

VISUALIZATION

OVERVIEW

The “RiskChanges” Visualization Module is a combination of methods and techniques, which enable the end-users to query, visualize and compare the risk-related data within the SDSS. Basically it consists of front-end web-GIS applications, designed for the particular type of data and the connection to the database and the geoserver for data retrieval and visualization.

The main goal within this work was exploit the large amount of data in relation to the needs of the end-user and apply a proper visualization technique.

The technologies used for the development of the visualization component combine the latest and most innovative open source JavaScript frameworks, such as OpenLayers 2.13.1, ExtJS 4 and GeoExt 2. The model–view–controller (MVC) pattern is used in order to ensure flexibility of the system at the implementation level.

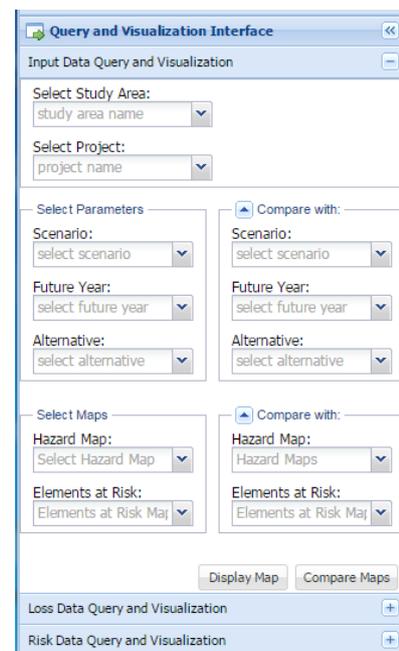
Using the above technologies, the visualization techniques implemented so far offer **data filtering**, **interactive map navigation**, **querying** and **comparison tools**. The map comparison tools are of great importance within the SDSS and include the following: a swiping tool for comparison of different data of the same location, a linked views tool for comparison of data from different locations and a time slider tool for monitoring changes in spatio-temporal data. All these techniques are part of the interactive interface of the system and make use of spatial and spatio-temporal data.

DATA FILTERING

A large number of data sets are stored in the database and published to the GeoServer after the first two stages of the use of the system (Data Uploading and Loss/Risk calculation). This complicates the data navigation process. In order to simplify it, the visualization module included a filtering tool, which guides the end-users through a querying mechanism and leads to the visualization of desired data.

The querying interface reflects the database structure of the SDSS and starts with the selection of the study area and the project. The user is required to specify the visualization parameters, which are determine by the particular data category. The three data categories are listed below:

- the **input data** is the data uploaded to the system at the initial phase
- the **loss data** is the data resulting after the loss calculation module, and
- the **risk data** derives from the risk analysis module.



The screenshot displays the 'Query and Visualization Interface' with the following sections:

- Input Data Query and Visualization:** Includes dropdowns for 'Select Study Area' (study area name) and 'Select Project' (project name).
- Select Parameters:** Includes dropdowns for 'Scenario' (select scenario), 'Future Year' (select future year), and 'Alternative' (select alternative).
- Compare with:** Includes dropdowns for 'Scenario' (select scenario), 'Future Year' (select future year), and 'Alternative' (select alternative).
- Select Maps:** Includes dropdowns for 'Hazard Map' (Select Hazard Map) and 'Elements at Risk' (Elements at Risk Maj).
- Compare with:** Includes dropdowns for 'Hazard Map' (Hazard Maps) and 'Elements at Risk' (Elements at Risk Maj).

Buttons for 'Display Map' and 'Compare Maps' are located below the 'Select Maps' and 'Compare with' sections. At the bottom, there are expandable sections for 'Loss Data Query and Visualization' and 'Risk Data Query and Visualization'.

Figure: Data filtering interface

INPUT DATA FILTERING

By input data in the visualization module is meant the spatial data uploaded to the system at the initial phase. It consists of hazard maps in raster format and elements at risk of a particular study area in vector format.

The first action in the input data filtering and visualization is to specify the study area and the project. After this step, the available scenarios, future years and alternatives populate the respective combo-boxes of the UI. At the next step, when scenarios, future years and alternatives are specified, the user should be able to select the hazard and the element at risk maps in the respective fields. Multiple selection is also possible for these last two fields.

