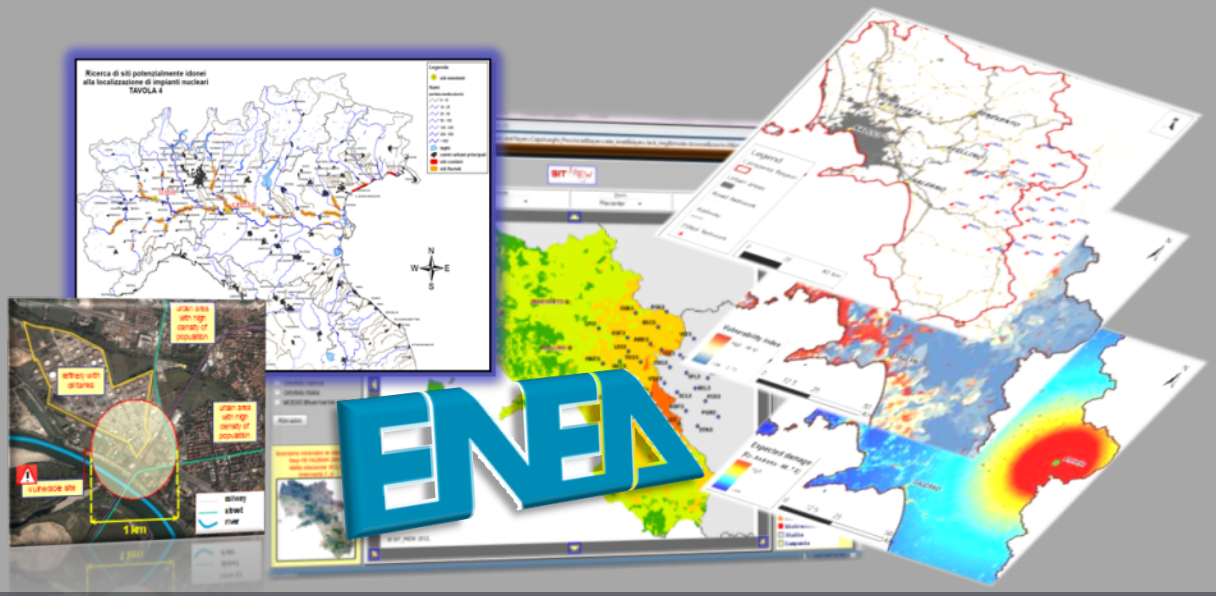
International workshop on Emergency Management for Critical Infrastructures Crises



ENEA Support Tools for Crises Prediction and Management

Vittorio Rosato, Antonio Di Pietro, Giuseppe Aprea, Roberta Delfanti, Luigi La Porta, Josè R. Marti, Paul Lusina and Maurizio Pollino

Conceptual framework

- Main goal (long-term plan): design and development of a new class of Decision Support Systems (DSS) integrating, in an unique framework, systems able to provide an efficient and accurate risk assessment based on events prediction and their impacts.
- Methodological approach: modeling and simulation techniques of environmental systems dynamics in DSS, aiming at forecasting crisis scenario. Event prediction is also associated to impacts predictions (damaged citizens and lands, loss of services for Critical Infrastructures, CIs).
- With respect to the emergency response issues related to critical events (e.g. natural disasters or nuclear accidents), the recent advances in geo-informatics, communication and sensor technologies have been opening new opportunities.
- An interactive DSS based on GIS approach could support the public government to address activities to emergency management and damage evaluations.

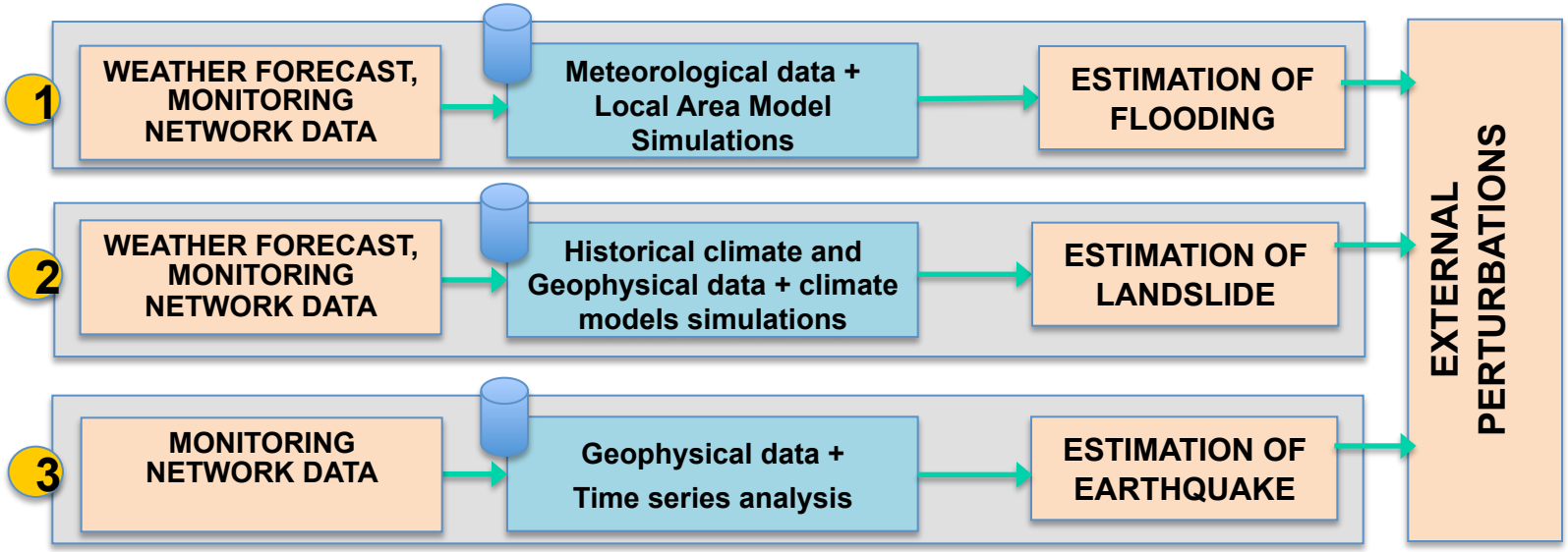
Summary

Three DSS tools will be described:

