

The ENEA logo features the word "ENEA" in a bold, white, sans-serif font. The letters are set against a dark blue background that includes a stylized sunburst or energy field graphic on the left side.

AGENZIA NAZIONALE
PER LE NUOVE TECNOLOGIE, L'ENERGIA
E LO SVILUPPO ECONOMICO SOSTENIBILE

CIPRNet: towards advanced decision system for supporting prediction and management of CI crisis scenarios

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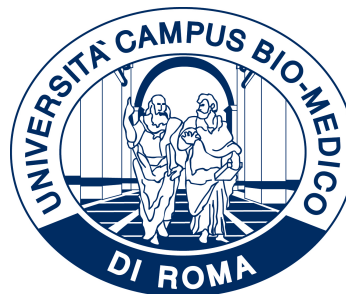
The CIPRNet logo consists of a dark blue square containing a white grid pattern. The text "CIPR" is positioned above "Net" in a white, sans-serif font. The logo is partially overlaid by a decorative graphic of overlapping squares and circles in the bottom right corner of the slide.

CIPR
Net

CIPRNet partners



Joint Research Centre - Sito di Ispra



Network of Excellence, co-funded by FP7

Term: 1.3.2013–28.2.2017

Summary

- Basic objectives of technological activities
- CIPRNET DSS workflow
- DSS Components
 - Sensing & event prediction
 - Damage estimate
 - Impact estimate
 - Decision Support
- Examples of DSS elements & functions
- Conclusions



Joint programme of activities

- Providing new **capabilities** to end users for better preparedness for CI-related emergencies:
 - **advanced decision support**
 - »what, if ...« analysis
 - **support of secure design of next generation infrastructures**
 - »ask the expert« service
- Building required **capacities** by educating and training experts and researchers (reaching a critical mass)
- **Providing knowledge and technology** to end users for improving their understanding of the role of CI in crises and emergencies.
 - simulators, middleware, models, ...
- Provide long-lasting end user support by establishing a **Virtual Centre of Competence and Expertise in CIP (VCCC)**

Basic objectives

- Which are the goals of the DSS ?

DSS will provide

- the prediction and the analysis of damages to CI in a given area potentially associated to predicted natural hazards
- The predicted estimate of impacts that such damages could produce on the functioning (through their QoS) of single and multiple CI
- The predicted estimate of impacts that such damages could produce on environment, population, economy, industrial activities

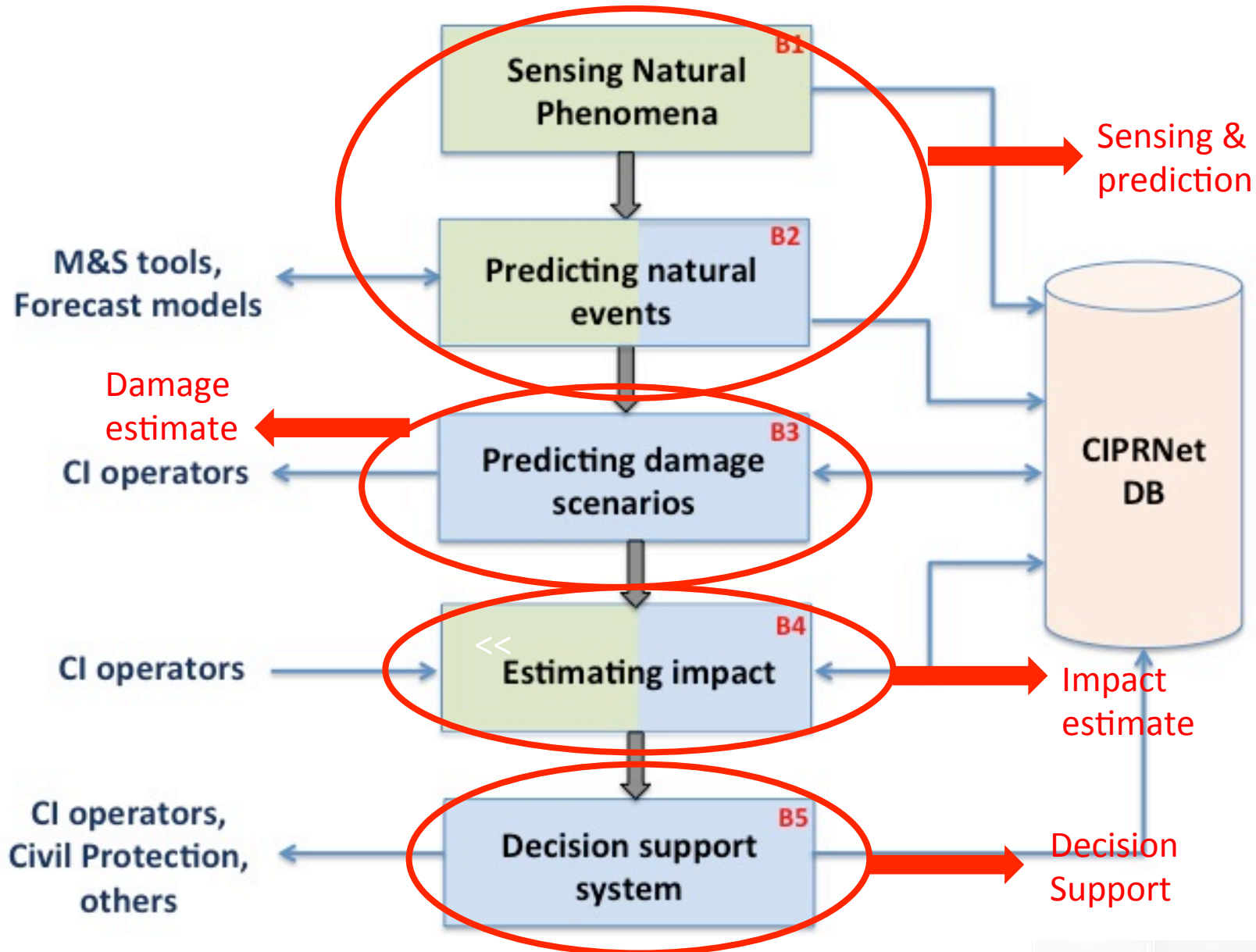
- Who will be the DSS end-users ?