Finally, by selecting the desired hazard maps, and/or the elements at risk, the user is able to visualize them through the single map web-GIS application by pressing “Display Map”, or compare different input data by completing the second field-set and press the “compare maps” button.

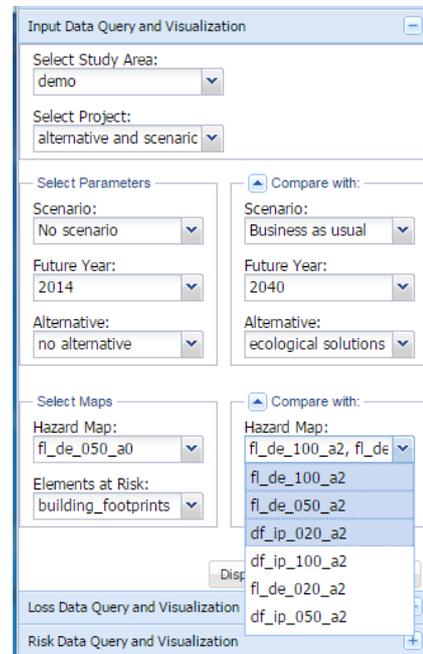


Figure: Input data filtering

LOSS DATA FILTERING

Similarly to the input data query and visualization, the loss data requires the specification of the study area, project, scenario, future year and alternative.

At the second stage, parameters such as hazard type, return period of the hazard map, elements at risk and loss type (physical or economical) should be indicated in order to visualize the desired loss map.

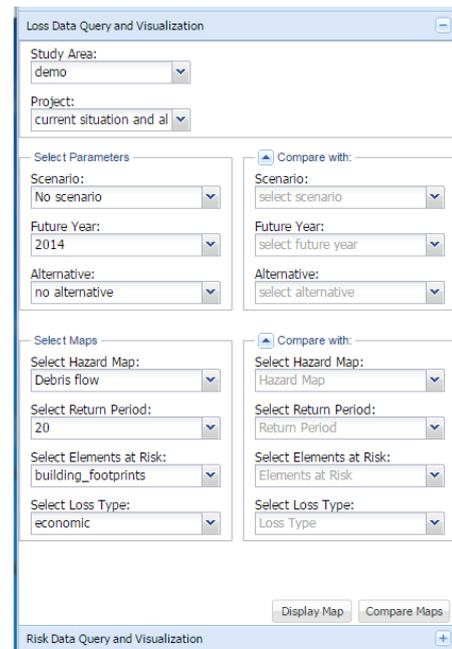


Figure: Loss data filtering

RISK DATA FILTERING

The procedure of querying the risk data is similar to the previous two. It requires, obviously, the a priori risk calculation.

Again, in the UI, study area and project should be indicated at the beginning. Then, the user is asked to identify name of the risk analysis, which was given during the risk calculation process. Next step stands for scenario, future year and alternative selection. Afterwards, the user should specify the hazard type and the elements at risk, select exposure or loss, give the unit type, and finally visualize the available risk maps.

The screenshot displays a web-based interface titled "Query and Visualization Interface". It features a sidebar on the left with three expandable sections: "Input Data Query and Visualization", "Loss Data Query and Visualization", and "Risk Data Query and Visualization". The main area contains several dropdown menus for configuration:

- Study Area:** nocera
- Project:** alternative and scenario
- Risk Analysis Name:** test3
- Select Parameters:** Most realistic, 2030, no alternative
- Compare with:** select scenario, select future year, select alternative
- Select Maps:** Debris flow, Elements at Risk Map, Exposure or Loss, Unit Type, Available Risk Maps
- Compare with (Maps):** Select Hazard type, Elements at Risk Map, Select Exposure/Loss, Select Loss Type, Available Risk Maps

At the bottom right, there are two buttons: "Show Risk Map" and "Compare Risk Maps".

Figure: Risk data filtering

SINGLE MAP VISUALIZATION

Single Map Visualization is the simplest web-GIS application, which draws/renders the layers selected in the querying interface. It contains the map region, the map toolbar, layer tree and the legend.