- for the risk analysis of a set of CIs due to extreme weather events.
- for the prediction of impact of nuclear wastes release from a plant
- For the near-real-time prediction of structure damages upon an earthquake

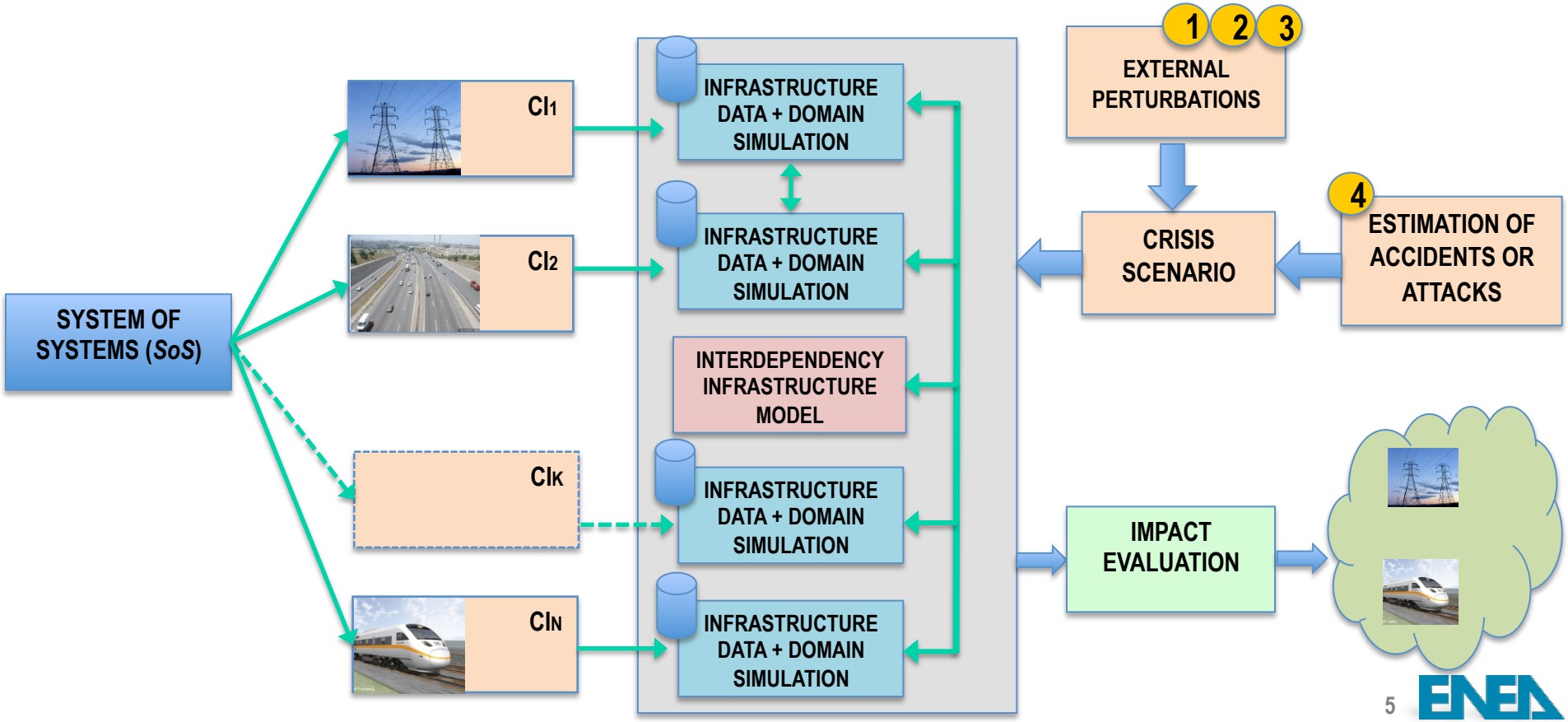
Event prediction: Extreme weather events

- When a specific perturbation strikes CIs several outages might result. They can also be worsened by cascading effects triggered by systems's interdependency, which propagate faults and outages from one technological system to another.
- An accurate prediction of the weather conditions and of their effects can help in estimating the probability that a specific (catastrophic) event might take place.
- A similar approach can be pursued also in case of non-predictable natural events, such as earthquakes.