DSS will provide data and info to the following set of selected end-users:

- CI operators
- Local P.A. (City, Land Administration) and its technical and emergency dept.
- Civil Protection

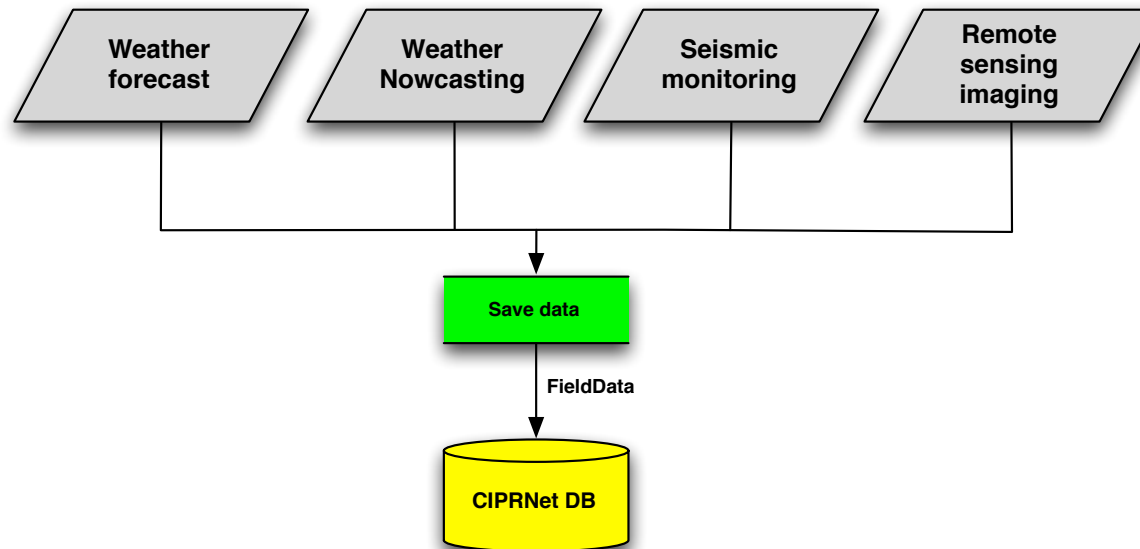
- Which decision will be supported ?
 - Preparedness actions
 - Planning for optimal restoring and mitigation strategies
 - Planning for Emergency operation
- Which data and info will be supplied for supporting those decisions?
 - Prediction of natural events with might have sizeable impacts on CI
 - Estimate of resulting damages
 - Prediction of QoS reduction of single CI
 - Prediction of dependency (and, if any, interdependency) effects leading to further QoS reduction, not visible from single-domain fault analysis
 - Expected “overall” impacts on CI functioning (QoS reduction)
 - Expected impacts on population, environment, welfare, industrial activities etc

