HE EVALUATION OF INDIVIDUAL RISKS IN CASE OF TOXIC GAS ESCAPE IN TRANSPORT

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The article describes experience gained during solution of project "BIOTRA" 2B08011 – Methodology of impact evaluation of transport paths on biodiversity and environment. The project is focused on creation of methodology, which could be used for evaluation of ecological risks related to transport of dangerous goods in transport with attention on individual society risks.

Key words: ecological risk, transport, toxic gas, dangerous goods

1 Introduction

Since 2008 there is solved the project BIOTRA in the Czech Republic, which is covered by National research program. The project is aimed for methodology creation of ecological risks evaluation associated with dangerous objects transport in special view of environment biotic elements. The result of the project BIOTRA it will be the decision making instrument for ecologically considerate transportation alternatives selection.

2 Road transport risk assessment

Standard methodic of present and planned traffic way effect evaluation to the environment is oriented to exhalation, dustiness and noise assessment by common traffic. The part of road transportation risk analysis is also the possibility of a vehicle accident connected with dangerous substance outflow. The probability of a major accident is low but the consequences may be large. At present, there is no methodology, which may allow complex risk assessment of dangerous substances road transport.

The risk analysis represents complicated process even if the algorithms for exposure and population jeopardy modeling in consequence of fire, explosion or toxicity can be found in technical literature. The trait of such problem is individual and social risk assessment in potentially affected area. The risk is possible to quantify and for its acceptability decision making is this quantification even necessary. Quantitative assessment represents an exposure. It is a numeric value (e.g. estimated number of deaths caused by an event per year) or numeric function, which describes the relation between probability and

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consequences of existing hazard. The hazards may be machines, activities or technologies, but also different objects or processes which endanger humans or environment. Generally the risk is the product of dangerous event probability and its consequences.

3 Potential dangerous substance outflow

The significant danger for transport, human health and environment is the dangerous substance transport. By traffic accident there are some following characteristics:

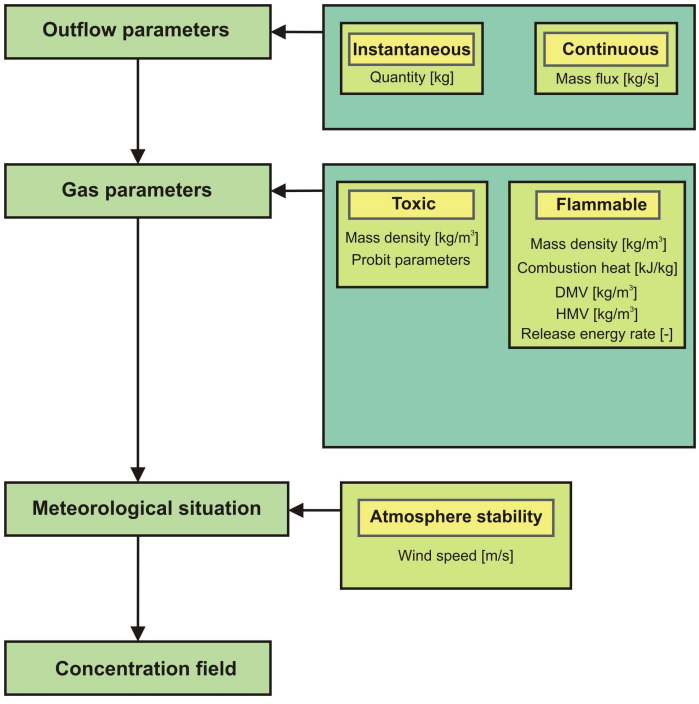
- The substance quantity is limited by transport vessel capacity (road tank, tank car),
- the escape time is limited by the vessel discharge; it is assumed the worst case, which is the instantaneous outflow of whole tank volume to the environment,
- the outflow location is not known in advance, it may be situated wherever on the transport route.

3.1 Gas dispersion in the atmosphere

The Pasquill – Gifford model PUFF is suited for dispersion modeling in instantaneous outflow conditions. It is a dispersion model with normal (Gauss) distribution of concentrations and Lagrange approach, which consists in gas element move monitoring in wind field. The gas cloud spreads in the wind direction. At first the cloud grows and the gas concentration sinks. Later the cloud volume decreases, because more and more gas disperses in insignificant concentrations outside the cloud. Finally the cloud disappears. The concentration field by instantaneous outflow is then time variable.

The dispersion is affected by wind speed and atmosphere stability. The atmosphere stability relates to the vertical temperature drop. It holds generally, that when the atmosphere stability grows, then the escaped substances get in longer distance, till their concentration sink. On that ground the higher stability classes are regarded as „bad“ weather conditions for dangerous substance dispersion.

