

A photograph of a cable-stayed bridge at sunset. The sun is a bright orange orb in the sky, casting a golden glow over the water and the bridge. The bridge's deck is the central focus, with a grid of white lines overlaid on it, creating a perspective that draws the eye towards the horizon. The sky is filled with soft, orange and yellow clouds. In the background, there are silhouettes of mountains and a small structure on the left side of the bridge.

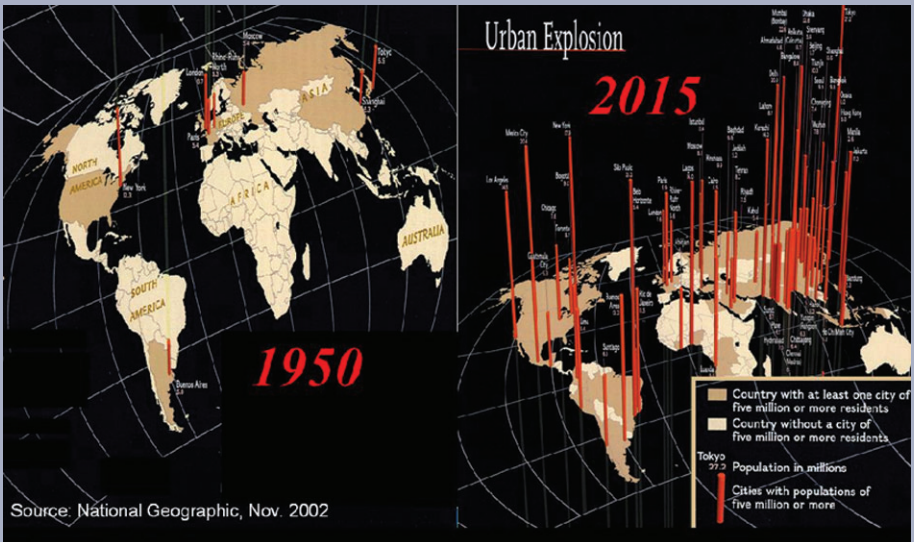
# MULTIRISK

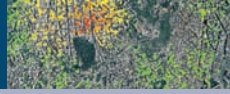
**amra**

■ analysis and monitoring of environmental risk

# AMRA ACTIVITIES

Traditional risk analysis considers each risk source independent from the others. As a consequence, exposed values are usually defined regardless of interactions among the multiple risks generally impeding on a territory. This approach is becoming ineffective for assessing risks bound to any hazard in a rapidly urbanized world (in the figure below a representation of Urban Explosion from 1950 to 2015, National Geographic source, Nov. 2002), where hazard and risk interaction follow complex patterns. In this context, multi-risk evaluations are becoming the most efficient instruments for a sustainable territorial planning and for a more competent emergency management, before and during an adverse event. In fact, this methodology allows for a joint analysis and a complete definition of all the risks induced by human and natural sources on a specific area.