DSS Functional diagram



B1: Sensing the environment

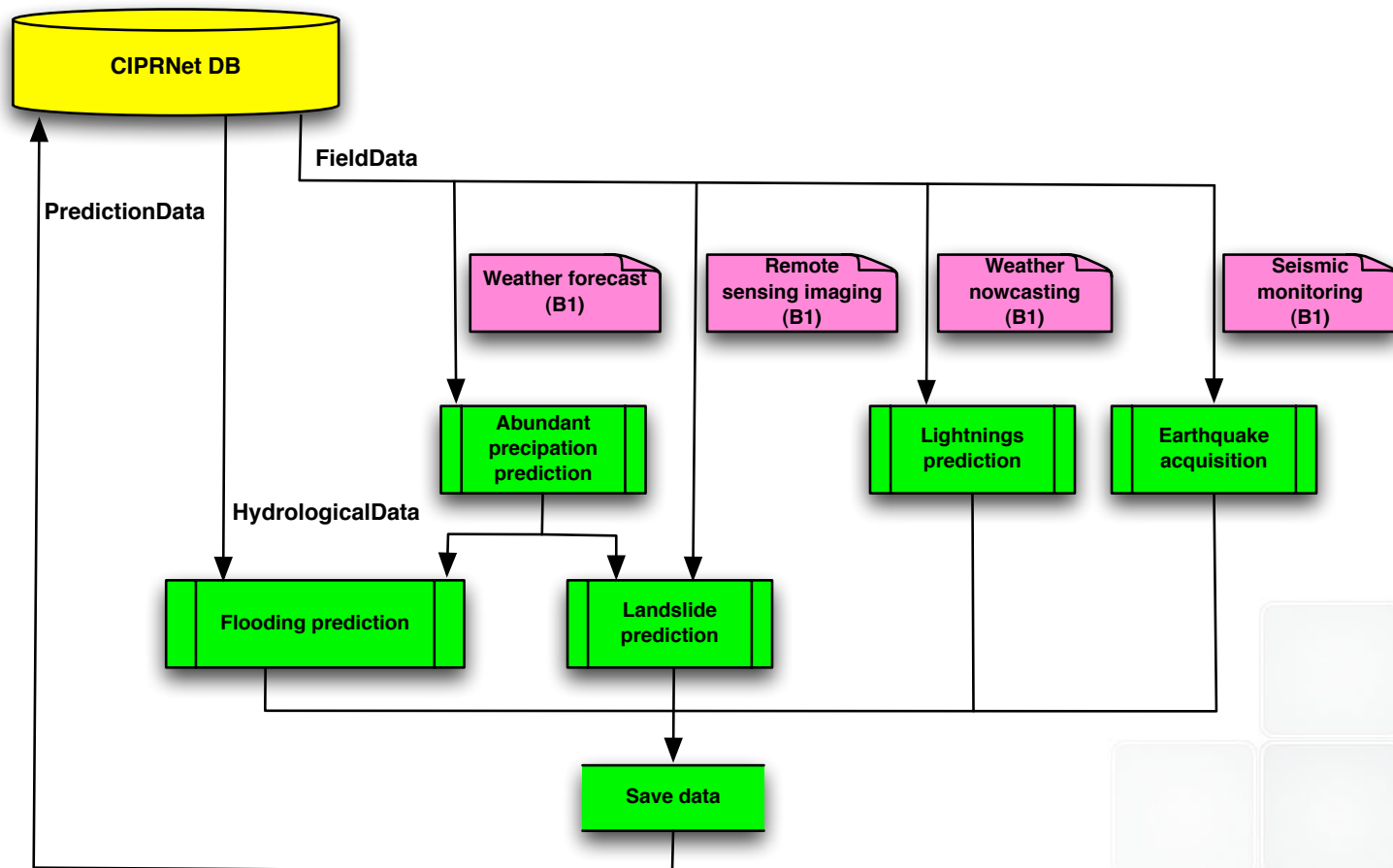
- *Seismic monitoring network to obtain data about earthquakes (localization, magnitude) (<http://cnt.rm.ingv.it/>)*
- *Nowcasting radar monitoring network (Himet Srl, Roma)*
- *Satellite SAR Images (E-Geos Roma)*
- *Flood Forecasting by EFAS¹*



¹ <http://floods.jrc.ec.europa.eu/efas-flood-forecasts.html>

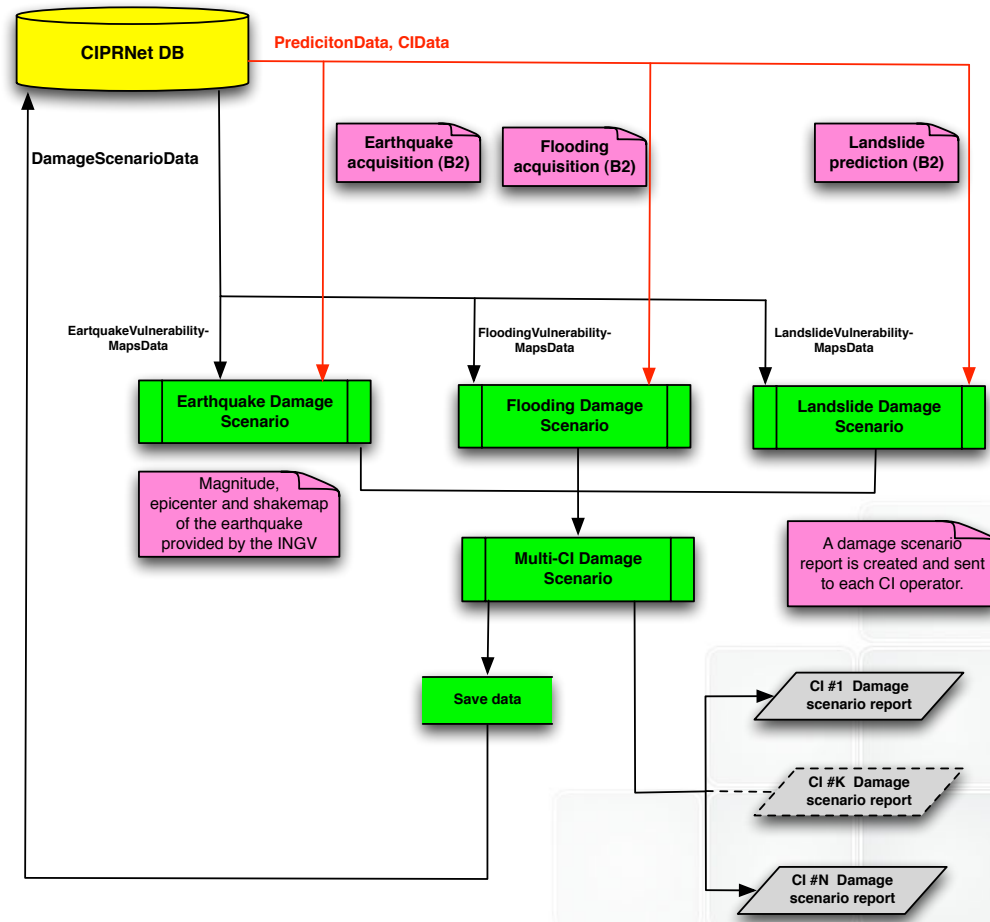
B2: Events forecast and event detection

- Prediction of natural phenomena at the appropriate (LAM) scale (Himet Srl & ENEA)
- Meteorological data are used to forecast precipitation abundance in a specific area
- Use of hydrological models to forecast a flooding threat (Himet Srl)
- Triggering of occurrence of an earthquake