3.2 Concentration calculation



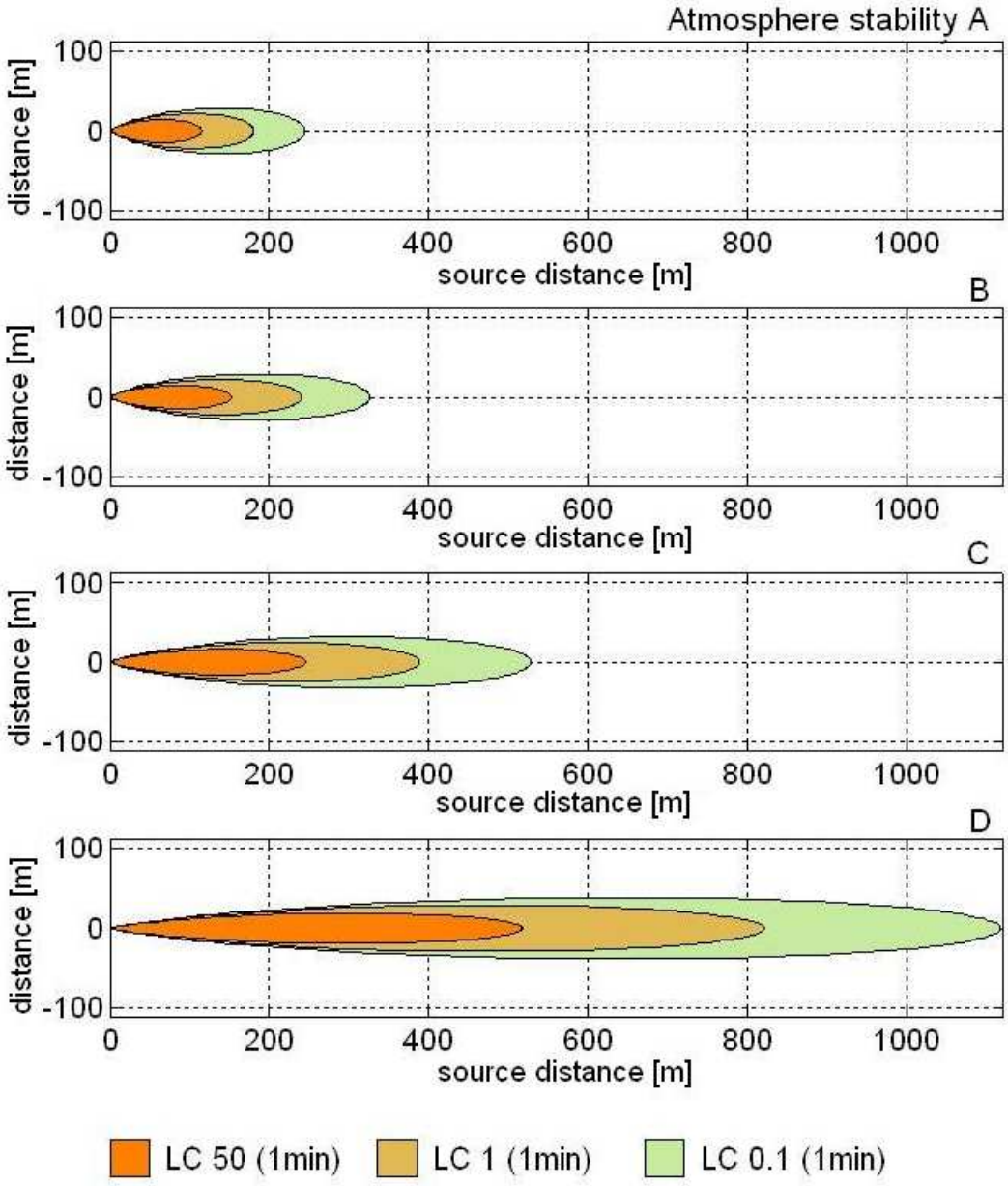
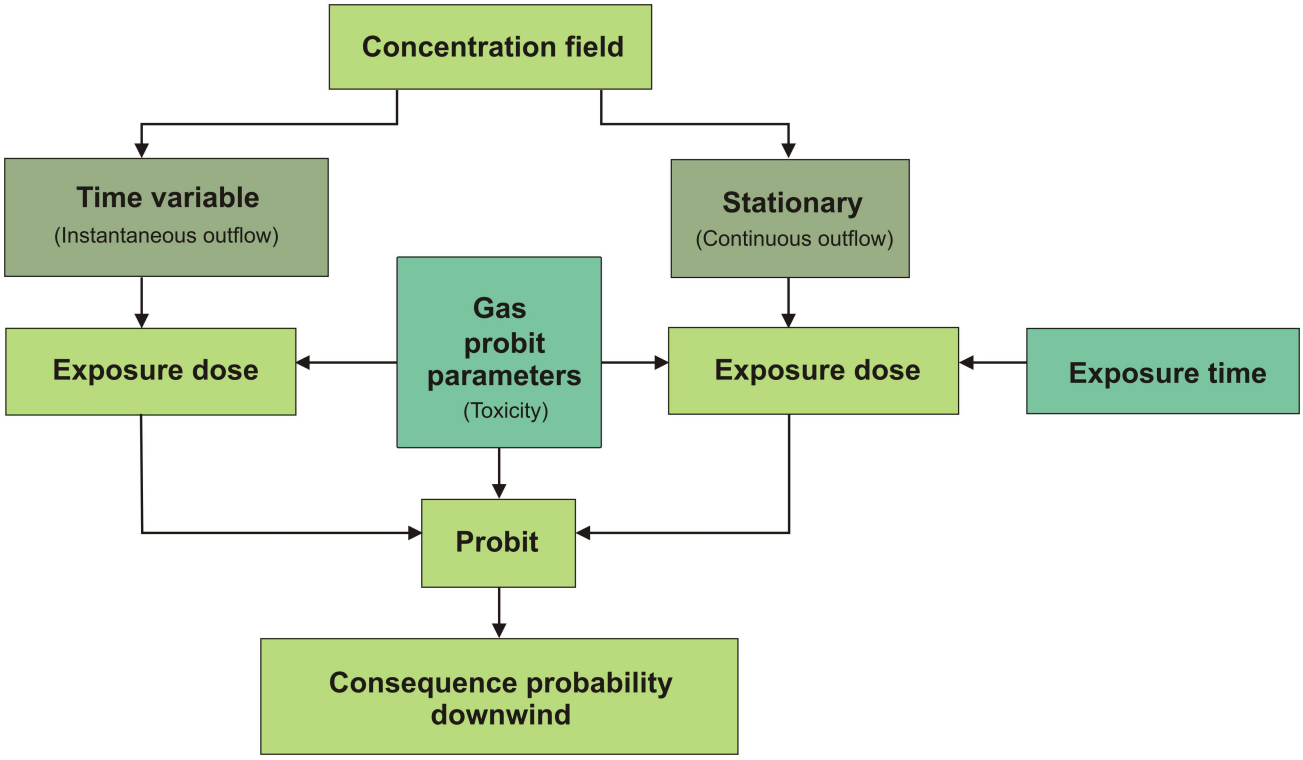