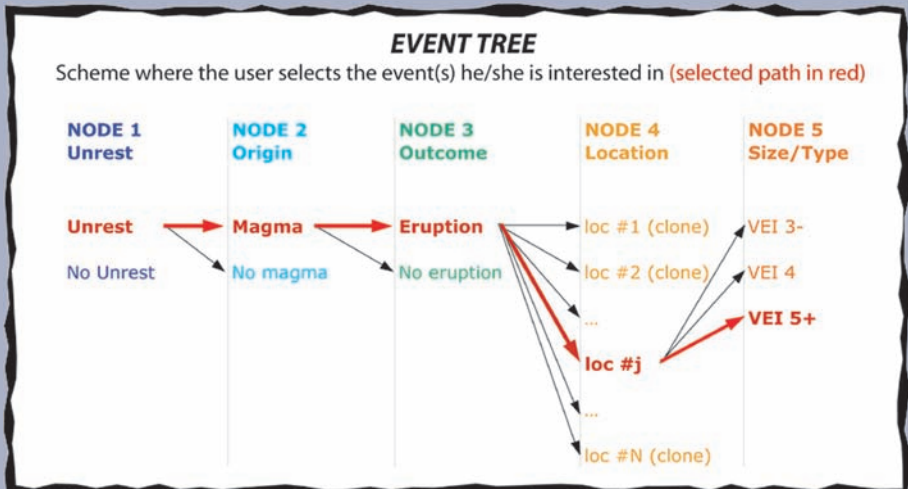
Multi-risk approach is a methodology proper of AMRA which can count on researchers with different expertise in risks' evaluation. A method often used by AMRA for quantitative risks' estimation is based on Event Tree Analysis, allowing for a description of all the possible events triggered by a risk source and for a probabilities assessment of combined events. Last output of AMRA's research in this field is related to a joint employment of an Event Tree Analysis with a Bayesian Approach for the evaluation of occurrence probability of adverse events, ensuring, in this way, quantitative and reliability of results (in the figure below, a landslide during the 2001 El Salvador quake).



# AMRA APPROACH

Bayesian Event Tree is a useful framework for discussing, from a probabilistic point of view, all the possible outcomes of adverse event (for example, the sketch of suitable BET is shown in the figure below). Basically, an event tree is a tree-like representation of events in which branches are logical steps from a general prior event through increasingly specific subsequent events (intermediate outcomes) to final outcomes.

In this way, an event tree shows the most relevant possible outcomes produced by the interactions among different risks' sources, i.e. cascade effects.



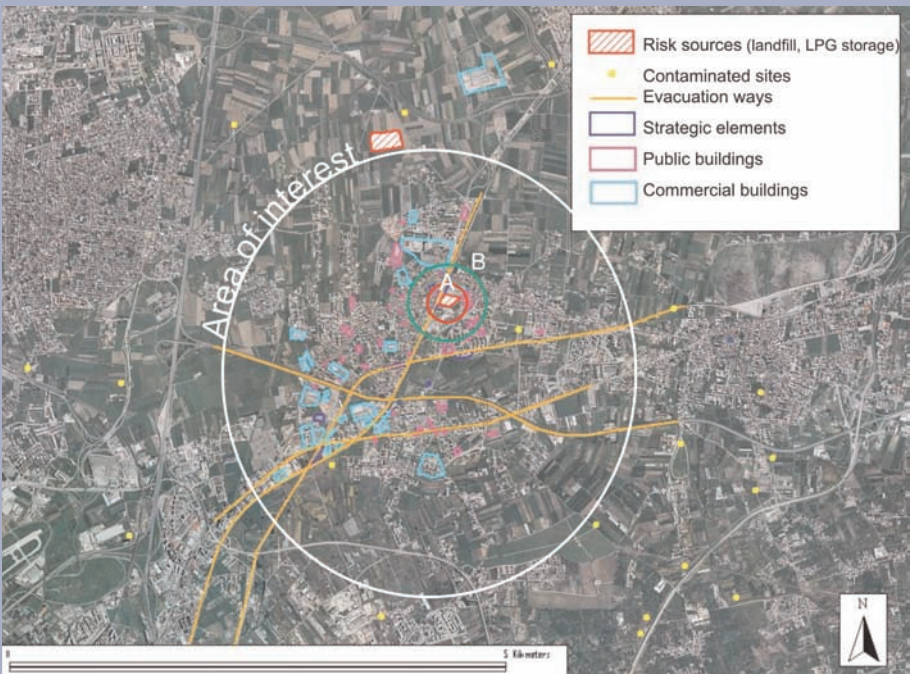


# MAIN OBJECTIVES

AMRA develops specific tools for the mitigation of most the highest risks, through:

- definition of occurrence probabilities of scenarios induced by interactions among different risks' sources, i.e. cascade effects;
- development of quantitative approach for the estimation of multi-risk indices considering all adverse events, both single and sequential;
- combination of multi-risk approach with GIS methodologies in order to perform time varying risks' evaluations supporting territorial planning in the context of environmental risk prevention.