Risk prediction of CIs

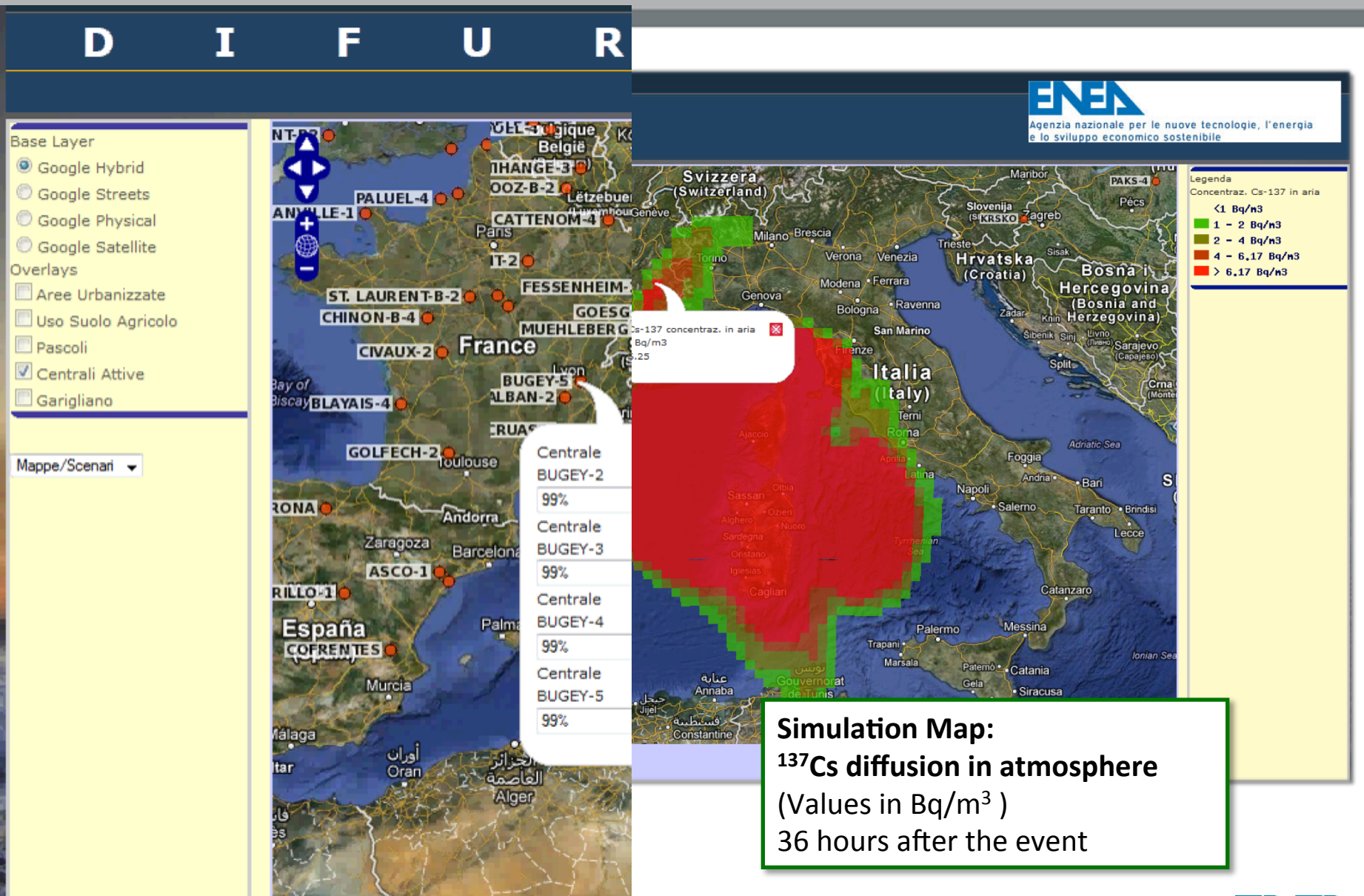
- After the *prediction* phase, the system produces a crisis scenario, locating elements above a given perturbation threshold. Simulation of the functioning of the systems is then performed to estimate the associated service reduction.
- Prediction are provided to crisis manager, with an advance of 24-48 hours); this allow to timely set up mitigation strategies and emergency plans.



