



Slovenian National Landslide DataBase as a Solid Foundation for the Landslide Hazard Analysis

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1 Introduction

Slovenian territory is, geologically speaking, very diverse and mainly consisted of sediments or sedimentary rocks. Landslides occur almost in all parts of the country. Based on the research, made in the early ninety's, Ribičič et al. (1994) estimated that there could be between 7.000 and 10.000 active landslides in Slovenia. The damage caused by landslides in the year 1993 summed to 4,8 %, of the GDP. In the year 2001, the damage caused by landslides summed to 1.575.000 EUR, excluding the remediation costs. In the last decade global climate changes probably caused several extremely large landslide events that were not observed on Slovenian territory before. The later represent additional, much higher burden to the state's and municipalities' budgets. In rare, but extreme situations, landslides resulted in human casualties.

2 National Landslide DataBase

In year 2002, several Slovenian Ministries expressed the will to finance the construction of the National Landslide DataBase. Some of the work, such as gathering a part of the landslide data and transforming it into the digital format and later into the GIS was done in ninety's with pilot projects (Ribičič et al., 1994). Until now little was done to update databases and to join the landslide data into a common database. Nowadays, up-to-date landslide database is vital for the activity of the Ministry of the Environment and Spatial planning and for the Administration of the RS for Civil Protection

and Disaster Relief.

Hence the project consists of 5 steps / goals, (1) to establish the up-to-date central landslide database, which can also be used for other natural phenomena, (2) the construction of the Information System that will allow different users to use the internet application for registering and reporting new landslide occurrences, and making additional changes or correcting already entered data. The database will represent (3) the basis for the spatial analysis of the landslide distribution and (4) the landslide data could be distributed very fast to different users in accordance with their privileges/rights. Also the database will serve for the production of hazard and risk maps of different scales (5).

The existing landslide data were acquired from different sources, from the Administration of the RS for Civil Protection and Disaster Relief (URSZR), from The Directorate of the Republic of Slovenia for Roads (DRSC), from the Ministry of the Environment and Spatial planning (ARSO), from the Geological Survey of Slovenia, from the Civil Engineering Institute ZRMK, and from Institute for Mining, Geotechnology and Environment. The data, acquired in different formats, were first analyzed and merged into the centralized database. The quality is questionable to a certain degree, since the separate databases were rarely maintained. The dominating problems were different database attributes, and missing or multiplied data.

The Landslides Information System consists of two different types of data; attributes and spatial data. Attributes are stored in Oracle database 9i2R (data was imported from different sources; dbf, excel, access) and Oracle Spatial is used for storing location of landslides. Other spatial data used in the system are stored on file server (raster data - background maps, digital orthophoto, etc), or in Oracle Spatial (vector data – land and building cadastre, infrastructure, etc). Applications that support users work consists of attribute and GIS module connected to one system. Both modules are based on multitier internet technology. The attribute module is created with the JSP (Java Server Pages) and runs on the Apache application server with installed Oracle Container For JAVA (OC4J). GIS WEB module is developed inside of Delphi environment with the ESRI MapObjects components for GIS. Also Internet Map Server was implemented to support communication between users and GIS WEB module. At the user level thin client in Java supports GIS functionality.

Landslide Information System (LIS) consists of three different modules:

- The Authorization module, which enables the system administrator to manage the DB,
- The Attribute module, which enables the registration and querying of the rele-

vant landslide data using the GIS WEB browser, and

- The Spatial module, which enables the visualization, identification and transfer of the landslide data to the attribute module. This module uses different graphical layers (landslides, infrastructure, DEM, topographic maps, Real-estate register etc.)

The users of the system can be divided into three segments: the administrator, internal users and the external users, each of them having specific degree of rights.

3 Conclusion remarks

At the moment there are approximately 4500 landslides in the initial database, but the number is constantly rising. It is estimated that at the end of the database construction project, the number of landslides in the database will exceed 5000. At the end of January over half of them were spatially located. The final goal is for the database to be a live system, which means constant updating of mapped data.

It is believed that the use of the Slovenian National Landslide DataBase will bring a huge progress in quick respond to landslide threat and in the field of the landslide prevention. Also many useful scientific results can be achieved on the base of analysis of landslide data. The data, stored in the Landslide DataBase, will serve as the foundation for the better understanding of landslides and will help the experts to build better models (simulations) of these natural phenomena in the second phase of the project. The data, and the results based on these data, will further serve for the production of the hazard and risk maps, which will gradually improve towards better prediction levels, with regular updating of the database.

The initial testing was successful and the application is ready for the first phase of implementation.

4 References

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