FUPOL SIMULATORS AND ADVANCED VISUALIZATION FRAMEWORK INTEGRATION

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ABSTRACT

FP7 FUPOL project No.287119 (see www.fupol.eu) aims at a new approach to traditional politics modeling. The FUPOL will be able to automatically collect, analyze and interpret opinions expressed on a large scale from the Internet and social networks. This will enable governments to gain a better understanding of the needs of citizens. Likewise the software will have the capabilities to simulate the effects of policies and laws and to assist governments in the whole policy design process. Basic visualization of the simulation results are supported by the simulators however visualization facilities are limited, therefore for detailed visual analysis of simulation data SemasVis environment is used.

Keywords: simulation, visualization, policy modeling, SemaVis

1. INTRODUCTION

The policy modeling process and lifecycle respectively is characterized by making decisions. The decision making process involves various stakeholders, that may have diverse roles in the policy making process. The heterogeneity of the stakeholders and their “way of work” is a main challenge for providing technologies for supporting the decision making as well as technologies to involve various stakeholder in the process.

Policy use case models depending on the domain could be described as discrete or continuous, and determined or stochastic systems. For simulation of the above-mentioned models different and heterogenic simulation tools could be used.

Simulation of scenarios can ask for collaboration of some separate simulation models joining for implementation of the task or policy domain use case. Therefore distributed and multi-level simulators can be designed (Aizstrauts et al. 2013). The simulation would be ensured at two levels: micro and macro simulation levels. In the micro level the Agent-Based/ Multi-Agent Simulation (ABM/MAS) operations related to versatile and small basic components interaction and forecasting of the interaction results will be carried out. Although ABM/MAS could be used for forecasting of continuing changes the system dynamics (SD) use would be reasonable. At the macro level (if it is necessary) the SD simulation can be implemented. Moreover, the micro level would be the data source for the macro simulation model. If the scenario establish simultaneously use the set of models then distributed simulation can be realised using Easy Communication Environment (ECE) (Aizstrauts and Ginters et al. 2012).

2. ADVANCED VISUALIZATION

Advanced visualization techniques provide helpful instruments for the various stages of decision making and active participation of citizens in the policy creation process (Burkhardt et al. 2013b, Kohlhammer et al. 2012).

2.1. Visualization of Semantics

The representation of domain knowledge is a simplification and abstraction of the real world. Certain aspects and features of the real world that are deemed important or helpful to represent a domain are emphasized while numerous facets of that same domain have to be neglected. The distinction between relevant and irrelevant is represented in the domain ontology. Thus, for a computer system this domain ontology can define what entities exist and what they are called. Such representations form the semantics that guide information visualization techniques to visualize the important and hide the unimportant. The successful and efficient use of semantics for information visualization is still a major challenge in this current field of research (Keim et al. 2006, Kohlhammer 2012).

The SemaVis framework (Nazemi et al. 2014) is designed to visualize semantic information by offering effective navigation and interaction mechanisms. A special feature consists in the adequate visualization for different user groups with different preferences and background knowledge, both in terms of information to be displayed as well as in interacting with the visualizations. These users and user group orientation with customizable look and feel of principles had been developed and integrated into the SemaVis framework (Nazemi et al. 2010).

The SemaVis pipeline structures the process of semantic information processing towards an adapted visualization in three steps (see Figure 1): Semantics, Layout and Presentation. Semantics processing extracts information of the semantic data sources which are needed for the visualization of the data. The identified and extracted information are enriched in layer layout with graph and visualization layout information. At presentation level the visual presentation of data is determined (Nazemi, Stab and Kuijper 2011). At presentation level the visual variables of data is determined. This might be hue, saturation, color value, size, shape, etc. but also the 'visual behavior' of the elements, for example a highlighting of selected elements by a modified transparency value. The Presentation takes into account constraints and preferences from the user, unless the information is stored by a user model or community model and can be queried (Nazemi et al. 2011a), and even more the data characteristics (Nazemi et al. 2011b).

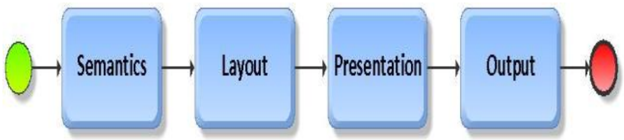

Figure 1: SemaVis Transformation Pipeline for Semantics Data Processing

2.2. Visualization of Heterogeneous Data

Visualizing structured data is beneficial for the user, but often data-sources contain additional data too, e.g. statistics or multimedia data. These additional data provides also additional information that leads to an improved information gathering, because the user can analyse further information for her his data analysis purposes.