Environmental impacts of nuclear waste release from plants

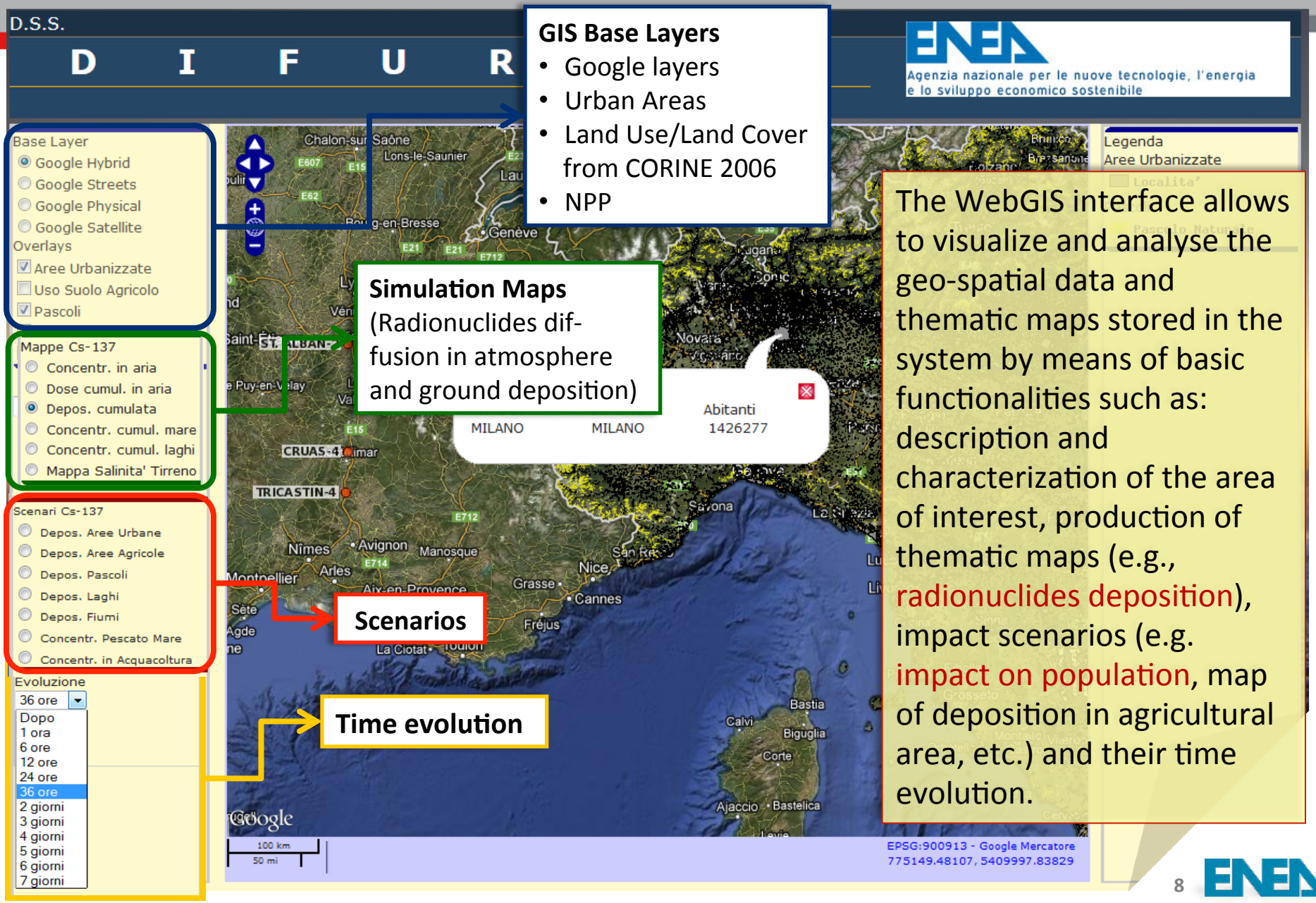
- An on-going research work is focused on the investigation and development of an innovative methodology for mapping nuclear waste release from plant after a severe accident, assessing the impact on Italian territory and evaluating the consequences for people and environment, by using geospatial methods.
- This GIS-DSS is conceived as a comprehensive tool that integrates model predictions and geospatial data for mapping radionuclides diffusion, scenario testing and disaster planning.
- The results become tools for an interactive DSS, supporting the public stakeholders to quickly evaluate consequences for people and environment and to address - in the post-event phase - the emergency management.

Nuclear waste release from plants



Simulation Map:
^{137}Cs diffusion in atmosphere
(Values in Bq/m^3)
36 hours after the event

Nuclear waste release from plants



GIS Base Layers

- Google layers
- Urban Areas
- Land Use/Land Cover from CORINE 2006
- NPP

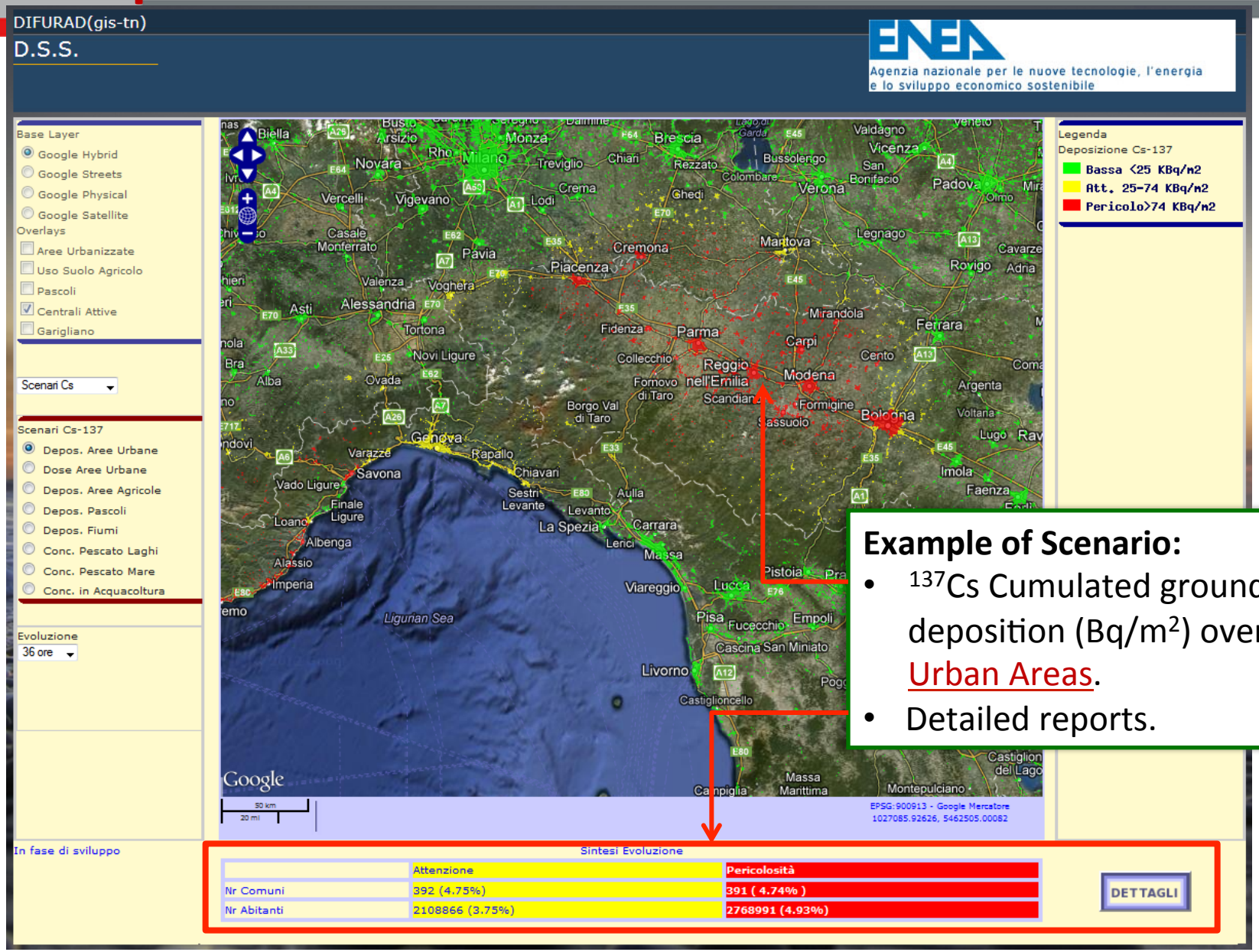
Simulation Maps (Radionuclides dif-fusion in atmosphere and ground deposition)

