource = ""

```

Fig. 2 – Python code for *MultiRISK - Modelling Tool*. The screenshot shows details on one process setup (e.g. Rockfall).

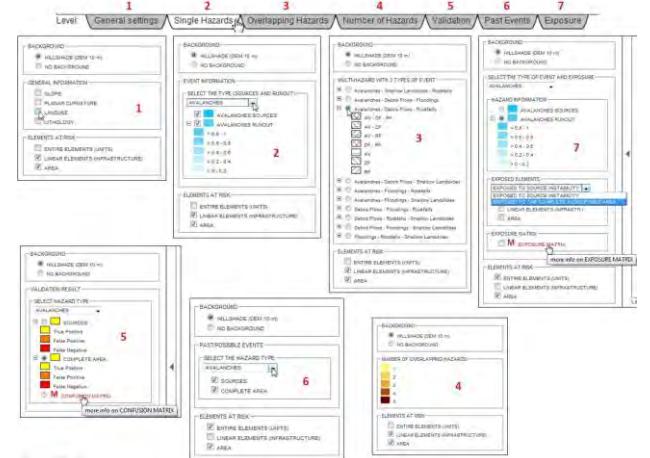


Fig. 3 – Tabs list and single datasets in Visualisation Tool

customization). The users are guided with a step-by-step analysis procedure, whose actions are 1) Project name and workspace setup 2) Upload of the input data 3) Selection of hazard processes to be modelled, detailed information on modelling techniques are in KAPPES *et alii* 2012, 4) Choice of

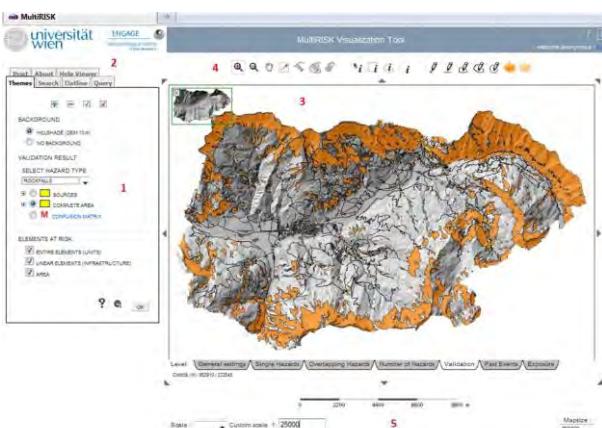


Fig. 4 – Prompt of Visualisation Tool 1) data list and menu 2) commands tabs 3) map layout 4) drawing and editing tools 5) scale and query tools

model parameters and model initiation 5) Upload of past events dataset and validation of the modelling results 6) Upload of elements at risk dataset threatened by each process (Fig. 2).

The *MultiRISK - Modelling Tool* is linked to the *MultiRISK - Visualisation Tool*, a direct user-friendly interface for non-

GIS-cartography experts. The *Visualization Tool* is WebGIS solution to display and interact with modelling output automatically managed in specific folders. It is a web-mapping service combining the open-source *CartoWeb3* as client-side with *MapServer* as geospatial engine and server-side publishing platform (other similar applications in FRIGERIO *et alii* 2010, FRIGERIO AND VAN WESTEN 2010). The information produced in the Modelling Tool is organized and spatially managed in seven maps/tabs (Fig. 3). Basic GIS tools allow a straightforward access and interactions with the spatial information obtained (drawing, editing, spatial querying). The user gets access to the information with a standard internet browser (Fig. 4). The *MultiRISK - Modelling Tool* and *MultiRISK - Visualisation Tool* have been designed and tested in Barcelonnette case study (South French Alps).

Within the *MultiRISK - Visualisation Tool* (Fig. 5), the *General Setting* information for Barcelonnette case study includes 1) DEM and hillshade as background 2) Slope and its derivatives, 3) Lithology and land use types. This information provides thus basic background information, but can be regularly customized for future challenges and requirements.

The detailed information on *Single Hazards* such as rockfall, debris flow or flood is retrievable in the second bottom tab (runout and the deposition zones should be jointly

