An Analysis and Geovisualization of Selected Hazards

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Abstract. The main aim of this thesis, together with theoretic part dealing with definition of environmental hazard, is focused on analyses of selected hazards on the area of interest – municipality with extended competence Olomouc. Analyses were required by the Department of Security of The Municipality of Olomouc. There are three main parts of simulation and evaluation of accidents and hazards – modelling of real happened accident with release of propane-butane in industrial estate in boundary city district of Olomouc, modelling of potential accidents with ammonia release in ice-stadium in Olomouc and modelling and evaluation of mobile sources of hazards – lorry transport of dangerous materials. The main part of the work is modelling of selected hazards in ALOHA software (Area Locations of Hazardous Atmospheres). ALOHA is an atmospheric dispersion model used for evaluating releases of hazardous chemical vapours. Interpretation of results was realized by geovisualization in geographic information systems – mainly in ArcGIS 9.3. The work includes investigation of input data – chemical, atmospheric and information about source, many consultations with specialists, analyses of chemical releases and different possibilities of running accident, modelling in ALOHA software in planning mode (results has been confirmed by modelling in another software) and subsequent geovisualization with statistical analyses in GIS software. The results are summarized in final documents. These documents are determined to next usage by the Department of Security of The Municipality of Olomouc.

Keywords: analyses, accidents and hazards, geovisualization

1 Introduction

Development of society brings new definitions of environmental hazards, which hasn't been considered as a risk or has been neglected till this time. Although most of projects addressing this branch work with the spatial determination, cartographic visualization, unfortunately, is still not an obvious outcome. However, this fact is not only a mistake of experts who addressed environmental projects, but due to the less than ideal linked professional software for modelling and risk assessment with geographical information systems. Often the only outputs of these specialized programs are graphs, tables and figures that need editation for further processing and cartographic visualization. To this conclusion led the realization of this thesis, which is focused on needs of the Department of Security of the Municipality of Olomouc.

The name of this work "An Analysis and Geovisualization of environmental hazards" is a little misleading. The main aim of the work is focused on analyses of selected hazards on the area of interest - municipality with extended competence Olomouc. Work also includes the theoretical part, which deals with the definition of environmental hazards. So the reader cannot find here quantification of the risk of volcanic activity or radon radiation in the Olomouc city. The central parts of this thesis are three case studies dealing with assessment of environmental hazards to the citizens of the city.

These three central theses are: modelling of real happened accident with release of propane-butane in industrial estate in boundary city district of Olomouc, modelling of potential accidents with ammonia release in ice-stadium in Olomouc and modelling and evaluation of mobile sources of hazards - lorry transport of dangerous materials. Into this work there were also included analyses of air pollution, cartographic visualizations and further analyses.