Figure 1: Maximal concentration in atmosphere ground layer
(Instantaneous outflow of 1000 kg NH3, atmosphere stability A – D)

3.3 Toxic exposure consequence assessment



Toxic exposure dose

- For constant concentration:

$$V = c^n \cdot t \tag{1}$$

- For time variable concentration:

$$V = \int c^n dt \tag{2}$$

Probit

$$Y = a + b \cdot \ln V \tag{3}$$

- Substance toxic parameters *a*, *b*, *n* is necessary to find in substance database (are different for single substances and also for variant consequences types)

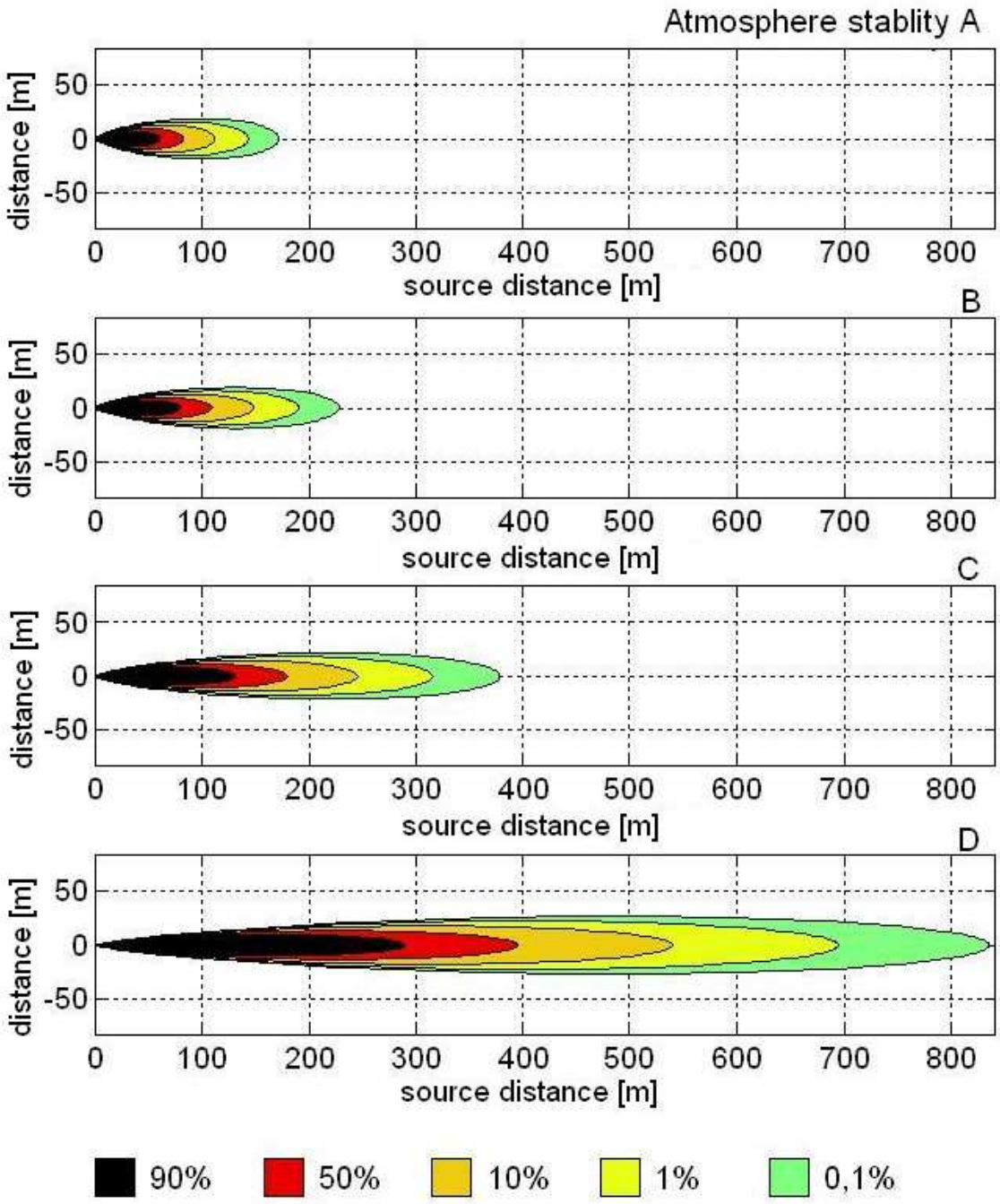
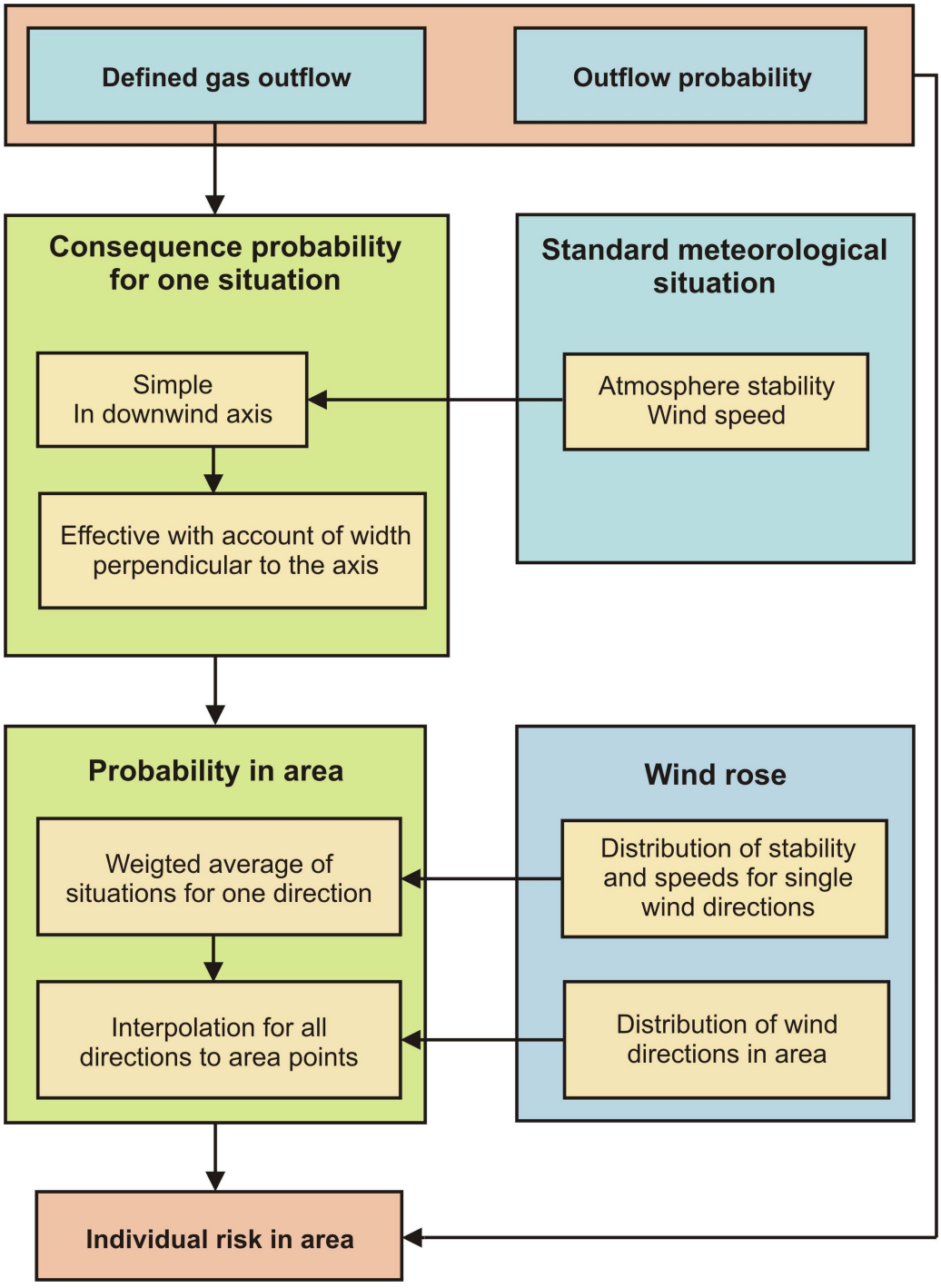