```

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3
4 #####
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7 #     MultiRISK - Analysis Platform
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11 # Date: Aug 30, 2010
12 #####
13
14 #####
15 # TOOLBOXES and other important paths
16 #
17 ArcToolbox = "C:/Program Files/ArcGIS/ArcToolbox/Toolboxes"
18 FloodAreatbx = "C:/FloodArea/FloodArea.tbx"
19 viewPlattform = "C:/MultiRISK/rev_viz"
20 #####
21
22 #####
23

import sys, os, os.path

os.chdir("c:\\ms4w\\apps\\cartoweb3")
print "C:\\ms4w\\Apache\\cgi-bin\\php.exe cw3setup.php --clean"
os.system("C:\\ms4w\\Apache\\cgi-bin\\php.exe cw3setup.php --clean")
print "C:\\ms4w\\Apache\\cgi-bin\\php.exe cw3setup.php --install --base-url http://localhost/cartoweb3/htdocs/ --project MHRA"
os.system("C:\\ms4w\\Apache\\cgi-bin\\php.exe cw3setup.php --install --base-url http://localhost/cartoweb3/htdocs/ --project MHRA")

```



- Cartoweb command lines
- Apache runout setting
- Localhost refresh

Fig. 5 – Python code for *MultiRISK - Visualisation Tool*. The screenshot shows detail on final output refresh, compulsory to upgrade the web service.

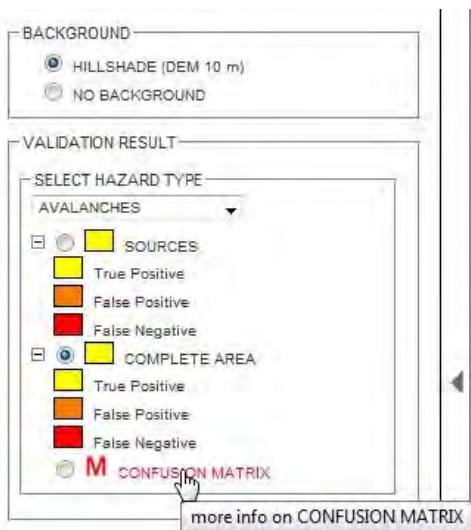


Fig. 6 – Example of layers menu, automatically listed for every tab. Here the example of Validation tab.

or separately displayed). The third tab offers information on *Overlapping Hazards*, three hazards is the number of overlaps currently limited due to easy-visible criteria but technically stretchable to more hazards. To overcome the problem of readability, in the fourth tab the *Total Number of Hazards* is displayed. It suggests locations exposed to several hazards with a graduated visual-friendly map and offers the identification of possible hot spots of interactions. The fifth tab provides information on *Past Events*, summarizing the past records obtained by research. It offers evidence to spatially compare historical dataset with modelling results for decision makers and final users. The sixth tab concerns the *Validation* of modelling with true positives, false positives, true negatives and false negatives distribution as proof on the quality of the modeled results. Finally the *Exposure* is presented in overlaying the elements at risk with the respective natural hazards (Fig. 6).

Various types of natural hazards are calculated and matched with elements at risk. The visualization tool is a final instrument for end-users but it can be continuously reviewed and updated as a planning strategy.

CONCLUSION

Multi-hazard risk analyses pose a variety of challenges in both schemes presented of the modeling and the visualisation tools. This implementation offers the possibility of rapid and user-friendly re-computation, and the comparability of modeling strategies is the basic aim. But many problems require experience in handling of multiple hazards as well as careful interpretation of analysis results. Quality and availability of basic information are the basis for multi-hazard

analyses as well as the scale on which the modelling and the validation are performed, here fixed on regional scale. Interpretation and acceptance of results is concretely important for end-user as well as modelling steps and thus both tools allow a direct and understandable communication of the results.

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