2 Analyses of selected hazards

Before starting the realization of the work there was primarily a study of available literature relating to environmental hazards, their identification and analyses capabilities. In addition, experts were approached for consultations.
State government focuses on problems of the environmental risks. There are the origin of legislation and other regulations regarding this field at the Ministries and the Government of the Czech Republic. At a lower level, for example at the regional offices of municipalities, urban and municipal authorities there are the functions of these documents implemented in practice. Consultation with these experts conducted primarily through the staff of departments of the Municipality of the Olomouc city and analyses of environmental hazards were consulted extensively with Ing. Štefan Győrög from the Regional Office of South Bohemia region, Department of Environment, Agriculture and Forestry, Department of IPPC and EIA, air, chemicals, accidents. Parts of modelling accidents were consulted with Prof. Ing. František Babinec, CSc. from the Department of Quality Management Institute of Metrology and Testing of the Faculty of Mechanical Engineering, Technical University in Brno.
Furthermore the branch of environmental hazards, their prevention or resolution of potential accidents and consequences, is of course solved on professional workplaces, such as the Police, Fire Brigade, etc. Consultation with the staff of these institutions has been addressed by the consultant of the thesis Ing. Radek Zapletal from the Department of Security of the Municipality of Olomouc.
Realization of this work can be divided into two basic parts. The first part is based on theoretical objectives, namely the preparation of professional literature, consulting with experts and the determination of the work progress. This section has been complied with implementation of the above-mentioned studies, completing the above-mentioned consultations and the result of is the base for the practical realization of the objectives and general description of the problem.
The second parts of the work are analyses of selected hazards. Here the emphasis was primarily on the current needs and requirements of the Department of Security of the Municipality of Olomouc. From requirements of the Department of Security came three main requirements for the outcomes of this work. They are mentioned above.
The first analysis represents a hazard located on the boundary line of the technological disasters with outflow of hazardous chemicals and risk of road traffic accidents. It is a realistic modelling of the outflow of propane-butane, which took place in the industrial area in the area known as the Moravian ironworks in Olomouc–Řepčín, where a private company stores propane in stationary, road and rail tankers. This accident happened on 7th of October 2008. Probably the careless handling during transfer of propane from the stationary container into a tanker there was a propane leak into the air. It can be said, that only a miracle avoid serious injuries and casualties of people life. The cloud of propane-butane was isolated from the source of open flame and outflow into the atmosphere without a flash or explosion. The accident clearly showed the need to give this field of branch greater attention. In modelling of this accident – on the basis of data that were identified – there was determined possible running of accident in such conditions, calculated quantity of the spill and the final work became to the document for Security Council of Olomouc city.

Fig. 1. Real happened accident with ammonia release in Olomouc [1]

The current need of making analyses of environmental hazards with release of hazardous substances to the atmosphere was reflected into the realization of this work not only by modelling of this accident, but as it is mentioned above, also by developing two other analyses. It is a risk assessment of mobile sources in terms of traffic, representing analyses and risk assessment for lorry transport carrying dangerous substances in the Olomouc city, the most recent updates and analyses of this field took place in 2001, and an analysis and assessment of potential risks of accidents in the ice-stadium in Olomouc, where is an ammonia storage because of necessary use on ice surface. A study that was focused on this problem was updated in 2002 and has been prepared for a different amount of ammonia than is currently stored. The first analysis is used as an update of the AZER project (An Analysis of Health and Environmental Hazards) [2] and solve other needs of the Department of Security of the Municipality of Olomouc city. Work on assessing the risk of possible accidents in the ice-stadium in Olomouc became the basis for revision of the emergency plan of Olomouc city in the section that is focused on this object.
All analyses were modelled in software ALOHA® 5.4.1, the results were verified by consultation with Prof. Babinec. He has made his outputs by using a commercial software Effects. Analysis of the impact on the population and geovisualization of numerical outputs subsequently took place in ESRI products – automated calculations by using Avenue scripting language in an Arc View 3.1, and the resulting visualization and outputs by ArcGIS 9.2.