In particular for Open Government Data (OGD) it is essential to consider that an overview about the existing indicators and the statistical data can result in a significant better understanding about a given problem. For such kind of heterogeneous data, it is essential to consider next to a visualization pipeline that generates the visualizations, also an interaction strategy to provide users with intuitive navigation possibilities through data. Therefore, we enhanced the semantics visualization pipeline with Shneiderman’s Information Seeking Mantra (Shneiderman 1996). In fact, the user starts his interaction with an overview about the hierarchy of indicators (see Figure 2). By navigating though the hierarchy and selecting his preferred indicators, he makes zooming and filtering on data level. The final step is the concrete (detailed) analysis of the statistical data.

2.3. Simulation Data Visualization

A specific challenge is the visualization of simulation data. On the one hand it is comparable to OGD visualization, because internally specific kinds of indicators are calculated as a future prediction. However, it is also different. OGD bases consist only about a time-based data-table. In simulation context also aggregated statistics are available in form of concepts. In fact, the visualization and the internal data-model have to consider a timely data provision (in an historical manner) or in abstracted form by category, which has a significant impact on the visualization, because some layout algorithms are not designed to illustrate data on categorical level.

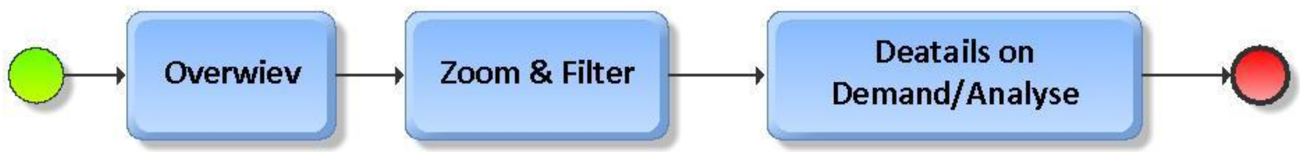

Figure 2: Overview-to-Detail Approach for the Visualization Interaction in Statistical Data to Provide an Intuitive Drill-Down Strategy in SemaVis to Find Relevant and Necessary Indicators

In a first inclusion of simulation data for visualization, we defined a similar API as many OGD portals do provide. A hierarchy for all available simulated data aspect was defined and is provided for the visualization. Even more, to each category all available simulation indicators are linked and can be chosen for the visualization. These simulation indicators are also similar to OGD bases. They hold the concrete data about the simulated aspect by time or category. If the user is selects a concrete indicator, the statistical data is loaded from the server and represented in the statistical visualizations.

A major advantage of the visualization is the form of an interactive dashboard (Nazemi et al. 2010 and Burkhardt et al. 2013a) that allows orchestration of the visualization in a personal preferred manner. Under this concept, the user can select and arrange visualizations about the indicator hierarchy, the meta-information about a selected indicator, the indicator data from an OGD portal (if available) and the simulation indicators at the same time and in depend of the user's preferences.

To request the data the web-API of the Simulator and SemaVis are used (see Figure 3).

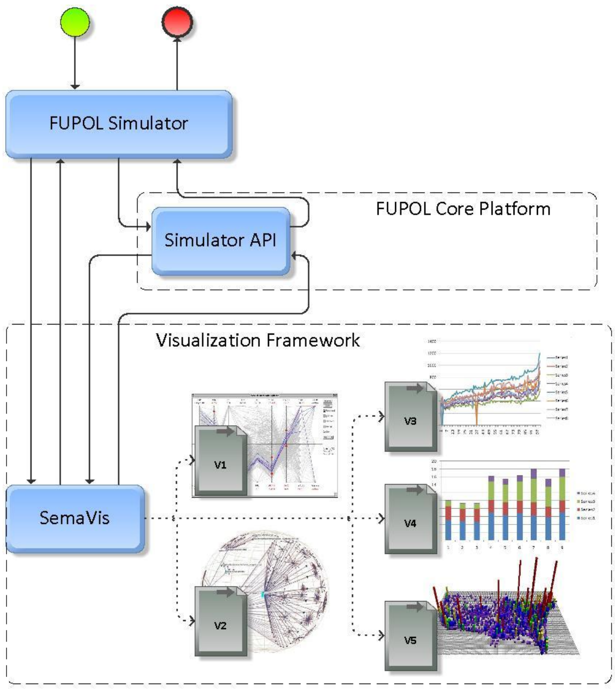

Figure 3: Visualization of Heterogeneous Data

The APIs of the simulator and SemaVis can be used directly or through the proxy at the FUPOL Core Platform.