Scenarios

Time evolution

The WebGIS interface allows to visualize and analyse the geo-spatial data and thematic maps stored in the system by means of basic functionalities such as: description and characterization of the area of interest, production of thematic maps (e.g., radionuclides deposition), impact scenarios (e.g. impact on population, map of deposition in agricultural area, etc.) and their time evolution.

Nuclear waste release from plants: example of scenario



Risk assessment of infrastructures upon earthquakes

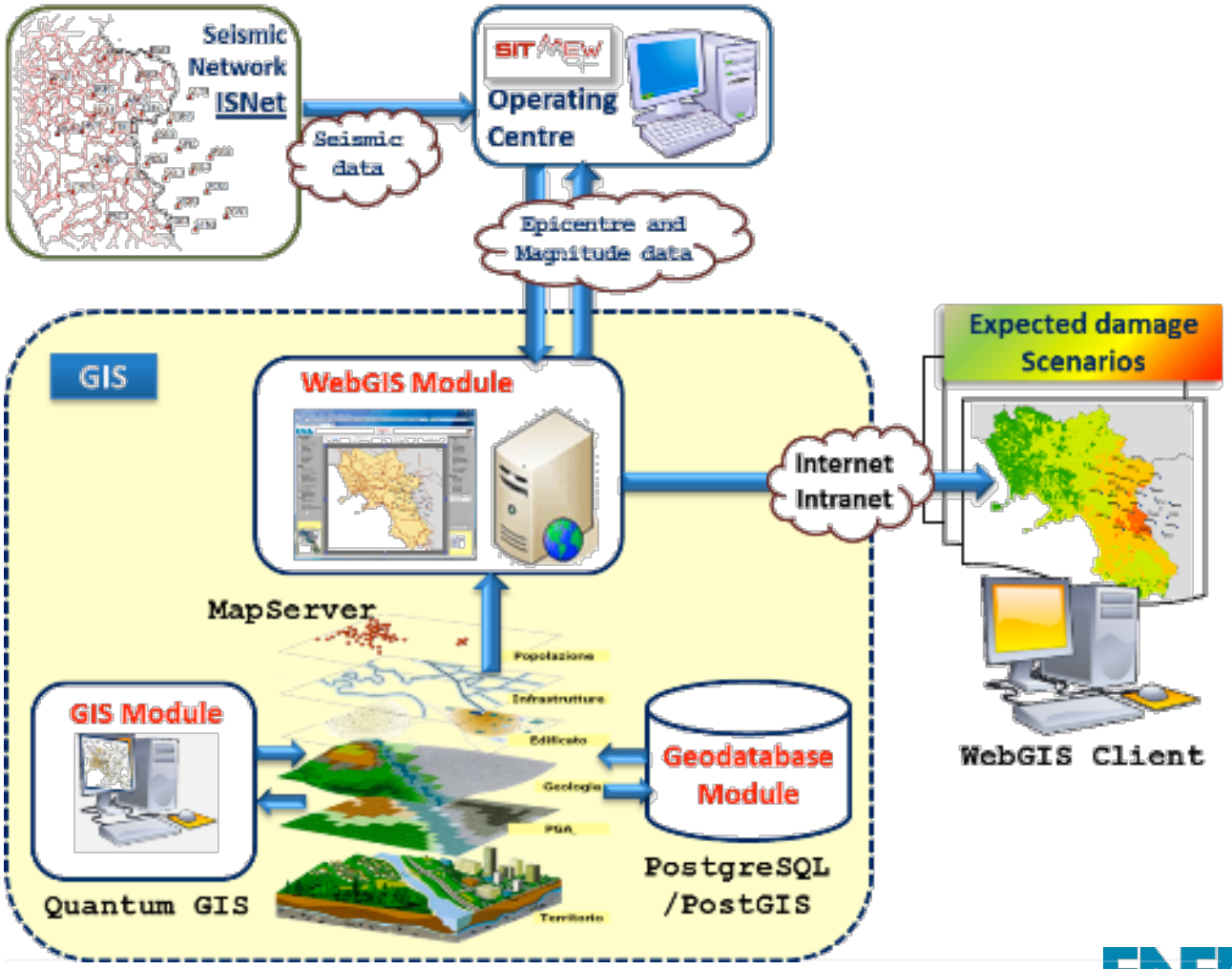
Predicting and mapping seismic vulnerability, assessing potential impacts of disastrous events.