Figure 2: Human death probability by toxic exposure depending on meteorological situation and source distance.

(Instantaneous outflow of 1000 kg NH3)

3.4 Individual risk assessment in source area neighbourhood



3.5 Data import to GIS

The main goal of the evaluation is the social risk assessment, which contains individual risk and characteristics of the environment, into which the substances leaked.

It is necessary to place the incurred cloud to the corresponding area. It enables the GIS tools usage, e. g. dwelling houses and threatened people number assessment etc., it means social risk calculation. When the outflow source geographic location is defined, also the wind rose for the area of our interest might be constructed. The output is a database file containing the data in X, Y, IR value format, but already in

corresponding geographic position data. This data section displayed in GIS contains continuously distributed IR values and it is possible to combine them with area population distributions, etc. The final combination of such as data is the **SOCIAL RISK**.

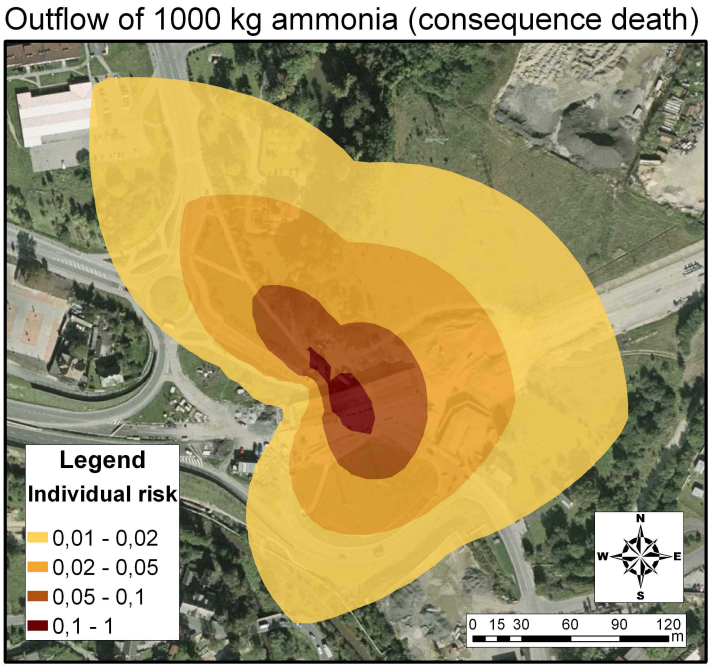


Figure 3: Individual risk map in concrete locality

4 Conclusion

In this paper there is proposed a methodic of exposure bandwidth assessment by dangerous gas transport. The methodic results form quantification of negative effects of whole transported volume instantaneous outflow to human and environment elements. The reach is strongly dependent on actual meteorological situation That´s why it is necessary to do an evaluation for all weather conditions relevant categories.

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