EO DATA FOR RAPID RISK ANALYSIS WITH THE RASOR PLATFORM

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ABSTRACT

Climate change challenges our understanding of risk by modifying hazards and their interactions. Sudden increases in population and rapid urbanization are changing exposure to risk around the globe, making impacts harder to predict.
RASOR will develop a platform to perform multi-hazard risk analysis for the full cycle of disaster management, including targeted support to critical infrastructure monitoring and climate change impact assessment. A scenario driven query system simulates future scenarios based on existing or assumed conditions and compares them with historical scenarios. Initially available over five case study areas, RASOR will ultimately offer global services to support in-depth risk assessment and full-cycle risk management.

Index Terms— RASOR, platform, multi-hazard, risk assessment

1. BACKGROUND AND MOTIVATION

Over the recent decades, there has been a dramatic rise in disasters and their impact on human populations. Rapid climate change has brought changing weather patterns, making risks increasingly challenging to predict and modifying the ways in which hazards interact with each other. In 2010, disasters left over 300,000 people dead, affected another 220 million and caused over $US120 billion in economic damages [1].

Despite the availability of operational mapping products, there is no single tool to integrate diverse data and products across hazards, update exposure data quickly and make scenario-based predictions to support both short and long-term risk-related decisions.

RASOR is the first integrated platform to provide risk assessment across multiple hazards, using satellite EO and in-situ data. The platform is designed to address first and foremost the needs of those who conduct risk assessment. Assessing risk is a necessary first step to reducing the exposure of populations and assets to risk. This assessment is mainly focused on the analysis of three important elements: exposure, hazard and vulnerability (Figure 1). Documenting them and understanding how they evolve and interact, is critical to reducing risk.

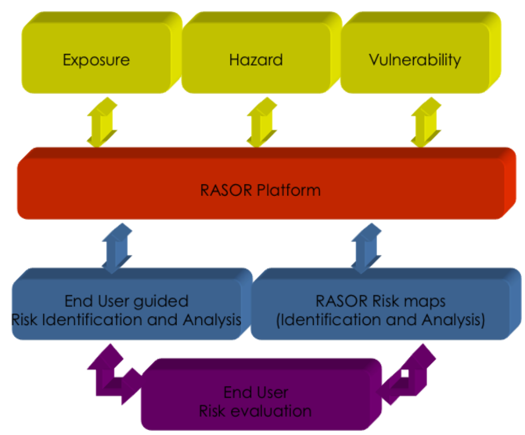

Figure 1. Overview of risk assessment approach.

RASOR offers improved accuracy by using the 12m TanDEM-X DEM as a base layer. The ability to assess future impacts before and during crises, as events unfold, empowers risk and disaster managers supporting both immediate and long-term risk reduction.

2. THE PLATFORM ARCHITECTURE

RASOR offers a single work environment that generates new risk information across hazards, across data types (satellite Earth Observation, in-situ), across user communities (global, local, climate, civil protection, insurance, etc.) and across the world (Figure 2).

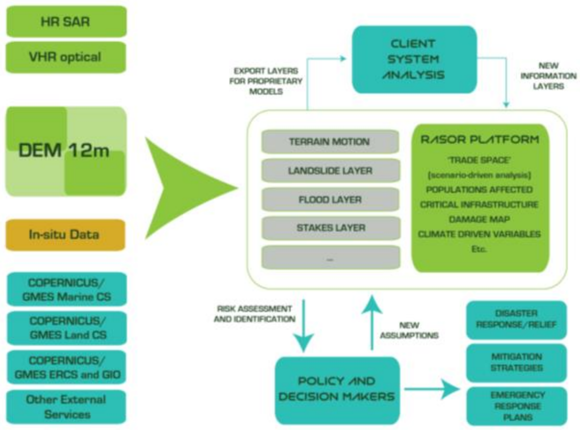

Figure 2. RASOR platform architecture.

RASOR uses the 12m TanDEM-X Digital Elevation Model as a base layer, and then adds archived and near-real time very-high resolution optical and radar satellite data, combined with in-situ data.