Overall, the SemaVis API offers the control and access to internal information and states by external applications. Here the actionscript API is used which allows to trigger changes or to ask for state information at runtime. It distinguishes between internal events and actions propagated to the external system, internal state information propagated to external applications; external events and actions propagated to the SemaVis visualizations as well as external state information (which should be handled like an action within SemaVis) propagated to SemaVis visualizations.

External or third party systems can be connected to SemaVis and adapt the framework for application-specific purpose. SemaVis offers the control of and access to internal information and states by external applications.

SemaVis is a visualization framework executed on client side as Adobe Flex application within the browser. The communication between SemaVis and the Simulators is realized by the use of CSV files and Simulator API providing two ways of integration to ensure reliability through the reservation of visualization channels (see Figure 4).

Figure 4 shows action and data flow to load and present simulation results with SemaVis framework. SemaVis is embedded as Adobe Flash application in Skopje Vodno Mountain Recreational Activities simulator which is web based application. After the simulation user is able to see the advanced visualization (SemaVis application) for particular simulation. BPMN2 flowchart (see Figure 4) has three level activities – SemaVis, FUPOL Core Platform (WP3) and Simulator. SemaVis level represents all activities related to SemaVis application, Simulator level shows all activities related to simulation data gathering. WP3 level works as data distribution, it manages all connections among all components. There are no direct connections between external component (e.g. SemaVis application) and internal system (e.g. simulator).

When the SemaVis application is loaded, simulation ID is passed to it, so that SemaVis can load data for this particular simulation. With given simulation ID SemaVis application makes HTTP request for data dictionary which explains data structure. This data dictionary is formatted as XML document (Figure 4 uses index.xml as a document name). Below see an example of such data dictionary document:

```
<xml>
<geolocation>Skopje</geolocation>
<category name="Occupancy">
category name="By day">
<indicator name="Monday"
url="/data/day1.csv?sim=1234" />
...
<indicator name="Sunday"
url="/data/day7.csv?sim=1234" />
</category >
</category >
</xml>
```

This request for data dictionary is handled by FUPOL Core Platform proxy who is used as performance booster (caching responses) and security by filtering who is allowed to use simulator. Core Platform requests simulator API for data dictionary by passing simulation ID to it. Simulator generates data dictionary (index.xml in Figure 4) for particular simulation. Data dictionary contains data structure and URLs for indicators. Data structure only describes what data is going to be visualized, what structure it has, but does not have any raw data within, the last entity in data structure is an indicator – link to raw data. Raw data are in CSV format.

