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Integration of Web Map Application and Simulation Modeling Tools for Sustainability Analysis in Regional Development

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Abstract

The sustainable development or sustainability has been highlighted as an essential principle in urban planning and regional development. Integration of Web map application and simulation modeling tools is essential for the analysis of sustainability in regional and rural development. The parameters and conditions of these areas are continuously changing. Design and development of a Web map application as part of Geographic Information Systems (GIS) is a complex activity and requires innovative approach for requirements identification. Enterprise modeling captures these ideas and offers tool for structuring of goals and definition of requirements. Simulation is used as an active research method, when the analytical solutions are unconvincing or even not possible. Integration simulation modeling tools in the web map application is challenging process as many of stakeholders have to be involved and complicated technical requirements have to be incorporated. The aim of this paper is to present the application of enterprise modeling for development of integrated Web map solution, GIS and simulation modeling tools for sustainability analysis in the regional development. It presents software prototype of developed Web map application to analyze the data from environment and to simulate future scenario.

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1. Introduction

The major objective of this paper is to show the importance of a new ICT solution, which is intended to help to evaluate and analyze impact of energy efficiency and sustainability. This paper will also present an appropriate method of achieving flexibility of analysis as well as predicting if housing development will have consequences on the environment in a regional context.

To be able to achieve these results, simulation modeling is needed to predict environmental sustainability and geographic information system (GIS) to provide simulation modeling with the needed spatial data.

Web Engineering is the way of managing the complexity and diversity of Web applications[1]. Web applications can be considered as a special class of software applications and may range from traditional online banking application to an online shopping mall application or complex geographical information system (GIS) with wide spectrum of analytical functions[2]. Design and development of a Web map application as part of geographic information systems (GIS) is a complex activity because of many reasons. Firstly, there are specific areas and stakeholders that are involved in this process.[2] Secondly, the complexity of Web map applications has increased in the last two decades and Web map applications have broaden in functionality from simple map portrayal to complex applications with a large number of functions (Rich Internet Application). Applied methodology and technologies have been employed to implement applications for[3]: 1) spatial data access and dissemination; 2) spatial data exploration and visualization; 3) spatial data processing analysis and modeling; 4) collaborative special decision support using public participatory GIS; 5) integration of web-based geospatial services in mainstream and enterprise computing processes and environments.

Within the overall structure of the research Section 2 contains the description of proposed approach for integrated solution of Web map application and simulation modeling tools for sustainability analysis in regional development. Section 3 describes the existing web mapping solutions for development. Section 4 addresses the improved architecture necessary for the ICT solution described in the paper. In Section 5 presents developed ICT solution. Section 6 forms the conclusion to the paper.

2. Proposed approach for integrated solution

The aim of simulation modeling in regional development is to explain and predict the impact of human activities on the environment and its sustainable development.

Enterprise modelling is applied as a method for capturing and structuring various perspectives, such as goals, concepts, actors and requirements of proposed solution in an integrated way[4]. Integration is applied in the combination of 4EM sub-models with requirements for Web map application.

System dynamic models have been recognized as having contributed a great deal to the improvement of the decision-making process in strategic planning through policy analysis by enabling the simulation of policy scenarios. Using a system dynamics model, behavior both in the character and in the nature of the system can be understood easily, and it is also possible to explore all possible development options through the evaluation of the behavior of the model in given scenarios[5].

The simulation model is divided into several sub-models - forest, meadow, swamp, arable land, water and building territories sub-models, as well as residential building, commercial activities, barn and transport sub-models. Parameters from the application to the simulation model are transferred as system data and are used in the simulation process. Then the simulation results with the total CO2 emissions to the application are transferred as system data using Insight Maker[6].

Fig. 1 shows general idea of proposed approach for integration of Web map application and simulation modeling tool for sustainability analysis in the context of regional development. Example of case for proposed approach is taken from the project *Platform Compatible Software Prototype for the Long Term Analysis and Monitoring of Energy Consumption in a Municipality Simulation Models*. Within the framework of this project various modeling tools and platforms matching and integration capabilities are being studied, as well as the reflection of their results in the Internet environment, to ensure energy consumption analysis, using an interactive map and capabilities of a geographic information system (GIS).