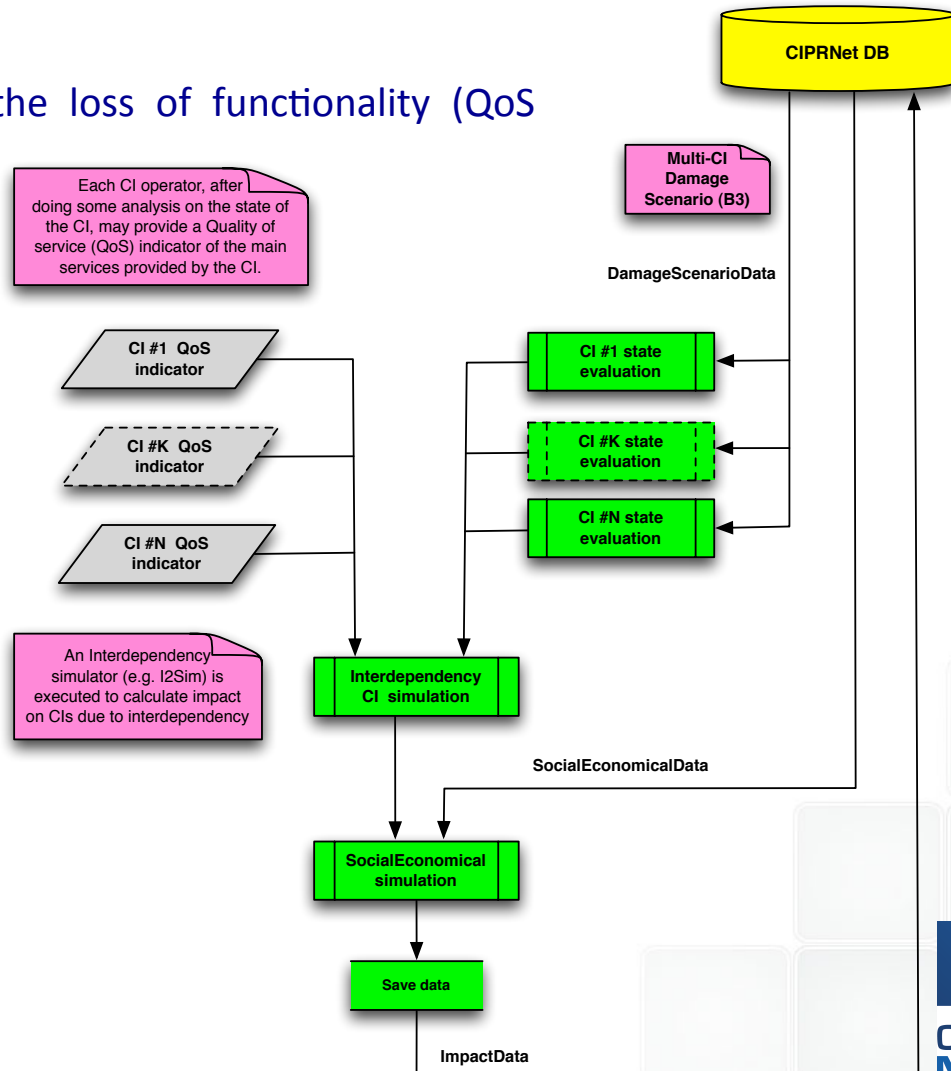
B3: Predicting damage scenarios

- Expected damage scenarios involving components of CIs providing **Damage Probability** of each CI component in a specified temporal horizon
- Prediction is done either by using historical data and vulnerability assessment based on empirical functions.
- **Damage scenario report** customized for each CI is sent to CI operators.