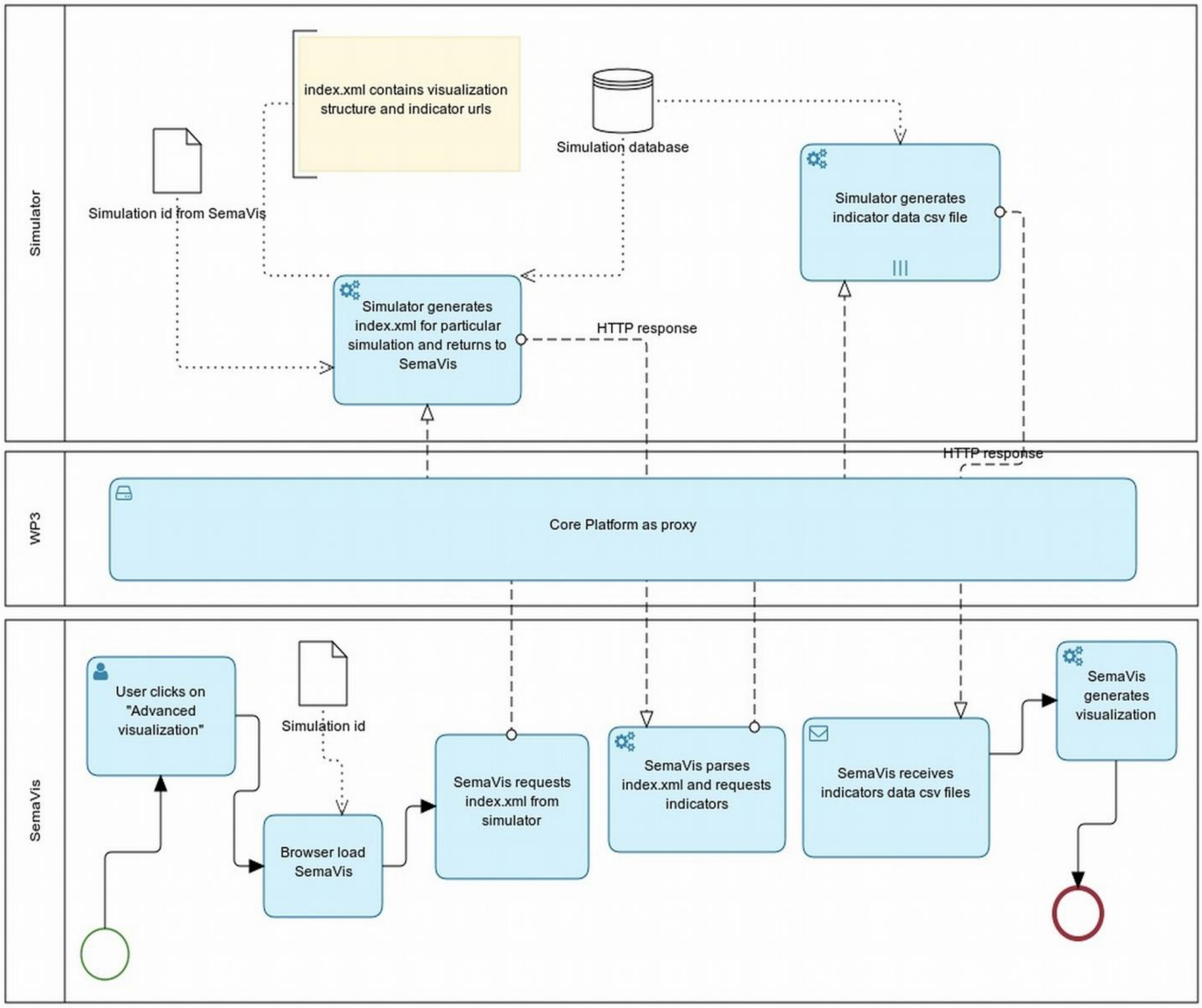

Figure 4: Simulators and SemaVis Interaction Diagram

When the simulator has built the data dictionary it returns dictionary to the SemaVis through FUPOL Core Platform and SemaVis receives data dictionary as HTTP response. SemaVis application parses data dictionary and builds structured data entities. For each indicator entity SemaVis makes a HTTP request for particular raw data. This request also goes through the FUPOL Core Platform and ends up to specific simulator API that generates raw data for each particular indicator. When the raw data are ready then the simulator returns them to the SemaVis application (through FUPOL Core Platform) and they are ready to be visualized.

3. VISUALIZATION OF SKOPJE VODNO MOUNTAIN RECREATIONAL ACTIVITIES SIMULATION RESULTS

The approach described above was verified designing Skopje Vodno Mountain Recreational Activities simulator (Ginters et al. 2014).

The main objective of the Vodno Mountain simulator design was elaboration the solution that offers the City of Skopje a possibility to realize a better schedule of resources and plan of activities on Vodno Mountain, which is located to the southwest of the capital city Skopje. The simulator offers to Skopje citizens the opportunity to forecast the occupancy of the recreational resources on Vodno Mountain and suggest new schedule, new ideas to the administration of City of Skopje. The system would help the administration of City of Skopje in improving the scheduling and resource planning, initiation and creating new projects involving the recreational area at Vodno Mountain. The citizens of City of Skopje also are involved in the decision making process by constant communication and expressing their opinion to the authorities, making the whole process more transparent and efficient.

The simulation is realized by using a simulation agents that simulates a typical behaviour of a person from a given user group. The agent's behaviour depends on the type of the simulation, with a specific input and output parameters. There are two types of simulations called Simulation 1 and Simulation 2. The Simulation 1 spans through the period of one year. Only hourly average data obtained by simulation are recorded and available for visualization. Simulation runs with random selection of input parameters within a defined range, such as, simulation of a weather condition, or agent behaviour. The input of this simulation is a complete simulation configuration. All parameters are simulated according to their behaviour and range of defined values. Citizens can initiate the Simulation 2. This simulation spans through a period of one week within a selected month. Users can change several parameters, such as desired weather, month selection, or number of persons in a certain user group. After simulation, the result data is available for visualization and users can see the effects of the changes.