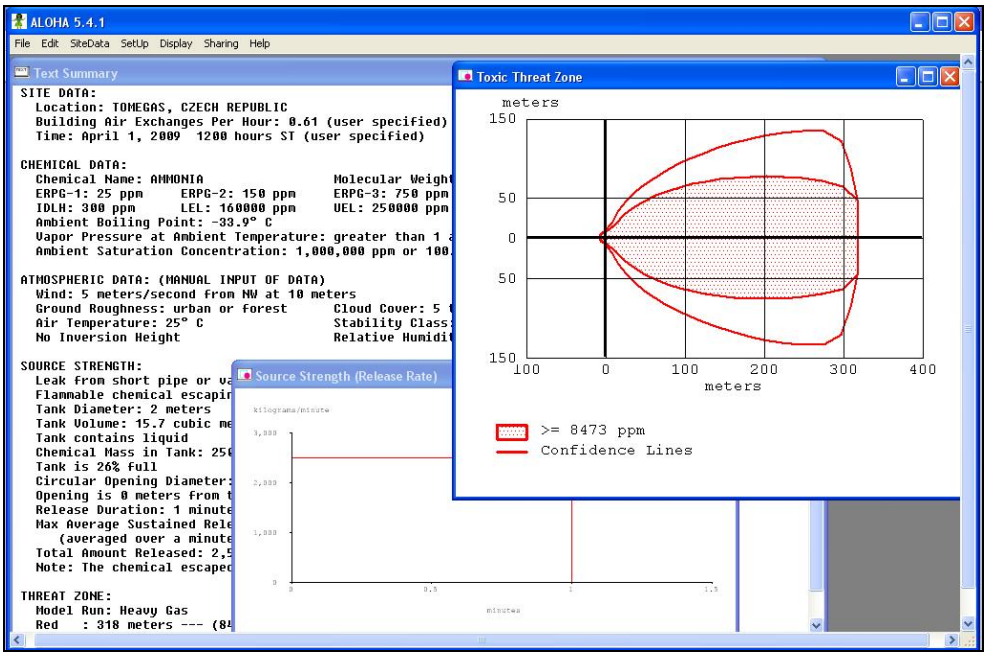

Fig. 2. Modelling in software ALOHA.

2.1 Data

Primarily, the data for the realization of this work were obtained from the Department of Security of the Municipality of Olomouc city, in collaboration with other departments of the city government. First there were obtained all the relevant underlying data for geovisualization, namely datasets of DMU, ZABAGED, cadastral maps, ortophotomaps, land-use plan and other available layers of communications, blocks, etc. from the Department of GIS of the Municipality of Olomouc city. Further in the context of the Department of Security of the Municipality of Olomouc city there were found data from the project AZER (from years 2001-2), such as map of noise, analyses of mobile sources, the map of risk objects etc. Some data that are no longer stored in a digital form, are registered in the printed output (data for mobile sources of risk, etc.), so part of the input data has been found in the archival documents.
To creation of a list of environmental hazards it was used the current legislation, especially emergency law [3] and the emergency plan of Olomouc city [4]. For making a list of possible analyses of environmental hazards there was important to find all available data that are owned by the Municipality of Olomouc city.

Modelling of the accident and assessing the potential risk of a real accident with release of propane-butane in the industrial area of Olomouc city was specific by acquisition of primary data about the accident. They were obtained from workers of the Department of Security of the Municipality of Olomouc city in conjunction with the Fire Department of the Olomouc Region and the Police. Modelling was confronted with the results of modelling made by Prof. Babinec and these data were also included into the resulting analyses.
Modelling of the potential consequences of accidents and hazards assessment of the ice-stadium in Olomouc city was based on the material of modelling and risk assessment from working group, which was established on the Department of Security of the Municipality of Olomouc under the leadership Ing. Radek Zapletal [5]. Static data such as information about the engine room were used in this work, because they are same. Additional data were obtained from the Emergency Plan of Olomouc city.
For creation of a work about risk assessment of mobile sources in terms of transport there were available primary data from a measurement of traffic intensity carried out by staff of the Department of Security of the Municipality of Olomouc city in the second half of year 2008. Further data were obtained from the Department of Transport of the Municipality of Olomouc city, particularly transport model of road traffic of the city of Olomouc and literature needed to convert data from measurement for analyses and visualization.
Data for further analyses were obtained from archival data, mainly by updating the database of risk entities for creation of a map of risk objects in Olomouc city and also by updating the database of buildings and institutions for calculating the number of people in dangerous area. Some additional data were obtained from other departments of the Municipality of Olomouc.