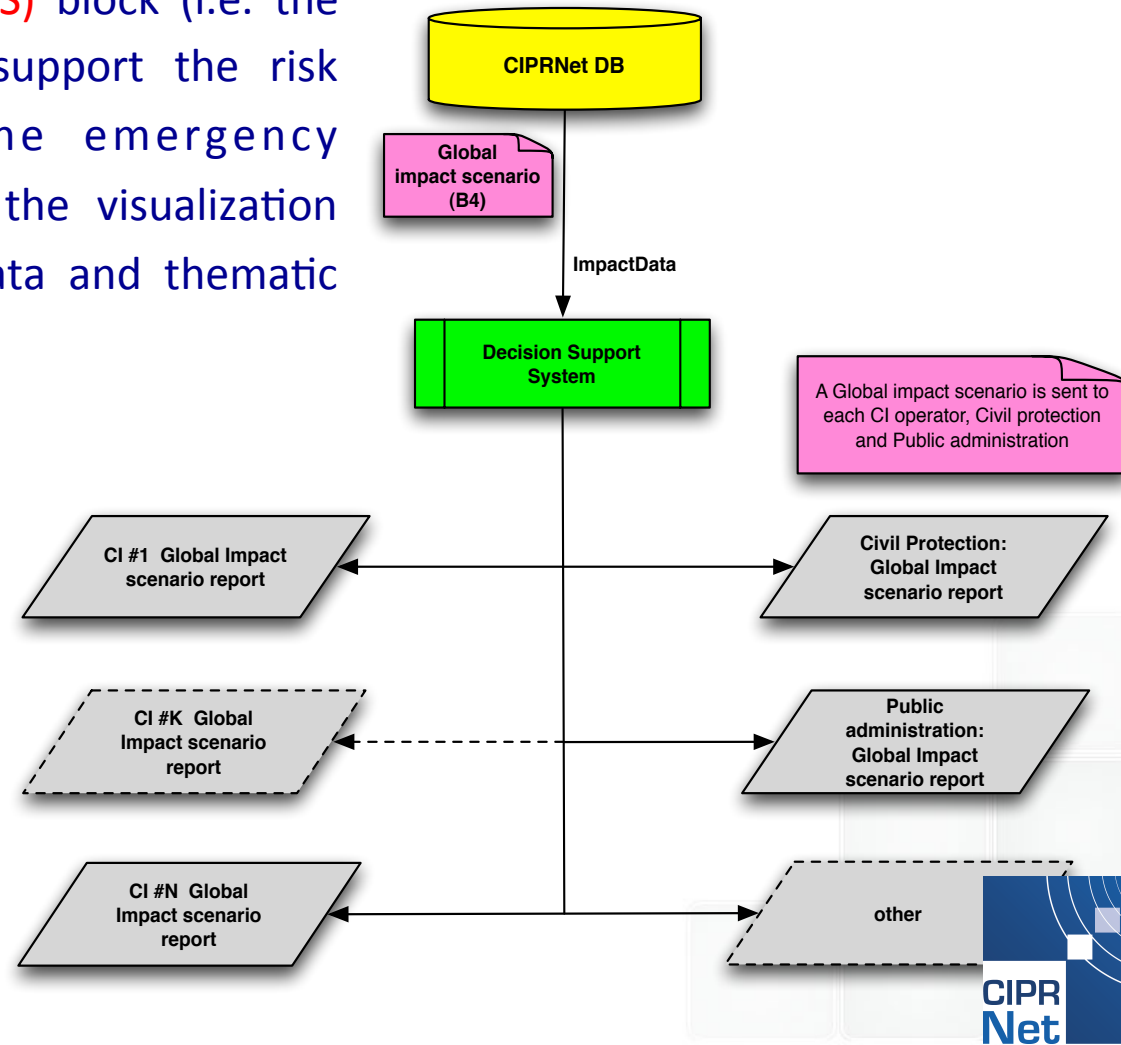
B4: Estimating impacts

- **Impact on CIs:** Detection of CI elements whose damage probability is above a given threshold
- CI operators can provide to the DSS the loss of functionality (QoS indicators) of the CI due to the failures.
- Functional impacts on CIs which supply a multi-infrastructures simulator (e.g. I2Sim by UBC) to assess impact due to interdependencies.
- **Impact on Society:** by crossing the resulting impact on the CIs system with data relative to societal activities (industrial and welfare system) and the environment (e.g. pollution caused by CI faults).