GIS-DSS architecture:

1) Geospatial database system;

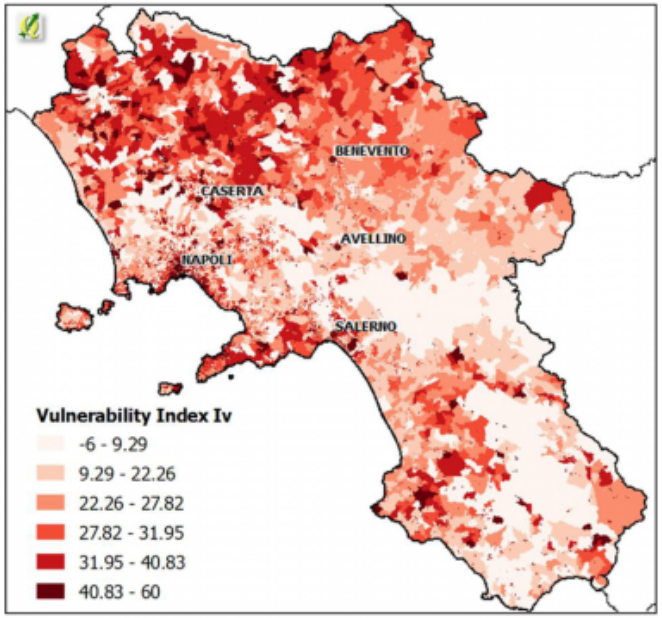
2) Local GIS application for analysing and modelling the seismic event and its impacts and supporting post-event emergency management;

3) WebGIS module for sharing the geo-information among the decision makers involved in disaster impact assessment and response management.

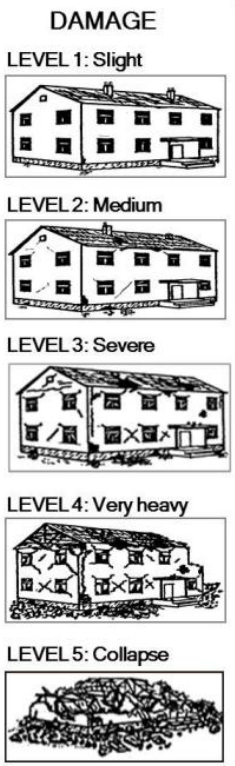


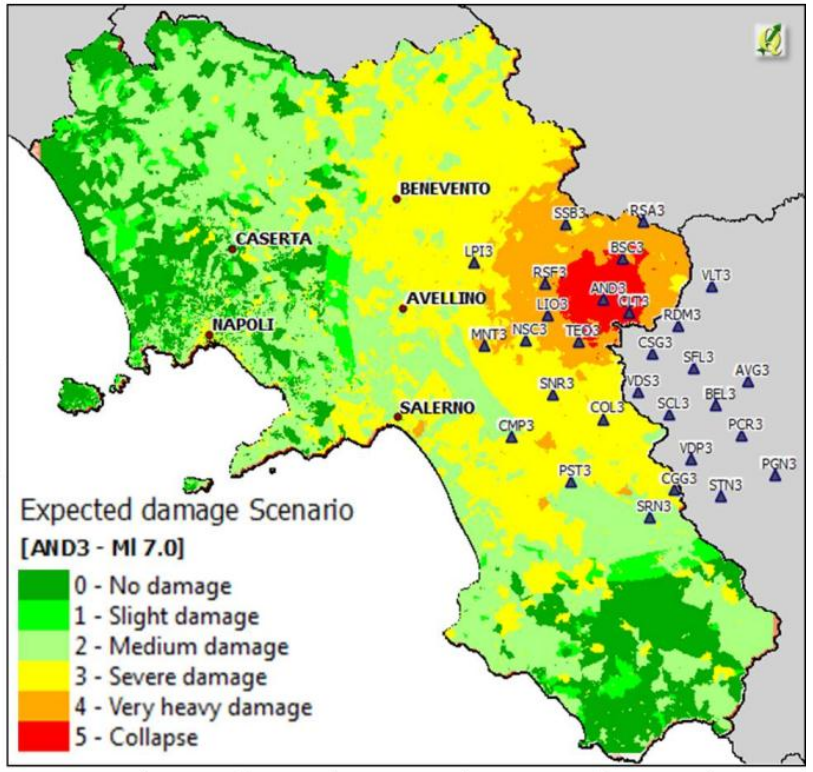
Risk assessment of infrastructures upon earthquakes

- The main aims of the GIS-DSS is to make geographic data, thematic maps and probable damage Scenarios available to specific end-users and, potentially, to the public.



Buildings Vulnerability Map (from land registry)





Example of expected damage scenario. The map is categorized considering six different levels of damage as described below (level representation shown on the left)

Levels of Damage	0	1	2	3	4	5
Factor of Damage (f_d)	0	0.01	0.1	0.35	0.75	1

- GIS-DSS supports a real-time monitoring of the vulnerability of structures and infrastructures within the area of interest, providing a preliminary assessment of the expected damages on structures and infrastructures a few seconds after the main shock.

SIT-MEW Regione Campania - Mozilla Firefox

File Modifica Visualizza Cronologia Segnalibri Strumenti Aiuto

http://gis-tn.casaccia.enea.it/cgi-bin/mapserv.exe?layer=centri_abitati&layer=Capoluoghi_Provincia&layer=Rete_Stradale&layer=rete_isnet&layer=Jack_img&u

SIT-MEW Regione Campania

ENEA

SIT MEW

Strati prioritari e dati ISTAT

- [ ] Province
- [ ] Comuni
- [x] Centri abitati
- [x] Cap. Provincia
- [ ] Rete Ferroviaria
- [x] Rete Stradale
- [ ] Aeroporti
- [ ] Istat 061-CE
- [ ] Istat 062-BN
- [ ] Istat 063-NA
- [ ] Istat 064-AV
- [ ] Istat 065-SA

Sismica

- [ ] Clas. sismica
- [x] Rete ISNet
- [ ] Sorgenti rischio vulc.
- [ ] Sorgenti rischio sism.

