Interactive Risk Assessment in the Field of Critical Infrastructure based on the Integrated Geographic Information System – RISKGIS – Final Report – ver 2

This project has addressed the problem how to assess risks related to complex, multileveled, multisectoral, interconnected and networked critical infrastructures in order to support a more comprehensive critical infrastructure protection policy. It has filled the gap in the application of GIS-supported computer tools to the cross-sectoral risk assessment in the field of critical infrastructure.

The first phase of the project focused on development of the integrated and multilayered Geographic Information System (GIS) for the sectors of energy and transport with all related subsectors (electrical energy, gas, oil, roads, railways, airports and ports) for one EU member state (Slovenia) (Deliverable 1). Several existing GIS data bases with relevant information on infrastructural objects and lines were integrated into a new interactive and multilayered GIS. ICT sector could not be included in the new database due to big dispersion of the geographic information databases among several providers and related low transparency of the information flows in comparison with the other two sectors. The integrated database contains some predefined attributes for all included infrastructural objects that represent a basis for further risk assessment.

Second phase of the project focused on the development of the integrated computer model/tool for interdependency-based risk assessment in the field of critical infrastructure (Deliverable 2). The computer tool enables the potential users to insert criticality and vulnerability factors for any infrastructural object in the country and any part of this object as well (the assessment point) based on the predetermined scenario. This means that the users can determine, describe and insert any terrorism-related scenario (or any other) that causes infrastructural malfunction and assess any object in the country's GIS according to this scenario. The number of scenarios is not limited in the model. The criticality index is then calculated for each point based on the following criticality factors assessed mostly on the five-point scale (from 0 to 4): potential number of dead or injured people, functional effects on the end users, economic impact (direct damage), area of unusable territory/environment, political effects, effects on the public services, interdependency (effects on the other infrastructure), cross-border effects, symbolic importance. The vulnerability index is calculated for each point (object) based on the following vulnerability factors inserted by the users: protection measures, planning measures, structural vulnerability, physical vulnerability (hazardous materials), reconstruction capacity and recoverability. Finally, each assessed point (object, including line object) is attributed a risk factor/index based on the formula risk = criticality index * vulnerability index.

When assessing any selected infrastructural object in the country according to the predetermined scenario, the users can use the predetermined information on the potential cross-border effects. Cross-border effect weights were attributed to all infrastructures in the transport and energy sectors that have a direct link with the border and simultaneously perform national's most important function in subsector (part of Deliverable 5). This was particularly important as some objects located in the center of the country unexpectedly have cross-border importance due to their direct connection with the border.

The third phase of the project focused on the applying and testing the computer model on the case of Slovenia (Deliverable 3). Firstly, the computer model was validated and then many objects from different infrastructural sectors were assessed according to terrorist scenarios (mostly bomb attacks). The test has reflected the usability of this model in Slovenia and other EU member states

Geographic interdependency was addressed in the project mostly from the perspective of infrastructural intersections and congestions. Our conceptual point of departure was that terrorist attacks on the infrastructural intersections of two or more infrastructures create multiplicative effects in those infrastructures. The infrastructural intersections represent the most vulnerable single points where an attack can simultaneously create effects in different infrastructures. After creating a conceptual model for identifying and assessing the most vulnerable infrastructural intersections (part of Deliverable 2), we identified all infrastructural intersections in Slovenia's GIS and calculated their vulnerability factors (part of Deliverable 3). This was done based on weighing all infrastructural links in the country according to their transfer (throughput) capacity/importance in the subsector on a scale from 1 to 100. On the entire territory of Slovenia, 2.477 infrastructural intersections were identified and displayed by the computer tool (13 intersections among three infrastructures and 1.464 between two infrastructures). The most vulnerable intersections with highest vulnerability factors were closely analysed and displayed in GIS. The vulnerability factors at each intersection were improved by adding the weight of potential cross-border relevance of the intersecting line infrastructures (part of Deliverable 5). The vulnerability factors calculated in this part of the project were integrated in the computer tool for interdependency-based risk assessment in form of additional attributes at each infrastructural intersection that can be utilized by the users, mostly for assessing the cross-sectoral effects of malfunction at the particular assessment point (object) or vulnerability assessment of an object considering the total number of intersections. Additionally, the whole country was analysed to determine the areas with highest levels of infrastructural congestions. The results showed that important infrastructure is congested mostly in urban areas as expected, but also unexpectedly in some less urban areas in the country (part of Deliverable 3).

Simulation method was used in the project to determine the consequences of malfunctions in the subsectors electrical energy and gas. The user of the integrated computer tool for interdependency-based risk assessment can call the simulation function for the purpose of improving understanding of the criticality of objects and related assessment of risk. The agent modelling method was used to conceptually and mathematically determine basic agents in the system (production nodes, consumers, transmission lines with their minimal and maximal capacity…) and their mutual relations reflected by the more or less general rules (part of Deliverable 2). Critical nodes in the electrical and gas infrastructural systems can be identified in the tested country by arbitrary disconnecting selected nodes from the system and observing the effects on the entire electrical and gas system in the country in time. These experiments can be repeated as many times as necessary to give the user a clear picture and improve the risk assessment reliability (part of Deliverable 3).

Workshops at national level (with relevant national sectoral experts) and international level were used to present project's partial results and get feedback to improve the integrated risk assessment tool, intersection assessment and simulation (Deliverable 4). Project results were disseminated and presented on the workshops, in the educational program at the university level, for the Governmental interministerial group on CIP and some subsectoral agencies (Deliverable 6). The group is currently working on national and international papers to be presented and published in the future.