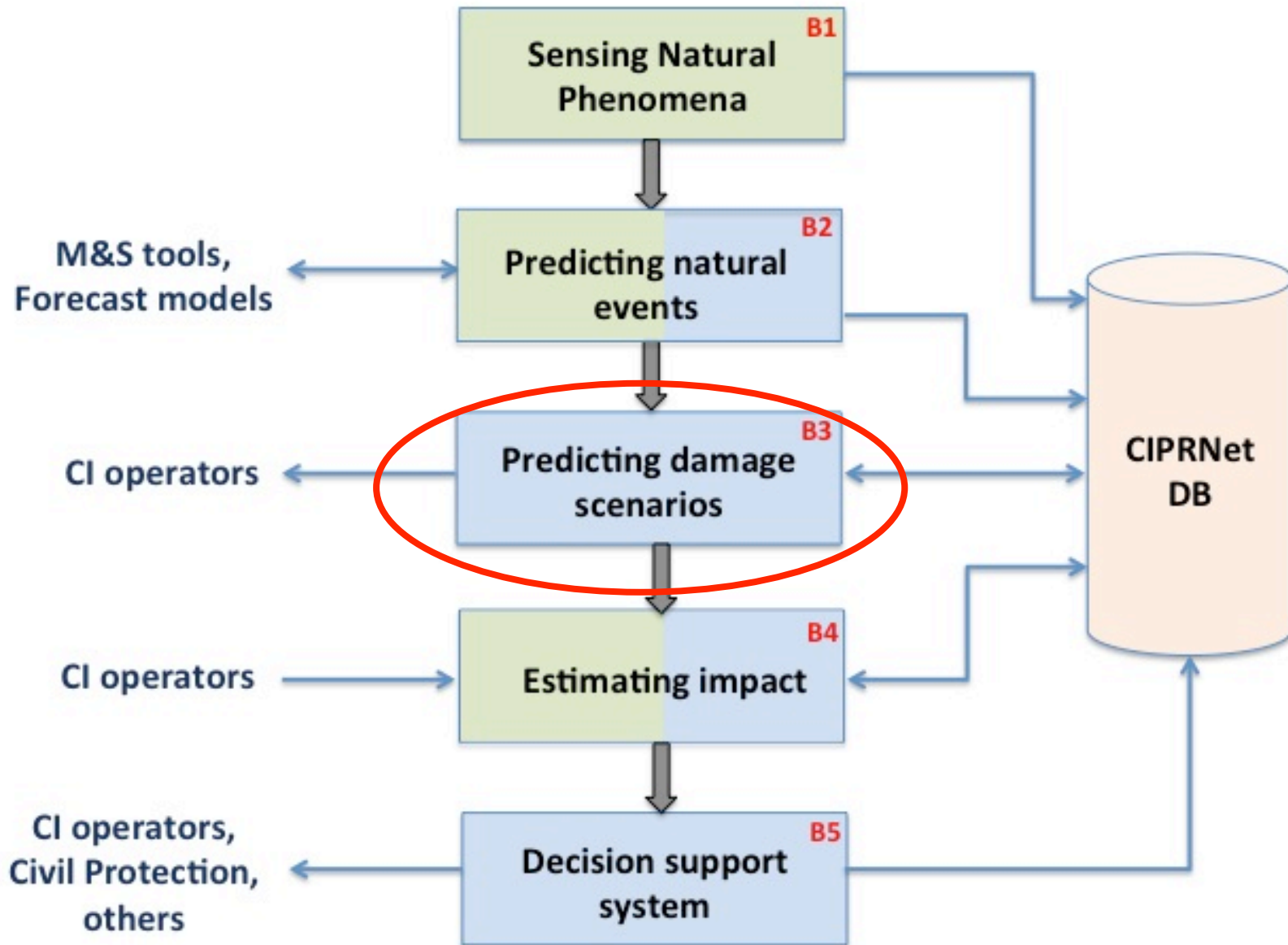


B5: Decisions support

- A **Crisis assessment report** is sent to CI operators, Civil Protection, Public Administration, etc.
- The **Decision Support System (DSS)** block (i.e. the **CIPRNet DSS WebGIS Module**) support the risk assessment analysis and the emergency management tasks, by allowing the visualization and analysis of the geospatial data and thematic maps stored in the CIPRNet DB.



DSS Functional diagram

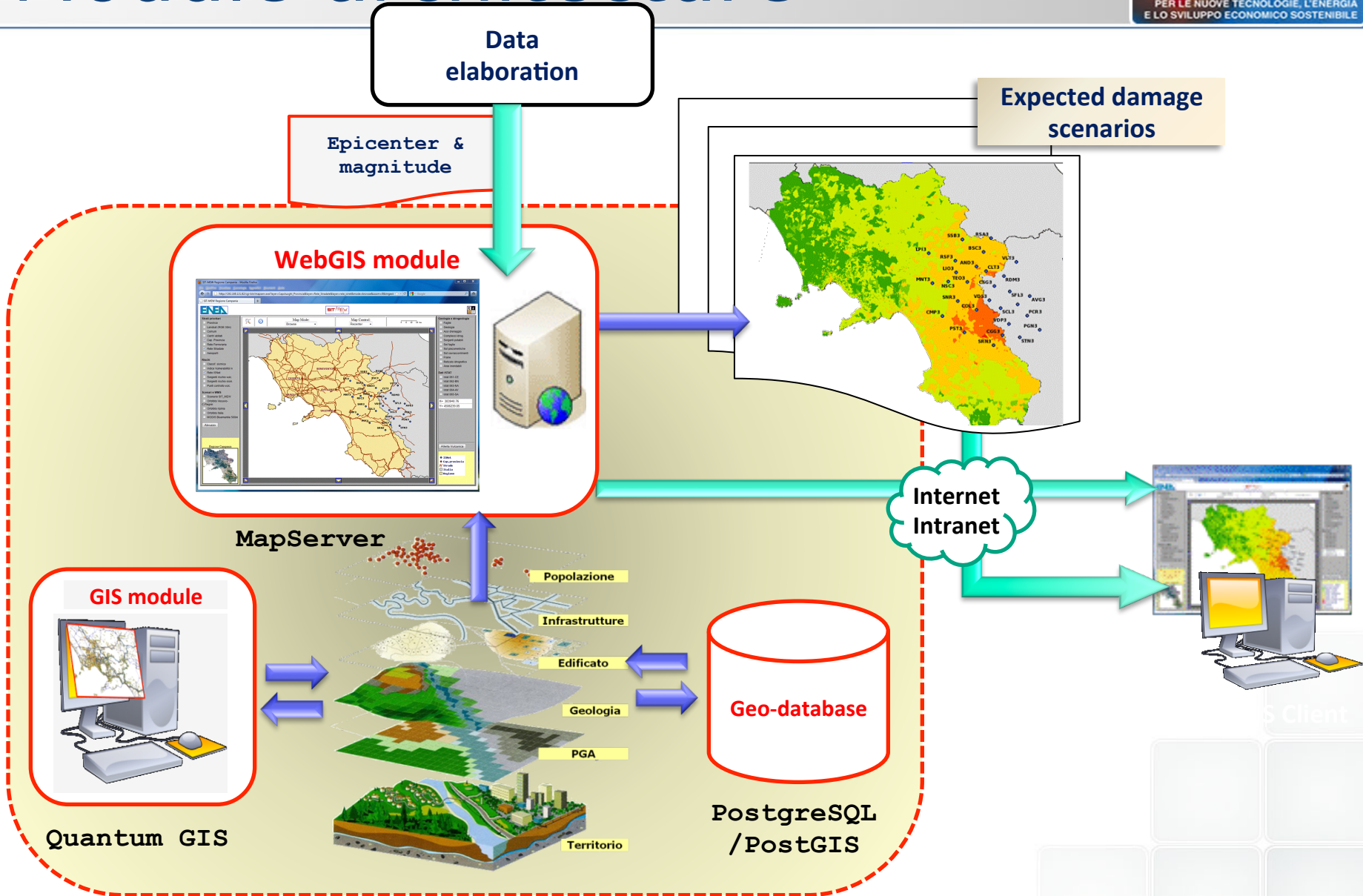


- Prediction of damages on buildings and other structure upon an earthquake sensed through a direct connection with field sensors.