The main kind of embedded visualization is map of Vodno Mountain recreational area allowing showing the routes and occupancy the resources using pie charts (see Figure 5).

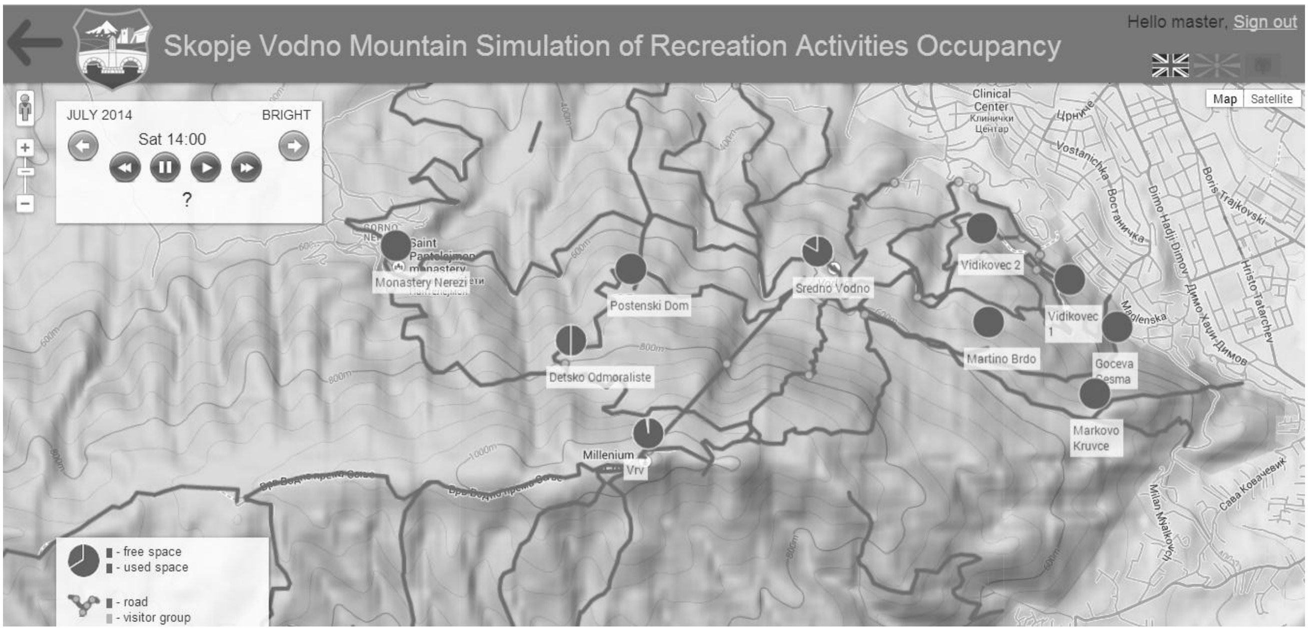

Figure 5: Resources Occupancy Map of Vodno Mountain Area

Figure 5 represents the situation in Vodno Mountain in particular timeslot. Pie charts represent occupancy of the resource (e.g. hotel, restaurant, etc.), black lines represent trails and the white icons represent activity for each particular user group in this current timeslot. In this example there are three user groups with the bicycle activity and four hiker groups.

However, detailed analysis of simulation results seeks/requires for more versatile visualization that is ensured by integration with SemaVis (see Figure 6).

Figure 6 shows an example of SemaVis application integrated with Skopje Vodno Mountain Recreational Activities simulator. SemaVis application screen consists of several (manageable) blocks. One of the blocks contains an integrated simulator with simulation results; other blocks around it contains different visualization for this particular simulation. User can add new visualization approaches, choosing from the right side menu. In this example (see Figure 6) there are four data representation blocks, besides simulator block, data structure block, data structure as graph block, raw data table block, line chart block and candlestick chart. All of these blocks are related to simulator block.

