The open geohazard widget to perform risk environmental analysis

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Abstract
In the framework of European project eENVplus (hhttp://www.eenvplus.eu) the Geological Survey of Italy and Geological Survey of Slovenia in collaboration with some technical partners developed a pilot to perform several geohazard analyses in the cross-border area. Several web processing services to perform hazard probability map have been developed using open-source software and a javaScript client widget based on Cesium1.11 to manage the pilot has been designed as well. The final data have been prepared in INSPIRE compliance format to be in line with European legislation and directive and data are provided with an open licence.

Introduction

Landslides are one of the most frequent and damaging natural events in Italy, Slovenia as well as in many other European countries. Landslide risk management is an important task in supporting Civil Protection during landslide events.

The aim of this processing service is to provide a landslide susceptibility map at 1:100k scale (starting from the approach of Komac & Ribičič, 2006). In areas, more prone to mass movement processes, such as landslides, rock-falls, and debris-flows, the map will be up-scaled to 1:25k scale.

The methodology, which has been implemented for the first processing service, is mainly based on the classification of mass-movements into two main categories based on the velocity of the movements. Rapid landslides, rock-falls, and debris-flows, due to their high velocity may affect population causing fatalities and structural and/or infrastructural damages. Slow velocity mass-movements principally concern losses of goods and infrastructures, because they involve re-activation of past landslide areas. Landslide susceptibility map
has been obtained by overlapping landslide areas with the harmonized geological map.

At the same time also flood risk assessment can be implemented on the basis of a thorough knowledge of the recent processes evolution mainly studying geologic and geomorphologic features. To identify the relationship between the flooding phenomena and/or fluvial areas where specific meteorological events occur, it is fundamental to consider both, past and recent responses of the catchment area mainly related to environmental changes as erosion and slope instability, basin evolution, human intervention.

This processing service compares data for the themes geology, geomorphology, morphometry, longitudinal and transverse profiles, floods and hydrology.
The comparison of these dataset allow the identification and characterization of critical sites in the vicinity of which areas of the alluvial plain have an increased risk of flooding.
The web services based on Open Source software, such as Geoserver, is expected to be used iteratively by an expert user through an open JavaSscript client. The user specifies the appropriate values for each parameter according to his/her experience or literature and evaluates the output of the automatic statistic process success rate. If the output map is not satisfactory, the expert user re-runs the process adjusting the parameter values according to the a-posteriori knowledge given by the previous outcome.

Flood and Landslide calculation procedure

This processing service related to flood prone area identification is composed by two steps:

- compare data for the themes geology, slope and geomorphology terraces (if they are available) to construct a general potential flood map;
- identification of major areas prone for flood occurrence based on the river basin sub-area classified using some morphometric parameters obtained by river network using geoprocessing: stream order average , stream bifurcation ratio and drainage density.

System calculates landslide susceptibility map (detailed geoprocessing model consisting of series of different geoprocessing modules, such as vector to raster, slope, reclassification, float, math based on Komac, 2006). Results and input data can be integrated into a Desktop GIS through WMS and/or WFS;
User is offered to accept the result or change the parameter values and start again the procedure. In figure 1 the processing diagram is shown; the external user can interact with tables for reclassification of geological and land-cover units according to landslide/rock-fall susceptibility:

a) System offers the user a reclassification table,
b) If some values are missing user can fill in or change values,
c) Or the values are calculated from cross tabulation of landslide data and geology (statistics)