Scenario: Campania Region (Italy)



Module architecture



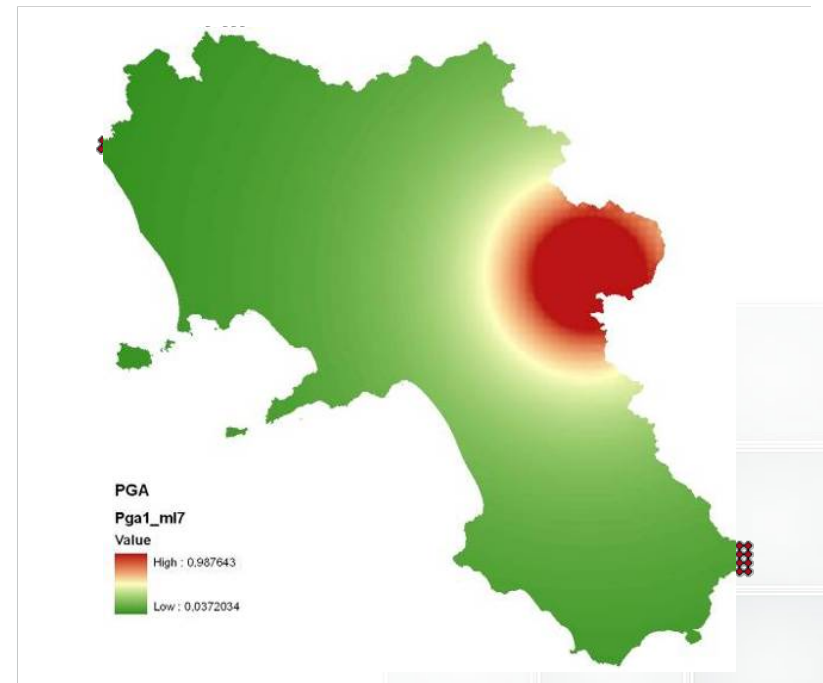
Shake maps

- Evaluation of Peak Ground Acceleration (PGA) and that of Seismic Intensity I_{MCS} is done according to Sabetta and Pugliese (1996):

$$\log_{10}(Y) = a + bM + c \log_{10}(R^2 + h^2)^{1/2} + e_1 S_1 + e_2 S_s \pm \sigma$$

- The system provides the PGA and the I_{MCS} and their relation (Decanini et al., 1995):

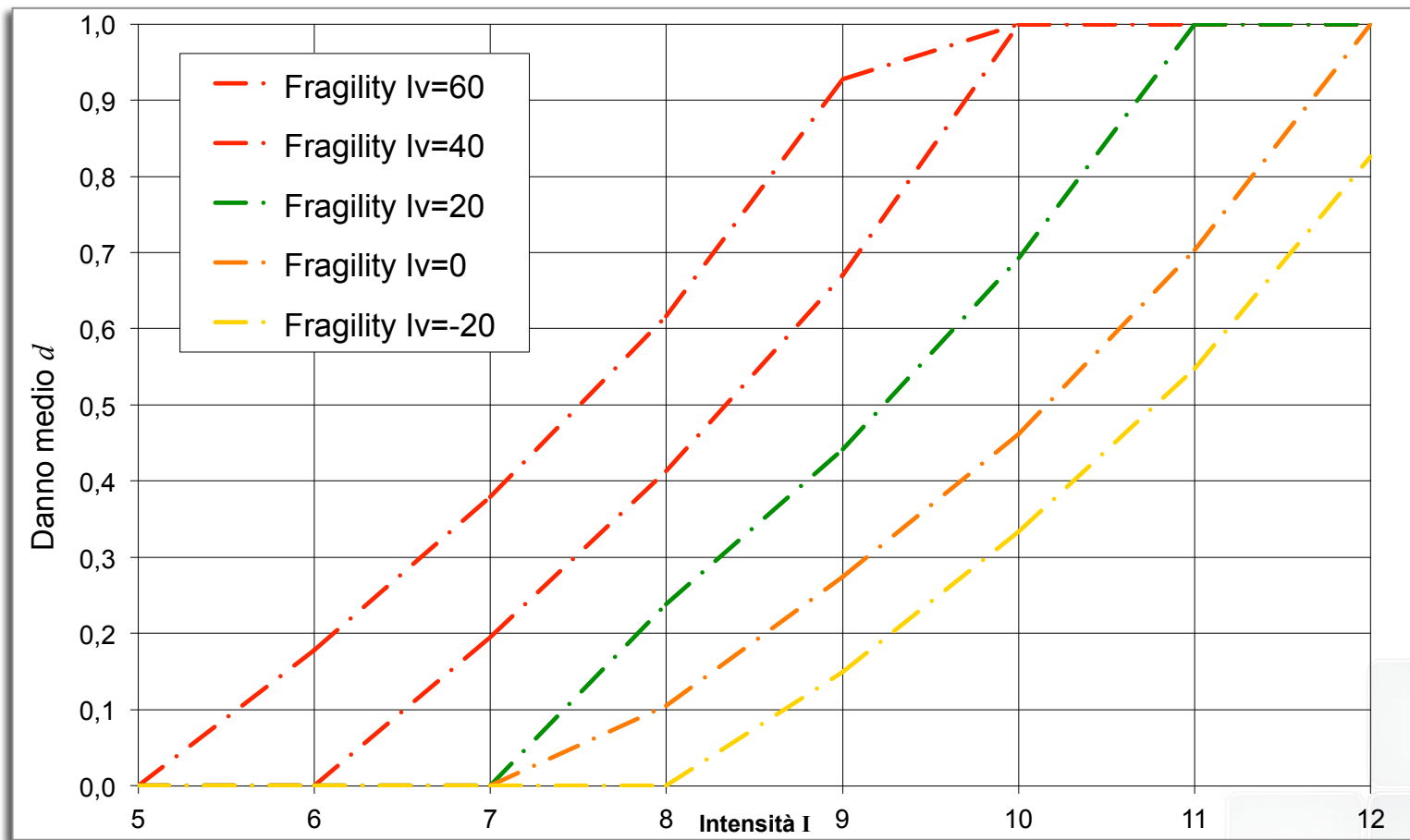
- The system allows to a fast evaluation of the PGA distribution after the event, allowing to estimate the damage scenarios
- More accurate PGA maps could be then acquired from proper sources (e.g. in Italy from the National Institute of Geophysics), to perform further refinement of the damage estimates.