This application is built using the GeoExt library, which combines OpenLayers and ExtJS. The MVC pattern is followed as much is possible, as to provide flexibility and code-reuse.

The map is updated every time the user selects spatial data from the query and visualization interface and presses the "show map" button.

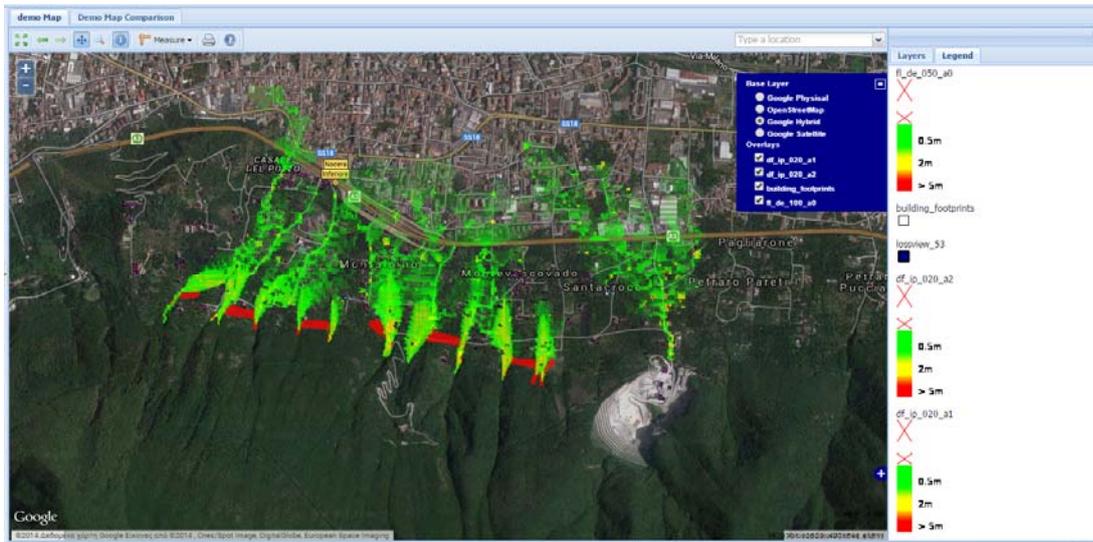


Figure: Single map visualization

MAP INTERACTIVITY

The map interactivity, basically, is the overall actions performed when interacting within the web-map region either by the mouse click or the keyboard. The actions triggered by mouse click are displayed in the map toolbar (see figure below). The actions triggered by the keyboard are related to map navigation and are shown in the following table.



Figure: Map Toolbar

Table: Map toolbar	
Action	Description
Zoom to full extent	Displays the existing layers at their extent.
Previous navigation state	Previous zoom or pan
Next navigation state	Next zoom or pan
Pan	Pan
Window Zoom	Zoom in according to the drawn polygon
Feature information	Window popup containing feature information on the clicked item.
Measurement tool	Measures the length and the area of a drawn shape (line or polygon)
Print	Generates a pdf file of the visible screen
Help	Opens the visualization module document

Table: Map actions triggered by keyboard keys

keyboard key	Action
+	Zoom in
-	Zoom out
→	Move right
←	Move left
↑	Move up
↓	Move down

LAYER CONTEXT MENU

The layer context menu is the menu appearing on the right-click on the particular layer listed in the layer tree (figure below). The options are: zoom to layer, change layer style, remove layer and change layer transparency.

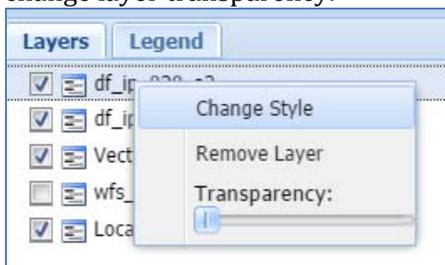


Figure: Layer context menu

ZOOM TO LAYER

Zoom to layer action is executed for each layer in the layer tree on double click. The function uses the WMS capabilities store to retrieve the layer name and its bounding box, then the OpenLayers "zoom to bounding box" function is executed.

CHANGE LAYERS STYLE

Changing the style of a particular layer can be performed by choosing the "Change Style" option in right click context menu. A list of available styles from the Geoserver will appear in a combo-box (see below).