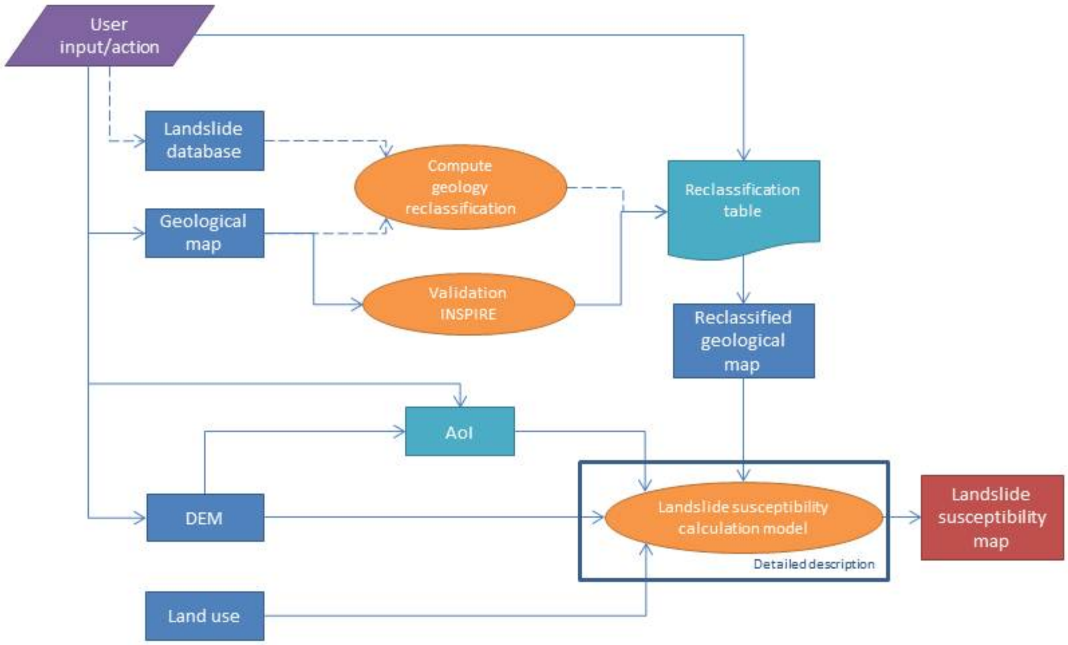

Figure 1 landslide susceptibility map processing procedure.

Web processing production:

To perform the two different analyses, a set of web processing services are developed, for each a workflow procedure has been written in python code and transformed in several Geoserver WPS based on existing Gdal library or new piece of code. All the codes developed during the eENVplus project are also available in a github repository (https://github.com/eENVplus) for any future extension or re-use. Beside that, most of the following web processing services are also available and discoverable using the showcase web page of the project (http://showcase.eenvplus.eu/client/).
To execute the flood prone area identification 3 WPSs are built to calculate first the flood prone area based on the geology input layer and then the topographic index based on DEM parametrers: (eep:ComputeFloodProneBaseMap; eep:ComputeTopographicIndexMap; eep:ComputeFinalFloodProbabilityMap).
Otherwise to create the susceptibility map and transform it in an INSPIRE conformant layer 6 different WPSs have been created to support the procedure; the first process is used to classify the input layers, the second and the third are needed to calculate the susceptibility model and validate it with own dataset. The last three WPSs are built to store the final map and to transform it in INSPIRE GML file. The complete list is shown below:

- eep:CreateReclassificationTable;
- eep:ComputeLandslideSusceptibilityMap;
- eep:LandslideValidation;
- eep:StoreSusceptibilityMap;

- eep:RasterToVectorGdal;
- eep:GmlInspireConverter.

Web client and data usability:

To orchestrate all the WPSs elaborated in the Italy-Slovenia cross-border pilot, a specific 3d Client based on the open source JavaScript library (Cesium 1.11) has been developed and customised. The flexible geohazard widget based on open source code to perform the two different scenarios has been developed and deployed (http://sgi.isprambiente.it/cesium/eenvplus/).

The widget developed, in fact, is able to manage different geohazard aspects: one for landslide analysis where the user can manage and manipulate the susceptibility classes of the input data (geology and land-cover) based on own experiences or analyse the geological parameters (i.e. consolidation degree or foliation classes) to better refine the map calculation.

The second procedure, which the user can perform in the widget, is the flood prone area identification; in this case the system is able in the first level to calculate automatically the flood prone map by a selection of geologic feature in the unified harmonised geologic layer. The second step is the procedure that calculates the water accumulation area (based on the topographic index from Tarboton, 1997) and where the users can manipulate the threshold of the model to determine better quality of layer to integrate with the previous one and produce the final flood probability map.

In the case of landslide moreover, when the user finds the final geohazard map optimal, the widget is able to store that map in INSPIRE NRZ standard format (JRC, 2013) applying the HazardArea Application schema to the WFS service and mapping the not structured Gml encoding of final maps in a standard way.

The major result of the web application is the flexibility of model applied, namely in the system we can modify the probability model used, building a new WPS and including this in the widget; the web application remains able to perform again the flood and landslide probability maps.

The INSPIRE WFS (OGC, 2010) and WMS (OGC, 2006) layer that are available in the client at the moment with CC-BY license represents another final result and it respects the main Open-Data requirements to provide public data useable.

References

CESIUM 1.11 (2015): *Cesium - an open-source JavaScript library for world-class 3D globes and maps.*

JRC - European Commission (2013): *D2.8.III.12 INSPIRE Data Specification for the spatial data theme Natural Risk Zones.* – Technical Guidelines v3.0. http://inspire.ec.europa.eu/index.cfm/pageid/2

KOMAC, M. (2006): *A landslide susceptibility model using the Analytical Hierarchy Process method and multivariate statistics in perialpine Slovenia*. Geomorphology, 74, 1– 4, 17 – 28.

KOMAC, M. & RIBIČIČ, M. (2006): *Landslide susceptibility map of Slovenia at scale 1:250,000*. Geologija, 49/2, 295–309.

OGC (2006): *OpenGIS® Web Map Server Implementation Specification*. OGC® 06-042, pp. 85, Open Geospatial Consortium (http://www.opengeospatial.org/standards/wms).

OGC (2010): *OpenGIS Web Feature Service 2.0 Interface Standard*. OGC 09-025r1 and ISO/DIS 19142, pp. 239, Open Geospatial Consortium (http://www.opengeospatial.org/standards/wfs).

Tarboton, D.G. (1997): *A new method for the determination of flow directions and upslope areas in grid digital elevation models*. Water Ressources Research, Vol.33, No.2, p.309-319

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