Scenari e wms

- [x] Scenario
- [ ] Vesuvio C.F
- [ ] Irpinia

Abruzzo

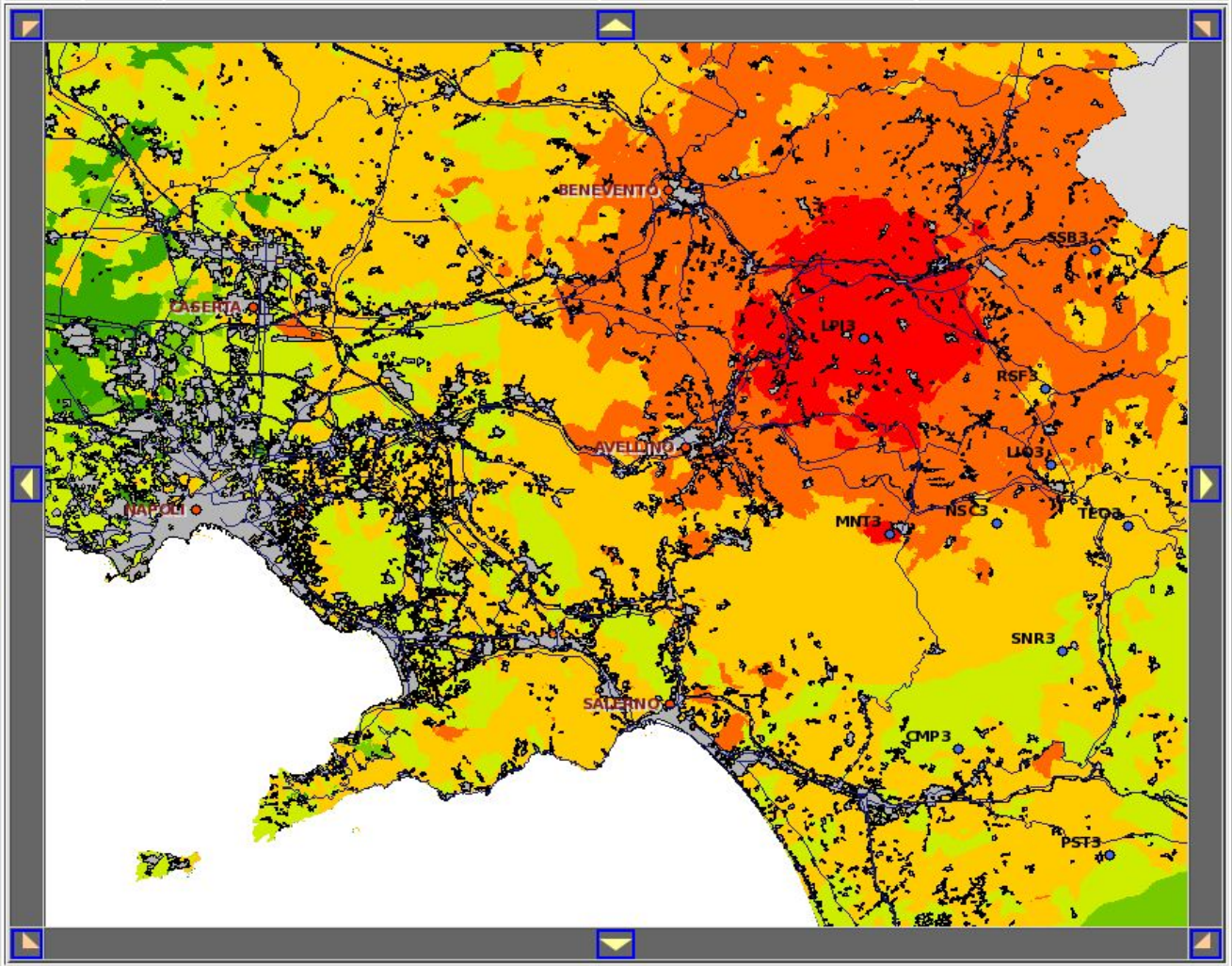
Scenario ricevuto in data Tue May 24 16:40:07 2011 dalla stazione LPI3 Intesita 7_0

Regione Campania

Map Mode: Browse

Map Control: Recenter

0 3 6 9 km



Elementi geologici e idrogeologici

- [ ] Faglie
- [ ] Geologia
- [ ] Grotte
- [ ] Geositi
- [ ] Inghiottitoi
- [ ] Assi drenaggio
- [ ] Complessi idrog.
- [ ] Sorgenti potabili
- [ ] Sot faglie
- [ ] Sot piezometriche
- [ ] Sot sovrascorrimenti
- [ ] Frane

Idrologia

- [ ] Reticolo idrografico
- [ ] Aree inondabili
- [ ] Retroargine
- [ ] Trasporto liq-sol

Allerta Vulcanica

- ISNet
- Strade
- Cap.provincia
- Abitato
- Nessun danno
- Danno lieve
- Danno moderato
- Danno grave
- Danno molto grave
- Distruzione
- Italia
- Landsat
- Regione

Completato

Risk prediction of CIs- ongoing actions

- All described DSS's are going to be assembled and functionally interconnected within the EU-funded NoE CIPRNET (start date: November 2012).
- CIPRNET has designed a road-map for the set up, in different EU countries, of a constellation of national EISAC nodes

European Infrastructures Simulation and Analysis Centers

These systems will boost EISAC nodes and will constitute their initial technological assets.