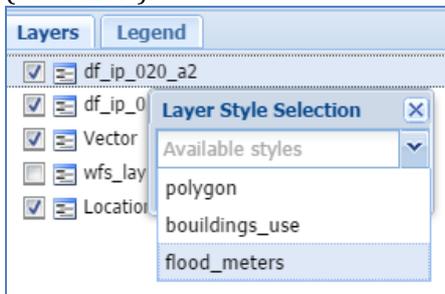


Figure: Change Layer's Style UI

REMOVE LAYER

The "remove layer" action will remove the overlay layer from the existing map.

CHANGING LAYER'S TRANSPARENCY

The transparency of each layer can be changed by using the transparency slider.

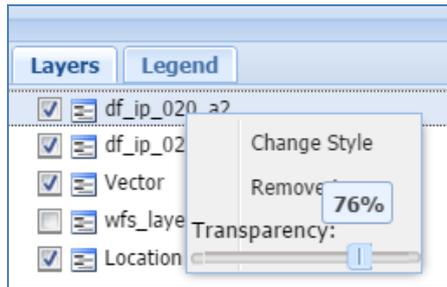


Figure: Transparency slider

MAP COMPARISON

Map comparison is composed by three different web-GIS applications: layers comparison, side by side maps comparison and time series animation.

LAYERS COMPARISON

This application is composed by two map objects, each created by the layers selected in the Query and Visualization interface (see figure below).

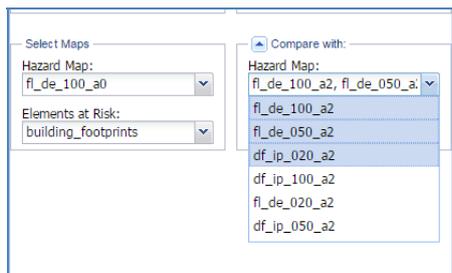


Figure: selecting maps for comparison

The layers selected in the left field-set correspond to the left map and the ones selected in the right field-set, to the right map. The center of the second map is located at $\frac{1}{2}$ window distance from the first map, giving thus the impression of overlay. By making the two windows that hold the maps resizable, the interface can be used as a swiping tool.

The advantages of this method is that layers can be changed/updated on both sides and actually multiple layers are being compared, while with the swiping tool only two layers at a time can be compared.

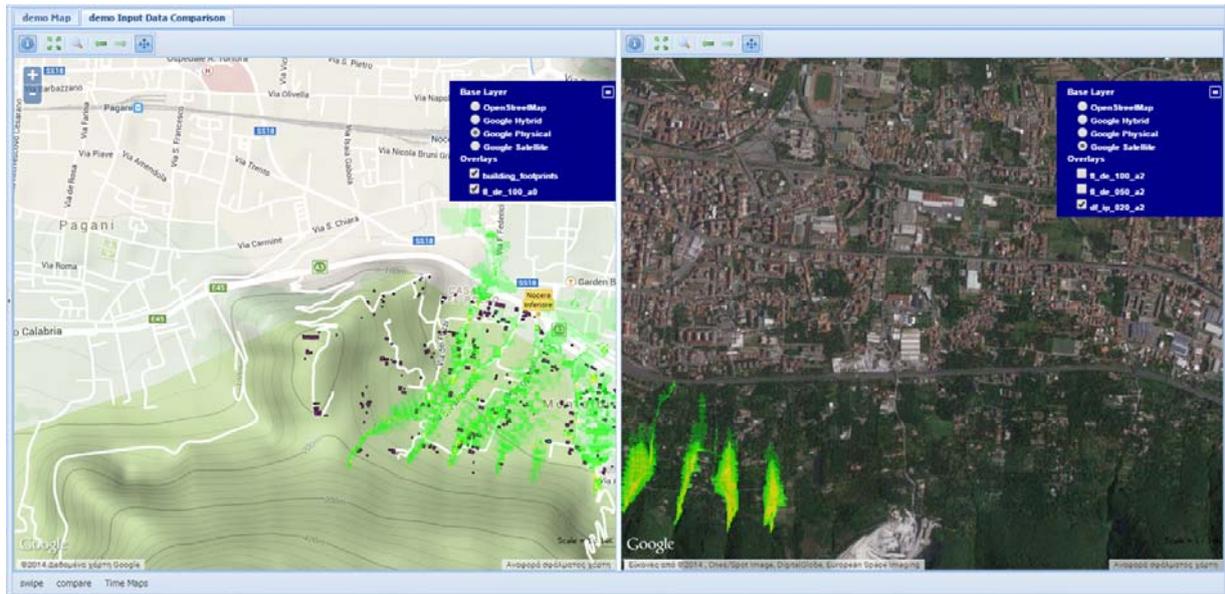
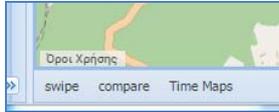