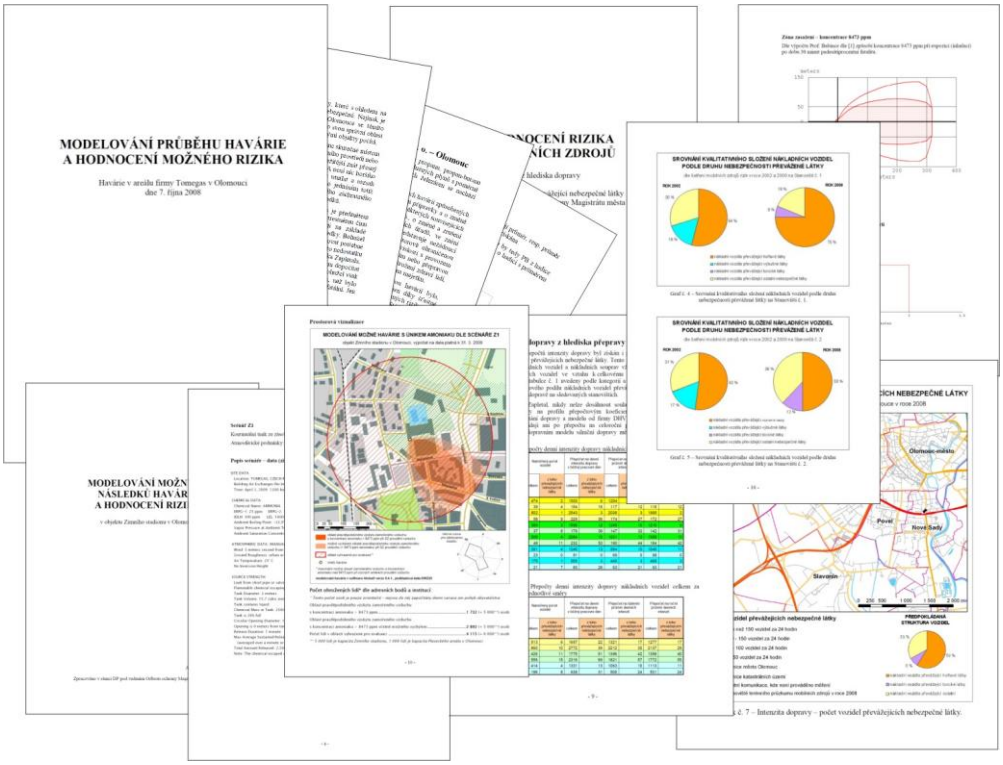

Fig. 2. Illustration of final reports

2.2 Geovisualization

An indisputable part of this work is a geovisualization of selected results. It is still true that one map is better than ten pages of text. In a moment, it is clear which objects are located in vulnerable areas. Through GIS tools it is easy to gain statistics of the population in individual houses, streets and areas as well as the density of traffic on affected roads. Unfortunately, still there wasn't good link between outputs of ALOHA software and GIS software, so the results obtained as images had to be manually georeferenced. This situation has particularly changed with the latest version of ALOHA software, but there are still a lot of problems. All geovisualizations were created in ESRI products, using features such as transparent layers of individual vulnerable zones, etc.