- A first seed of I-EISAC is going to be proposed in the frame of a Call for Proposal issued by the Italian Ministry of Education and Research and will involve, as use case, the Metropolitan Area of Rome and the Lazio Region.

EISAC is the result of the efforts of a number of people during the last 10 years: among them I wish to acknowledge

Sandro Bologna (ENEA and AIIC)
Erich Rome (Fraunhofer)
H.A.M. (Eric) Luiijf (TNO)

Conclusions

- We have presented a number of implementations of kernel of DSS in different areas of risk analysis.
- The unifying picture is the awareness that the inclusion, in the DSS workflow, of a capability of predicting environmental threats and that of considering the environment as a propagator of perturbations is a key ingredient for the effectiveness of these systems.
- This approach to risk analysis is intrinsically multidisciplinar, as it involves the clustering of a number of expertises, from those related to CIs to those of geomatics, weather forecasting, oceanography, seismology etc.
- This approach will certainly foster in the future a new generation of risk assessment/management tools which will enable an easier and more effective management of crises.

Authors information

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Thank you

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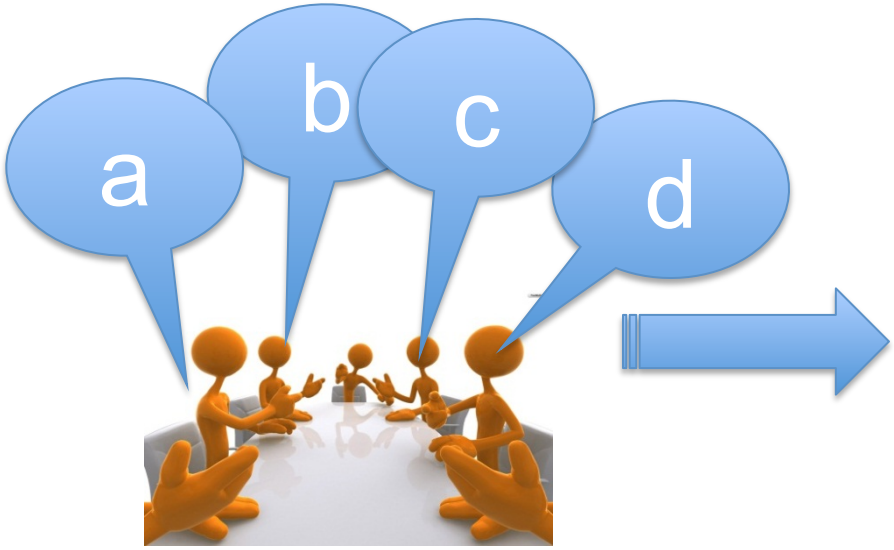
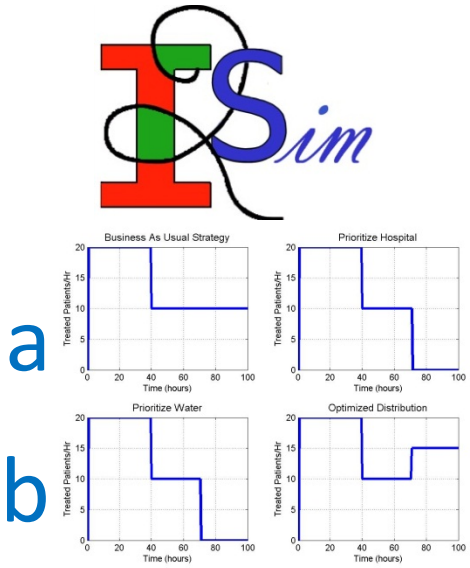
I2Sim (Infrastructure Interdependencies Simulator)

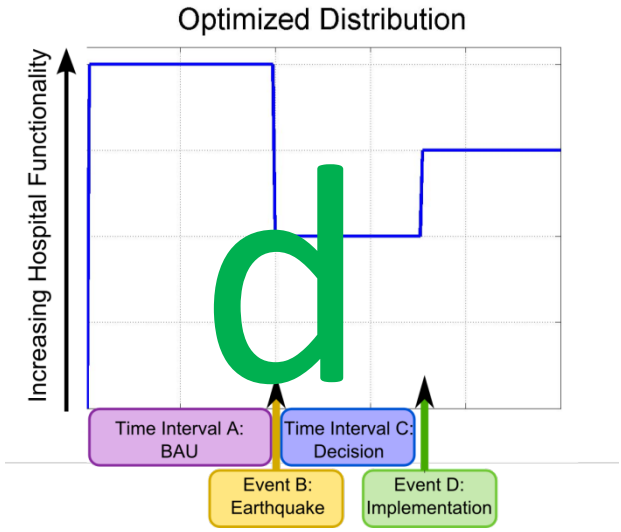
- I2Sim - Interdependency Infrastructure Simulator: discrete event simulator.
- Simulate the Emergent Behavior of a System of interconnected infrastructures.
- In Emergency times it is useful in understanding the impacts of decisions.
- Core components: Tokens, channels, production cells, distributors, storage cells.

Decision Evaluation using I2Sim





Policy ranking using I2Sim decision support simulator



Policy with the best predicted outcome is implemented, e.g. best hospital operation

A case study: Sendai Tsunami and Earthquake

- Sendai Tsunami and Earthquake case study modeled with I2Sim