Expected damage scenario

Damage d is evaluated as follows (Giovinazzi e Lagomarsino, 2001) where I is the seismic intensity and I_v is a vulnerability index :

$$d = 0.5 + 0.45 \left\{ \arctan \left[0.55 (I - 10.2 + 0.05 I_v) \right] \right\}$$





Strati prioritari

- Province
- Comuni
- Centri abitati
- Rete Ferroviaria
- Rete Stradale
- Istat

Rischi

- Classif. sismica
- Indice Vulnerabilita' Iv
- Rete ISNet
- Sorgenti rischio sism.

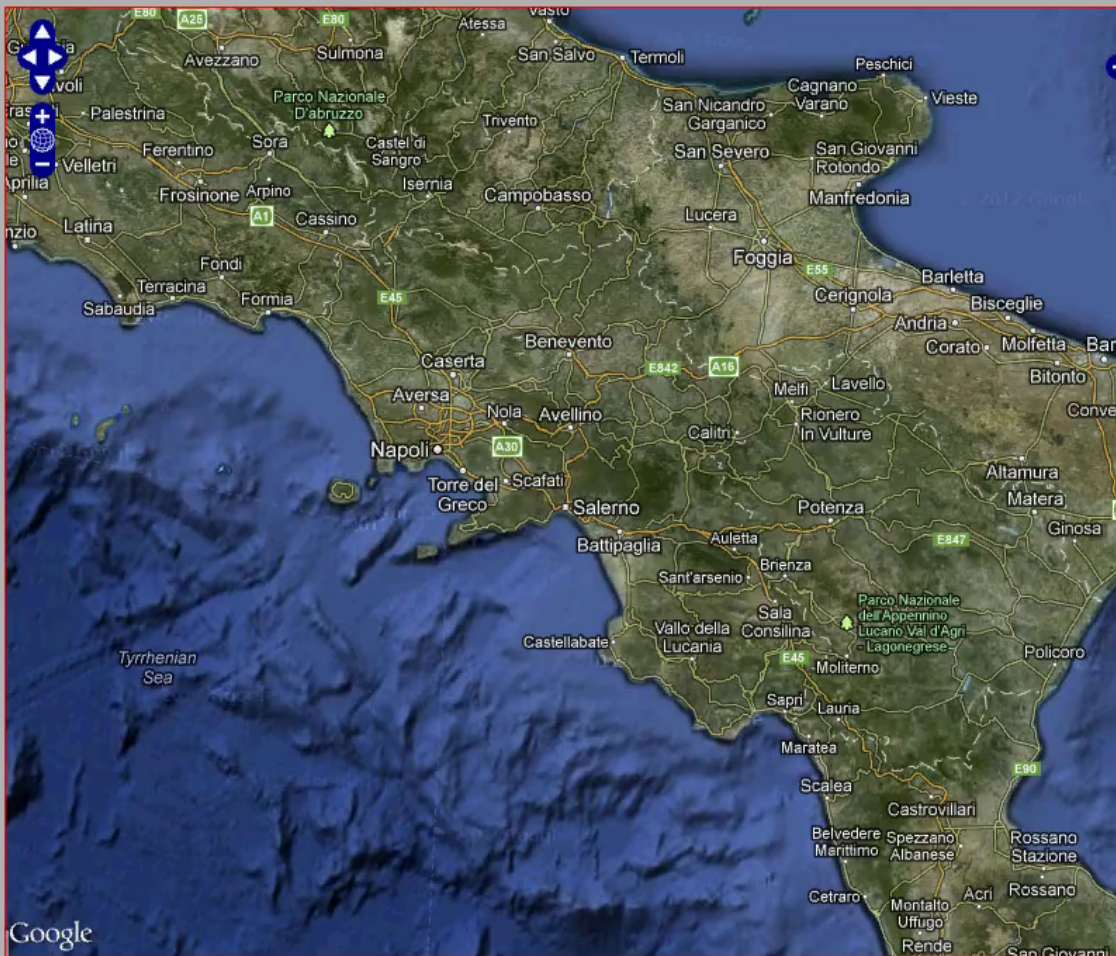
Geologia e idrogeologia

- Faglie
- Geologia
- Complessi idrog.
- Sot faglie
- Frane
- Reticolo idrografico

Scenari

- Scenario SIT_MEW

Client simul



Legenda

- Prediction of events and the implementation of a suite of evaluation tools (from damage to impact scenarios) of dependent-interdependent systems can provide valuable insight for enhancing CI resilience.
- CIPRNET will also test a new interaction strategy with CI operators, by involving them in the risk prediction workflow
- The ending point of CIPRNET will be to realize in EU a constellation of EISACs (European Infrastructures Simulation and Analysis Centre) to perform coordinated, pan-european CIP activity

Thanks for the attention

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