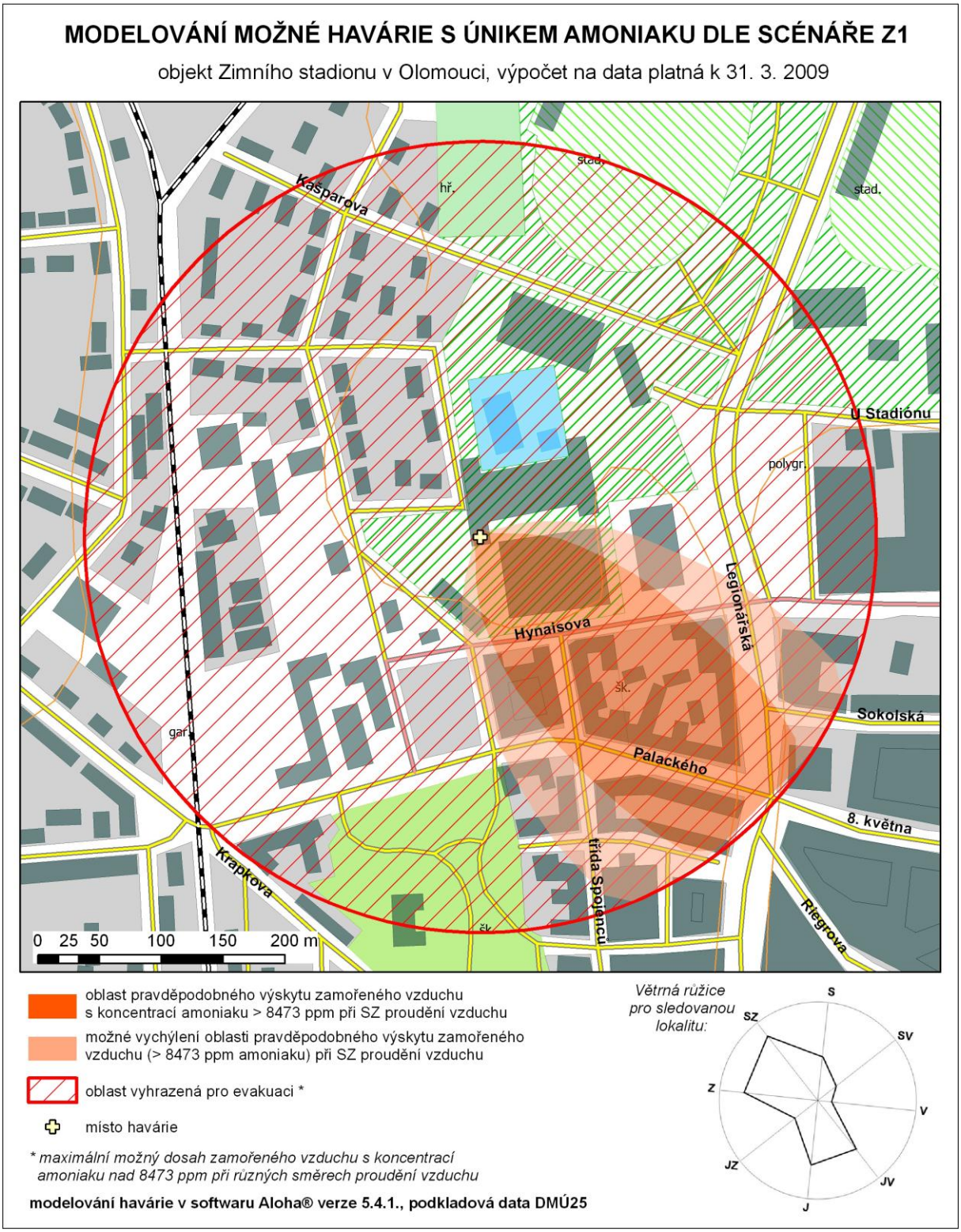

Fig. 4. Geovisualization of modelling of possible accident at the ice-stadium in Olomouc [6]