A scenario-driven query system allows users to model multi-hazard risk both before and during an event. Managers can use actual scenarios when determining new mitigation or prevention measures, and integrate new, real-time data into their operational system during disaster response.

2.1. Main sources of Earth Observation data

2.1.1. TanDEM-X Digital Terrain Model

Considering the lack of a standard Digital Terrain Model (DTM) at a sufficient level of resolution, one of the main challenges in risk assessment is to apply currently available DTMs (like SRTM) to real scenarios (flooding, for ex). Until recently, projects like RASOR faced an insurmountable hurdle: the inexistence of a readily available high resolution DEM that could serve as the backbone for a global system that rapidly analyses and spatializes risk.

Within RASOR, the newly developed 12m resolution TanDEM-X Digital Elevation Model (DEM) will be adapted to risk management applications, using it as a base layer to interrogate data sets and develop specific disaster scenarios.

2.1.2. Earth Observation data

Satellite data is a critical component of the RASOR tool. Baseline optical and radar data need to be ingested into the system in order to extract exposure information tied to built-up areas, critical infrastructure, roads and access and many other features. Interferometric data stacks will be acquired for the analysis of the geo-hazard components based on ground deformation monitoring. Near real-time data may be necessary when the rapid risk assessment is based on a dynamic situation and used during the warning phase or in support of decisions during recovery when populations are fragilised and subsequent events are possible.

The largest single data source for on-going RASOR operations is expected to be the Sentinel missions, especially Sentinel-1 and 2 [2].

2.2. Demonstration sites

Five case study areas are considered for the platform development, located in Haiti, Indonesia, Netherlands, Italy and Greece.

- Within Europe, RASOR will allow for in-depth understanding of risk, integrating satellite and in-situ data in complex, scenario-driven, multi-hazard risk assessments, before an event, or as it unfolds.
- Outside Europe, especially in countries with little data, RASOR brings proven methodologies based on standardized satellite-EO data products that offer rapid, synoptic analyses to support European and global assistance before, during and after crises.

Once the feasibility of RASOR objectives is demonstrated in these areas, RASOR plans a second Phase to develop a global prototype available to support global applications.

3. THE RASOR PLATFORM OPERATION

RASOR makes use of a large amount of spatial data originated and used in different contexts, from satellite-based data to in situ measurements, from physically-based models to social information. In this perspective, availability, accessibility and interoperability of data/information between the involved data and systems is a key feature of the system, through the adoption of specific standards. Main examples are at a European policy level, the INSPIRE Directive and, at a technological level, Open Geospatial Consortium (OGC) standards; they both promote the distribution of data and information through standardized web services.

3.1. The platform architecture

The RASOR platform is a support tool for rapid risk analysis. It is formed by a cluster of software modules that interact between them in a transparent way to produce the requested output. The RASOR system makes extensively use of consolidated and flexible open source technology for data storing, publishing and sharing, such as Geoserver [3], Geonode [4], Thredds [5].

3.2. The Web interface

The RASOR Web Interface is designed to easily perform a step-by-step impact analysis. A user-friendly query system guides the user into simulations of possible future impacts, multi-hazard risk scenario building and impact assessment.

The user interface presents a collection of modules that deal with a specific task in the impacts analysis process:

- Monitor (opened as default)
- Exposure
- Hazard
- Vulnerability
- Direct Impact
- Systemic Impact
- Analysis

The first 4 module have been implemented so far, while “Systemic Impact” and “Analysis” will be implemented in the next versions.

3.2.1. *The Monitor module*

The Monitor Module is a consultation section that allows the user to access all the information on Hazard, Exposure, Impacts, which are already available in the system and can be used for further elaboration.

In the geographical domain selected by the user, the system and the system make visible the different available layers (according to the current level of zoom) of the three categories. A color coded scheme is used to recognize the categories (Figure 3).

3.2.2. *The Exposure module*

The exposure module is focused on assets characterization. These elaborations produce a description of the territory in vectorial format, with a predefined set of attributes characterizing the asset. These indicators are then used in the vulnerability module to build the vulnerability curves.