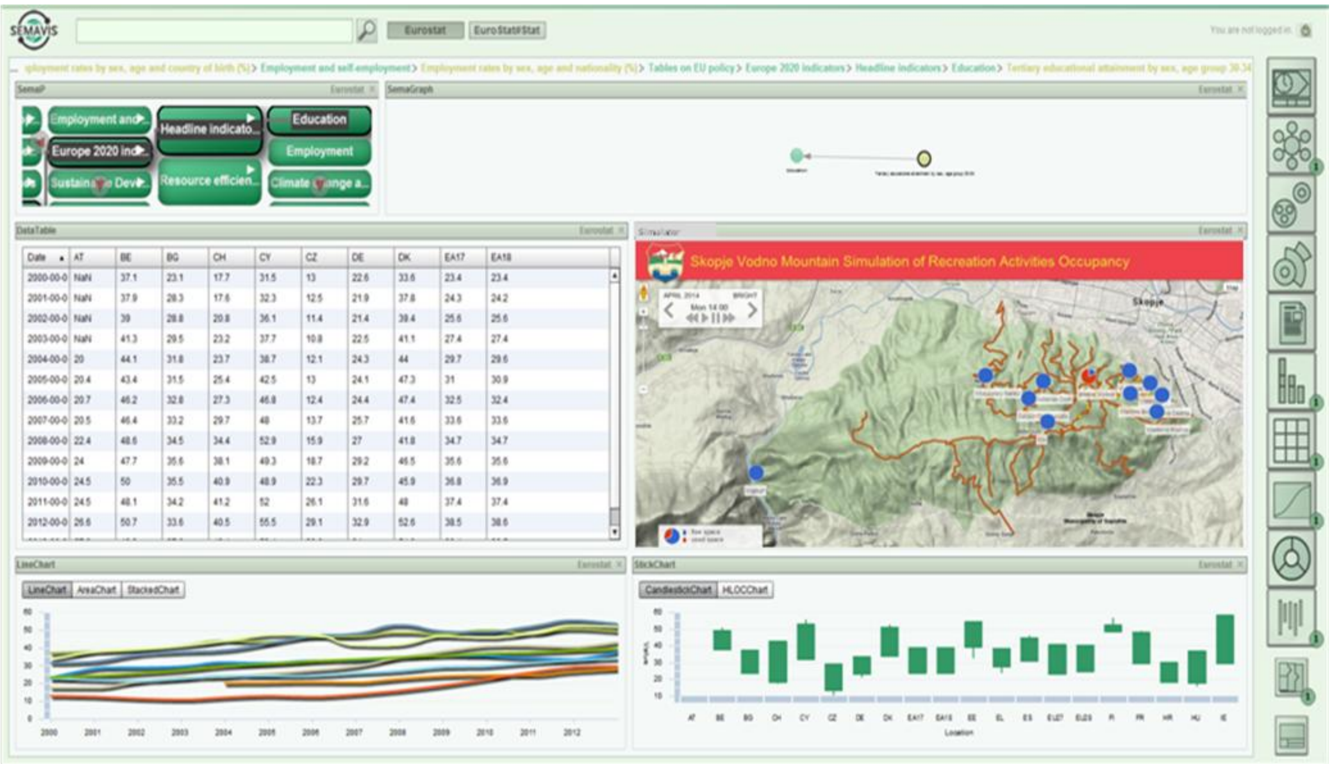

Figure 6: Vodno Mountain Simulator Integration with SemaVis

The approach mentioned above ensures interactive visualization of simulation results as statistical data. The visual analysis of the results can be performed: drilling-down navigation to select the relevant indicators; identifying of relevant influencing factors or impacts; interlinking of various data-sources for an advanced information acquisition and context comprehension; combining of an analysis cockpit to see the data from “different perspectives”.

4. CONCLUSIONS

In situation of ambiguous potential solutions and significant amount of important influencing factors the simulation is right tool for possible trends and features interactive identification.

Even the best solution can remain misunderstood if it will not be displayed in the language and form clear for the user.

One of more traditionally efficient form of perception is visual. However this is necessary requirement only, because difficult and multilayer results must be shown in understandable form in conformity with the user’s requests.

The visualization functions built-in in simulators are limited, therefore for visualization of versatile and intelligent data the use of specific visualizations tools is reasonable, for example, SemaVis in FUPOL case.

If the simulator is Open Source Software (OSS) tool, but visualization environment belongs to commercial products then for the integration CSV formats can be used that does not break the rules of commercial license.

Respecting development of Virtual and Augmented Reality (VR/AR) solutions the next step could be use of VR/AR authoring platforms for simulation results visualization.

Nevertheless more or less standardization activities must be carried out before related with simulation tools connection alignment with VR/AR environments. Unfortunately this is the future of research which must be implemented together with Future Internet standardization.

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