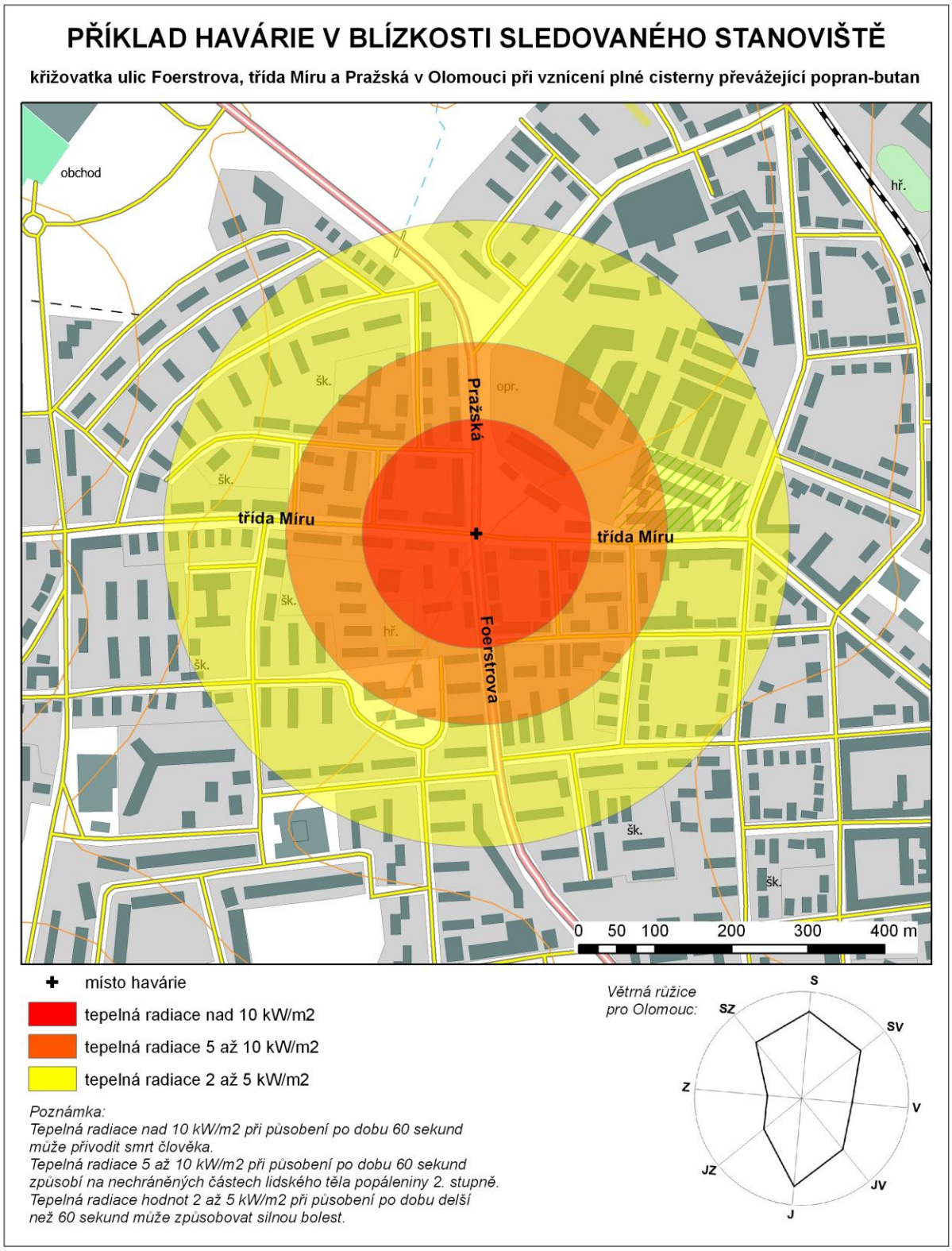

Fig. 5. Example of accident of lorry transport with dangerous materials [7]

3 Conclusion

The result of this work is the realization of the three main analyses of environmental hazards, which were required by the Department of Security of the Municipality of Olomouc city (all analyses are described above) in the form of separate documents – the final reports, a list of selected environmental hazards with possibilities of its analyses and a map of risk objects in Olomouc city from data that were registered by the Municipality in the text form. The entire work, as well as its individual components, are of course entirely for the Municipality of Olomouc city available for further use, as it was intended at the beginning of this work. Sub-components, such as work of risk analysis at the ice-stadium in Olomouc, are provided to address relevant work stations, in this case Fire Rescue of Olomouc Region.
Additional part of this work was a creation of sample analyses, which can be performed, if there are available data from different time periods. Data relate to air pollution that was used have been provided by the Department of Environmental Protection in Industry Faculty of Metallurgy and Materials Engineering at VŠB – Technical University of Ostrava in the order of the Municipality of Olomouc. These data are from a project of the management of air quality of Olomouc.
Already during the realization of this work some aspects of the work were used. For example an analysis of the real accident with release of propane-butane into the atmosphere has become the basis document for the Security Council of Olomouc city, risk assessment on the ice-stadium in Olomouc city was provided to Fire Rescue of Olomouc Region as a basis for revision of the emergency plan for this building. The whole work is available for further use and is a basis for further studies.

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