The user can import features from an external file (a prepared GIS layer), import from Open Street Map (OSM) or modify an existing layer. He is also asked to relate features of the original file with taxonomy required by the RASOR platform. A screenshot of the web interface is shown in Figure 4.

3.2.3. *The Hazard module*

The hazard module aims to compute hazard spatialisation either from simulated scenarios or from direct observations.

Data and information derived from direct or indirect observation (such as flood extent map generated from optical or SAR imagery) belong to the observed category.

Simulated hazard products can be generated thanks to several modelling chains embedded into the platform. The hazard that can be modelled within the platform are listed in Figure 5. An example of simulated output is moreover presented in Figure 6.

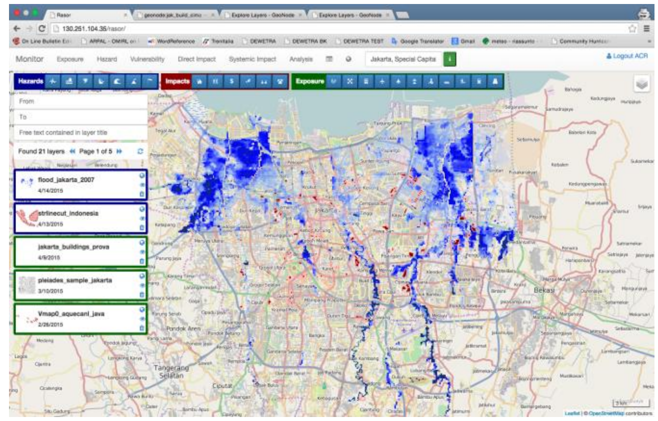

Figure 3. The *Monitor* module - The system displays a list of layers available in the selected geographic window.

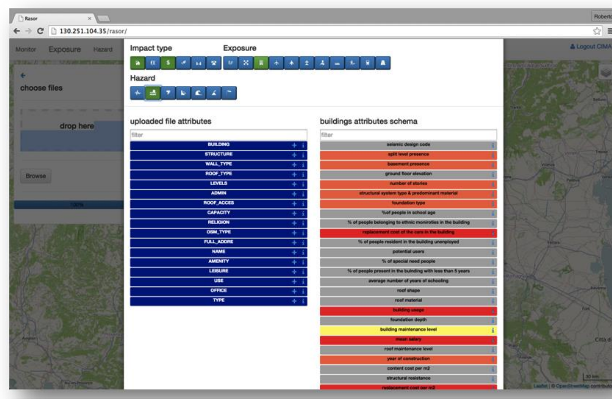

Figure 4. The *Exposure* module - when assets are imported into the platform, the user is asked to related the original features nomenclature (column on the left) with the RASOR taxonomy (column on the right).

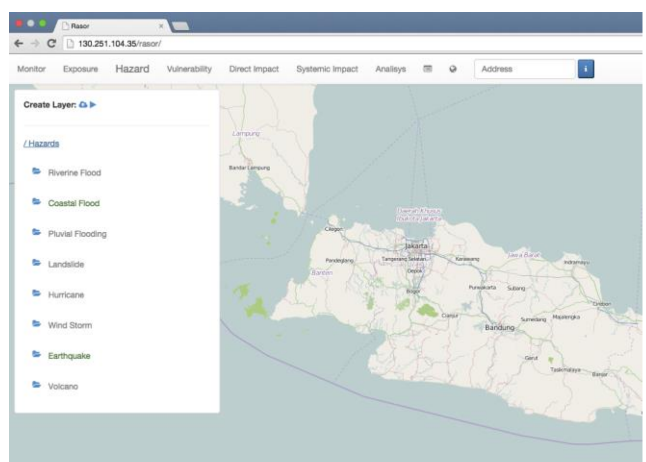

Figure 5. The *Hazard* module - List of modeling chains available in the RASOR platform.