Figure: Layers' Comparison

SIDE BY SIDE MAPS COMPARISON

The idea is similar to the layers' comparison tool. The difference is that, from the technical point of view, the coordinates of the center of the second map are exactly the same with the first map. Thus, different layers of the same region can be compared at their extent.

Here two interactive maps are created from the selected layers in the Query and Visualisation Interface. The option is available by pressing the “compare” button in the bottom left corner (by default the layers comparison or “swiping tool” is activated).



The user can use the navigation tools (zoom in, zoom out, pan, navigation history, zoom to full extent) on one map and the other map will be automatically updated. Moreover, the Info button can be used on both sides, as to better understand the differences between maps.

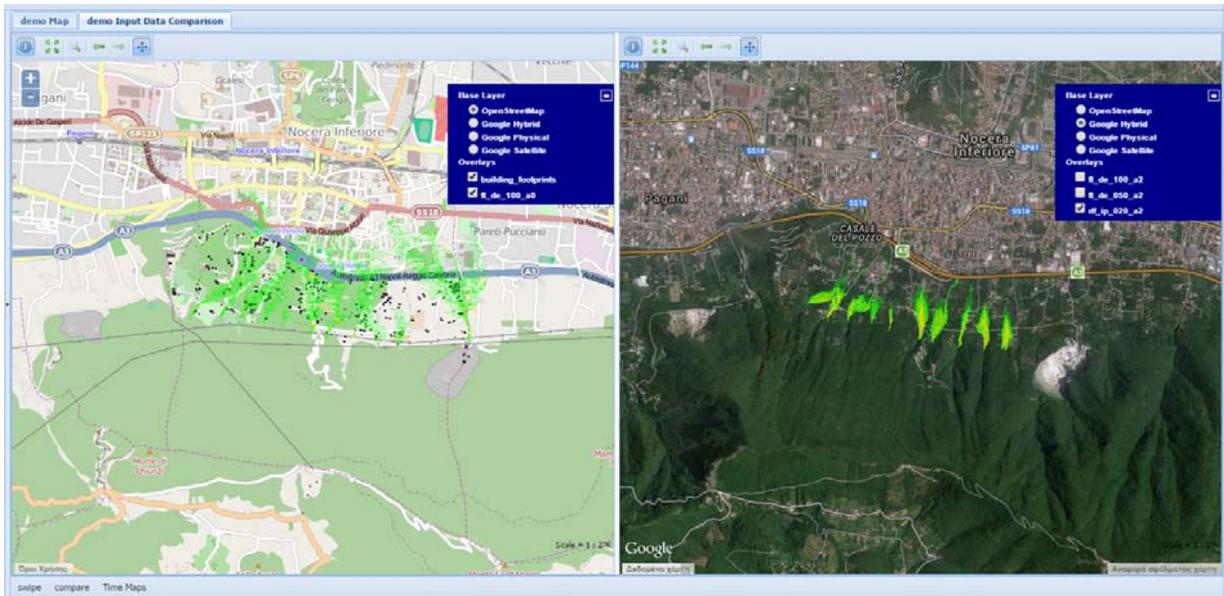


Figure: Side by side map comparison

TIME SERIES ANIMATION

The differences in data can be detected through time animation by selecting layers in the Querying and visualization interface. The implementation is based on the generation of an animated gif image from the multiple layers in the WMS request.

The animation option is available by pressing the “Time Maps” button in the bottom left toolbar (figure below).

