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Development of a WEB-GIS real-time dynamic landslide risk scenarios procedure – Umbria Region civil protection early warning system, a case study

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Umbria Region Functional Centre, part of the Umbria Region Civil Protection Dept., since 2009 has developed an experimental, operational early warning system for landslide risk assessment, named *PRESSCA* (*PRE*visione *Soil* *Slips* e *Contenuto d'Acqua*), based on rainfall thresholds, soil moisture evaluation, quantitative precipitation forecasts – QPF, and an open source WebGIS decision support subsystem/platform – DSS.

Rainfall thresholds were obtained by the analysis of past landslide events, correlated with their initial soil moisture condition reconstruction: observed and forecasted accumulated rain, together with modeled saturation index, compared with threshold values at different alert levels, lead to the production of early warning indicators, calculated at each point of a 738 grid covering the entire Umbria Region (approx 8000 sqkm).

The evaluation of the indicator grid values, is used on a daily base for the alerting state assessment over the six alert zones in which the regional territory is divided (main role of the Functional Centre); but, in order to take full advantage of all the available information layers useful for the hydrogeological risk evaluation, a real time scenario with high spatial resolution was developed too: every time that second-level rainfall thresholds are exceeded, the early warning indicators are used to start a procedure aimed at dynamic, real time risk scenario generation. A Linux API “inotify” waits for changes on warning indicators-thresholds ratio: if overtopping conditions are reached, the risk scenario procedure initiate a “bash” Linux script with all the commands aimed at generating and inserting the resulting geotiff on the web-gis platform.

Aimed to the generation of the risk scenario, Geospatial Data Abstraction Library (gdal library) composed by raster and vector utility programs, calculating risk from hazard, susceptibility and vulnerability layers is used.

More in detail, a procedure has been developed as follows:

Step #1: from early warning indicators (hazard information), a dense interpolated regular grid using inverse distant weight algorithm is used;

Step #2: in order to combine time-dependent landslide hazard with space-dependent landslide susceptibility, three different types of susceptibility layers are used (a regional-level raster layer of susceptibility developed by CNR-IRPI of Perugia; a regional-level raster layer of susceptibility, developed by the Functional Centre, obtained by combining slope from DEM, geological maps, landslide map information; a specific municipal-level raster layer of susceptibility for Perugia town, developed by CNR-IRPI and Perugia Municipality, aimed at generation of a specific local scale risk scenario).

Final step: Exposed elements/vulnerability information (from vector type layers of buildings, infrastructures, etc...) is used, able of leading to the generation of a dynamic (refreshing rate increased in case of event), real-time risk scenario.

Using the “gdal_calc.py” program, raster combined data produce the risk scenario layer. Then, real-time results are published on the web-gis platform (see Fig. 1).

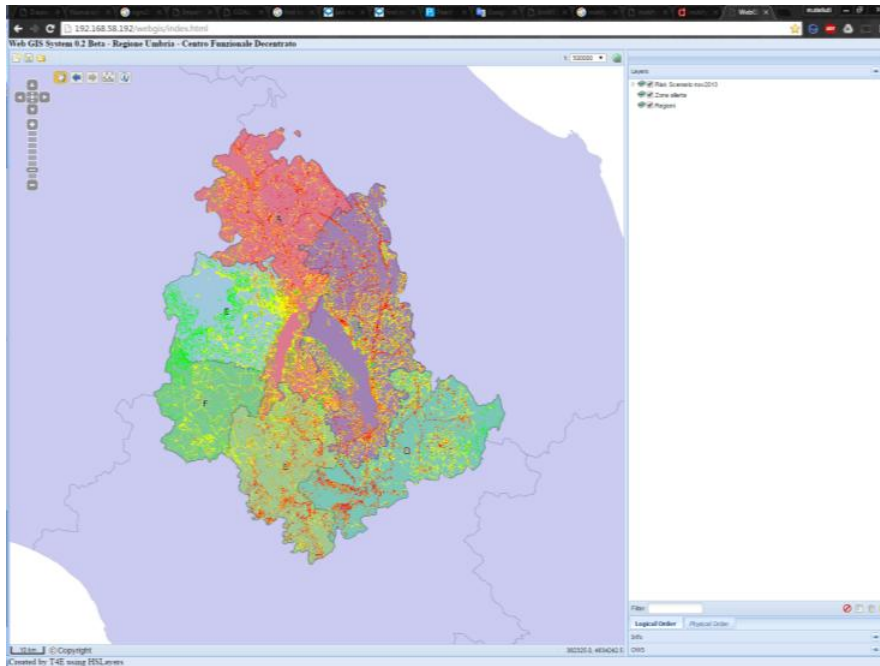


Fig. 1 – Real-time risk scenario obtained using early warning indicators, susceptibility and vulnerability layer developed by Functional Centre.

The reliability of final results is obviously very strongly dependent by the quality of the information layers, but general performances appear to be promising and satisfactory for Civil Protection purposes (alerting issues, emergency management, territorial presidium/direct monitoring of the territory organization, etc..).

Concluding, open source Web – GIS platforms appear to be an ideal tool in order to share dynamic hazard/risk scenarios with all the institutional subjects and stakeholders involved, and allow administrations to maintain sustainable and flexible operational systems.