**TASK #1**

Building virtual scenarios using free web-based sources of classical and unconventional geospatial data

**TASK 1** of the Digital Earth Action concerns the research and the analysis of free web-based sources of geographic information (GIS data) and the assessment of a possible information alternative based on non-conventional data present on the Internet.

The first part of the work has touched three main activities:
- A global look at the GIS data free distribution on the Internet, with particular attention to international projects.
- A selection of the most useful GIS data, for CIMA Foundation to elaborate scenarios for the Opera System. In particular, the research has focused on the ancillary layers, necessary to describe the studied environment as precisely as possible, and to define vulnerability and risk maps.
- A creation of information sheets containing the main sources of GIS data, divided by typologies, and reporting some useful information about them.

**TASK #2**

Definition of single element functionality response for flood damage evaluation

**TASK 2** of the Digital Earth Action focuses on studies of vulnerability and functionality at single element scale in case of flood hazard. Three variables determine the risk: hazard, vulnerability and exposure.

The vulnerability is defined as the degree of loss to a given element or set of elements at risk, resulting from the occurrence of a natural phenomenon of a given magnitude. It is expressed on a scale from 0 (no damage) to 1 (total loss) through depth-damage functions or vulnerability functions.

After a research of relevant literature and collection of significant depth-damage functions, a new methodology to create vulnerability functions able to describe the micro-vulnerability of an element (i.e. the vulnerability due to specific characteristics of the element) is proposed. The methodology studies the micro-vulnerability of single elements of the territory in a virtual way and consists in the following main steps:
- Identification and classification of elements at risk in point, linear and areal scales and their 3D-representation;
- Creation of sheets to allow micro-vulnerability assessment;
- Definition of specific vulnerability functions for each element;
- Definition of guidelines to modify vulnerability functions.

In an emergency, in addition to the estimation of the damage of the exposed element, it is useful to evaluate the residual functionality of it. Residual functionality indicates the function that the element is still able to perform once the flood event occurred.

Functionality studies are essential in emergency situations to define which element are able to perform its functions and how the loss of functionality of an element can cause difficulty to the entire territorial system.

Both a qualitative description - definition of range of high/medium/low residual functionality, giving guidance on accessibility to the building / road / area - and a quantitative description - creation of residual functionality curves that describe the relationship between residual functionality and water depth - of functionality are proposed.

The methodology is then tested in a case study, the flood occurred in the plain of Shkoder in December 2010. Through the use of software OWIS some exposed elements (buildings, bridges, ...) were extruded and specific vulnerability maps and damage map were created.

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**TASK #3**

Vulnerability assessment of infrastructure networks finalized to emergency management

The goal of the Digital Earth Action **TASK 3** is the development of a structured method to create a systemic vulnerability assessment of infrastructural networks subject to flood, starting from online GIS sources and satellite images.

In this approach the territorial system is modelled through the application of graph theory: roads, villages, buildings are the nodes of the graph while the edges are represented by their topographic connections.

The relevant territorial elements are those that play a significant role in the emergency management:
- service providers with active roles in emergency management: hospitals, clinics, first aid, fire ...
- subsystems which show a decrease in its functionality as a result of external stresses: water services from other sub-systems (schools, universities, residential areas or in general areas affected by a large influx of people);
- instrumental elements (roads, highways, railways ...).

The information related to the network is organized in a database, which contains tables specific for each type of exposed element, inside which it is possible to collect all the available information.

The response of the network to the external stress is evaluated by applying an algorithm developed in literature by Minciardi et al.[1], modified to receive in input the residual function of each network element, that is function of the considered hydraulic scenario through damage curves. The algorithm provides as output a value of residual efficiency for the active and instrumental element and a value of criticality for the passive elements, analysing the influence that each active node and instrumental exercises on the other nodes in the network.

The accessibility and the level of necessary information of this approach allow us to implement it in emergency management also in unknown areas.

The knowledge of the systemic response of a territorial system to a given external input, allows stakeholders to operate not only in emergency but also in prevention by implementing proper land planning and management and in mitigation carrying out a proper emergency management.

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