In the figure below the case-study of Casalnuovo municipality (near Naples), developed during Na.R.As. Project, used to describe a possible procedure for multirisk assessment, considering its exposure to adverse events from many sources: volcanic activity (Mt. Vesuvius), earthquake occurrence (Irpinia Region), stream passing through the municipality.



# MAIN PROJECTS

## **EUROPEAN COMMISSION FP7**

**MATRIX**, New Multi-hazard and Multi-risk Assessment Methods for Europe. The main objective of the project will be to tackle multiple natural hazards and risks in a common theoretical framework. It will integrate new methods for multi-type assessment, accounting for risk comparability, cascading hazards, and time-dependent vulnerability.

## **EUROPEAN COMMISSION FP6**

**Na.R.As.**, Natural Risks Assessment.

The aim of this project has been to contribute to harmonise the risk assessment procedures and indicate ways to quantitative evaluation of hazard and risk levels through a two years long programmed series of Workshops, seminars, meetings, formation and educational activities which involve scientists, administrators and insurance experts who have been actively working in risk assessment problems in the latest years.

## **REGIONE CAMPANIA, POR CAMPANIA 2000/2006 MISURA 3.17**

**MIRARE**, Integrated Model for Environmental Risk at the Regional scale.

The main objective of the project is to build for the first time a theoretical model of environmental risk assessment on a regional scale able to return a map of risk due to several phenomena potentially polluting.



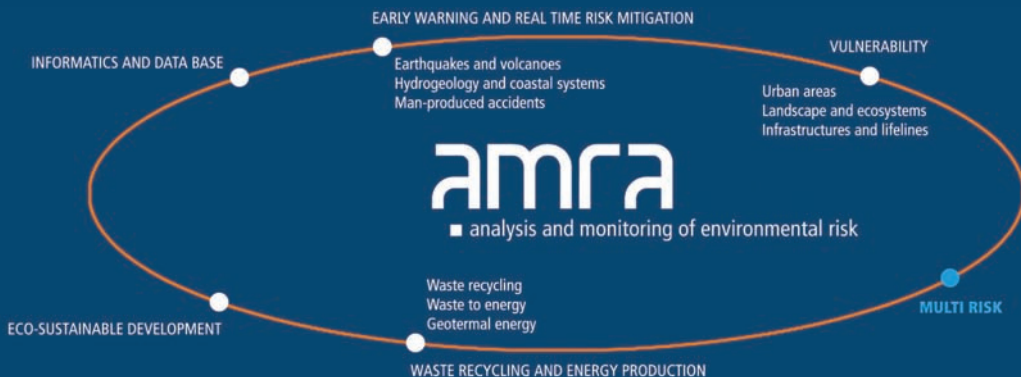
# MAIN SCIENTIFIC PAPERS

A. Grezio, W. Marzocchi, L. Sandri, A. Argnani, P. Gasparini  
**Probabilistic tsunami hazard assessment for Messina Strait area (Sicily – Italy)**  
submitted to Natural Hazards, 2010

A. Grezio, W. Marzocchi, L. Sandri, P. Gasparini  
**A bayesian procedure for probabilistic tsunami hazard assessment**  
Natural Hazards, 53, 159-174, doi:10.1007/s11069-009-9418-8, 2010

W. Marzocchi, M.L. Mastellone, A. Di Ruocco, P. Novelli, E. Romeo, P. Gasparini  
**Principles of multi-risk assessment**  
European Communities, EUR 23615, ISBN 978-92-79-07963-4, 2009

W. Marzocchi, A.M. Lombardi  
**Real-time forecasting following a damaging earthquake**  
Geophys. Res. Lett., 36, L21302, doi:10.1029/2009GL040233, 2009



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