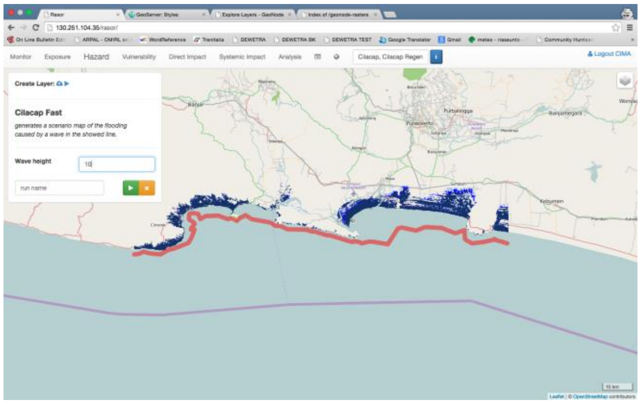

Figure 6. The *Hazard* module - Interface of tsunami module over Cilacap (Indonesia).

3.2.4. The Vulnerability module

This module aims at evaluating the asset characterization in terms of vulnerability curves and assigning the vulnerability curves to the exposure layer. The system is equipped with a set of vulnerability curves that the user can assign to each asset, depending on vulnerability indicators. The user can also modify or create new vulnerability functions and store them in a personal library. The assets can be evaluated and mapped with respect to their degree of vulnerability characterization and the possibility of applying the vulnerability curves (Figure 7). This functionality allows the user to detect where the selected vulnerability curves are applicable and what parameters (indicators) are missing for the applications of a given function.

3.2.5. The Impact module

This module combines exposure and hazard layers through the application of vulnerability functions in order to determine impacts on assets. Depending on the exposure characterization, the user can perform computation on physical, economical, social, environmental and functional impacts.

3.2.6. The Analysis module

The analysis module aims at the presentation of results in different formats in order to help understand the impact and to facilitate the decision making process. Further operations can be performed on a result workspace, in particular adding outputs at different scales for subsequent interpretation of the results. Graphs, tables, reports, etc. can also been generated at this step.

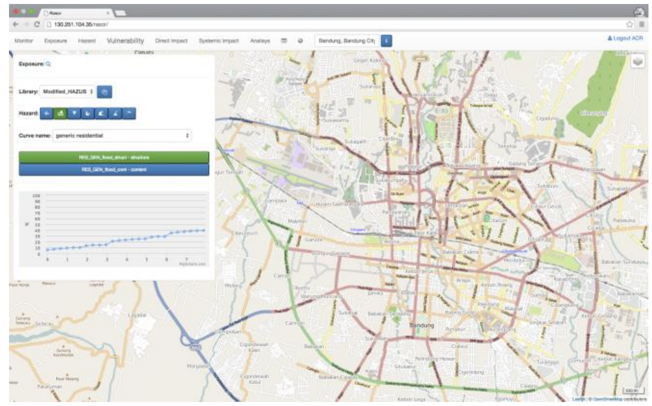

Figure 7. The *Vulnerability* module - The assets can be evaluated and mapped with respect to their degree of vulnerability characterization.

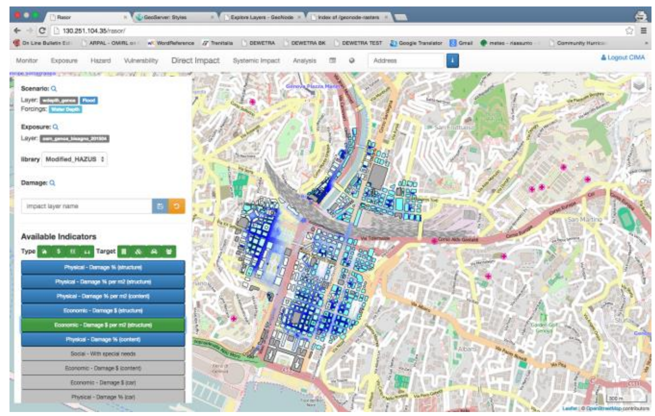

Figure 8. The *Impacts* module - Example of economic damage computation for buildings in the city of Genoa.

11. REFERENCES

[1] http://www.emdat.be/disaster-profiles.

[2] http://sentinel.esa.int/web/sentinel/home.

[3] http://geonode.org/.

[4] http://geonode.org/.

[5] www.unidata.ucar.edu/software/thredds/current/tds/.