Systematic analysis of natural hazards along infrastructure networks using a GIS-tool for risk assessment

Mirko Baruffini

IST - Istituto Scienze della Terra, SUPSI/DACD, Canobbio, Switzerland (mirko.baruffini@supsi.ch)

Due to the topographical conditions in Switzerland, the highways and the railway lines are frequently exposed to natural hazards as rockfalls, debris flows, landslides, avalanches and others. With the rising incidence of those natural hazards, protection measures become an important political issue. However, they are costly, and maximal protection is most probably not economically feasible. Furthermore risks are distributed in space and time. Consequently, important decision problems to the public sector decision makers are derived.

This asks for a high level of surveillance and preservation along the transalpine lines. Efficient protection alternatives can be obtained consequently considering the concept of integral risk management.

Risk analysis, as the central part of risk management, has become gradually a generally accepted approach for the assessment of current and future scenarios (Loat & Zimmermann 2004). The procedure aims at risk reduction which can be reached by conventional mitigation on one hand and the implementation of land-use planning on the other hand: a combination of active and passive mitigation measures is applied to prevent damage to buildings, people and infrastructures.

With a Geographical Information System adapted to run with a tool developed to manage Risk analysis it is possible to survey the data in time and space, obtaining an important system for managing natural risks.

As a framework, we adopt the Swiss system for risk analysis of gravitational natural hazards (BUWAL 1999). It offers a complete framework for the analysis and assessment of risks due to natural hazards, ranging from hazard assessment for gravitational natural hazards, such as landslides, collapses, rockfalls, floodings, debris flows and avalanches, to vulnerability assessment and risk analysis, and the integration into land use planning at the cantonal and municipality level. The scheme is limited to the direct consequences of natural hazards.

Thus, we develop a system which integrates the procedures for a complete risk analysis in a Geographic Information System (GIS) toolbox, in order to be applied to our testbed, the Alps-crossing corridor of St. Gotthard. The simulation environment is developed within ArcObjects, the development platform for ArcGIS. The topic of ArcObjects usually emerges when users realize that programming ArcObjects can actually reduce the amount of repetitive work, streamline the workflow, and even produce functionalities that are not easily available in ArcGIS. We have adopted Visual Basic for Applications (VBA) for programming ArcObjects. Because VBA is already embedded within ArcMap and ArcCatalog, it is convenient for ArcGIS users to program ArcObjects in VBA.

Our tool visualises the obtained data by an analysis of historical data (aerial photo imagery, field surveys, documentation of past events) or an environmental modeling (estimations of the area affected by a given event), and event such as route number and route position and thematic maps.

As a result of this step the record appears in WebGIS. The user can select a specific area to overview previous hazards in the region. After performing the analysis, a double click on the visualised infrastructures opens the corresponding results.

The constantly updated risk maps show all sites that require more protection against natural hazards.

The final goal of our work is to offer a versatile tool for risk analysis which can be applied to different sit-

uations. Today our GIS application mainly centralises the documentation of natural hazards. Additionally the system offers information about natural hazard at the Gotthard line. It is very flexible and can be used as a simple program to model the expansion of natural hazards, as a program of quantitatively estimate risks or as a detailed analysis at a municipality level. The tool is extensible and can be expanded with additional modules.

The initial results of the experimental case study show how useful a GIS-based system can be for effective and efficient disaster response management.

In the coming years our GIS application will be a data base containing all information needed for the evaluation of risk sites along the Gotthard line.

Our GIS application can help the technical management to decide about protection measures because of, in addition to the visualisation, tools for spatial data analysis will be available.

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