Methodology of Preliminary Flood Risks Assessment in the Czech Republic

Assessing the degree of flood hazard belongs to topical problems with all-society implications/ consequences. One of the closest obligation imposed by the Directive of European Parliament and The Council 2007/60/EC on assessment and management of flood risks (Flood Directive), is preliminary flood risk assessment. Accomplishing the task, aiming to delimiting the areas of potentially significant flood risk is guaranteed by the Ministry of Environment together with the Ministry of Agriculture of the Czech Republic. It is necessary to distinguish the degree of danger of flood hazard or to identify the parts of the Czech Republic territory exposed to a significant flood risk which required the proposal of transparent procedure, development and application of relevant tools. Overall view on the total territory of the Czech Republic with relatively easy update of data sets and tools was provided by space analysis of possible consequences of flood hazard in flood plains based on selected aspects (basic, auxiliary). The choice of the aspects is strongly conditioned by the accessibility of the data from standardly obtained and kept databases in the Czech Republic which could contribute to approximation of the degree of the exposure of inhabitants, property, environment etc to floods or other forms of flood hazard.

Main aspects

For the stage of preliminary flood risks assessment the main aspects have been selected, according to which the impact of flood exposure can be quantified:

1. The number of permanent residents aggrieved by the flood extent in flood plains,
2. The value of property aggrieved by the flood extent in flood plains and for various probabilities of occurrence (respectively return period – 5, 20, 100 years at least) of flood hazard, so-called hazard scenarios.

Auxiliary aspects

Flood directive requires including also the impact of the activities in expressing flood risk which can, in case of flooding, have a negative influence on the environment (accidental pollution etc.). Thus the relevant potential sources of pollution were selected as an auxiliary aspect in connection with the flood risk.

The presence of significant historic buildings in the flood plain was other auxiliary aspect.

Appropriately expressed parameters of so-called auxiliary aspects have been compared only with the demonstrations of hazard scenarios with the return period of 100 years.

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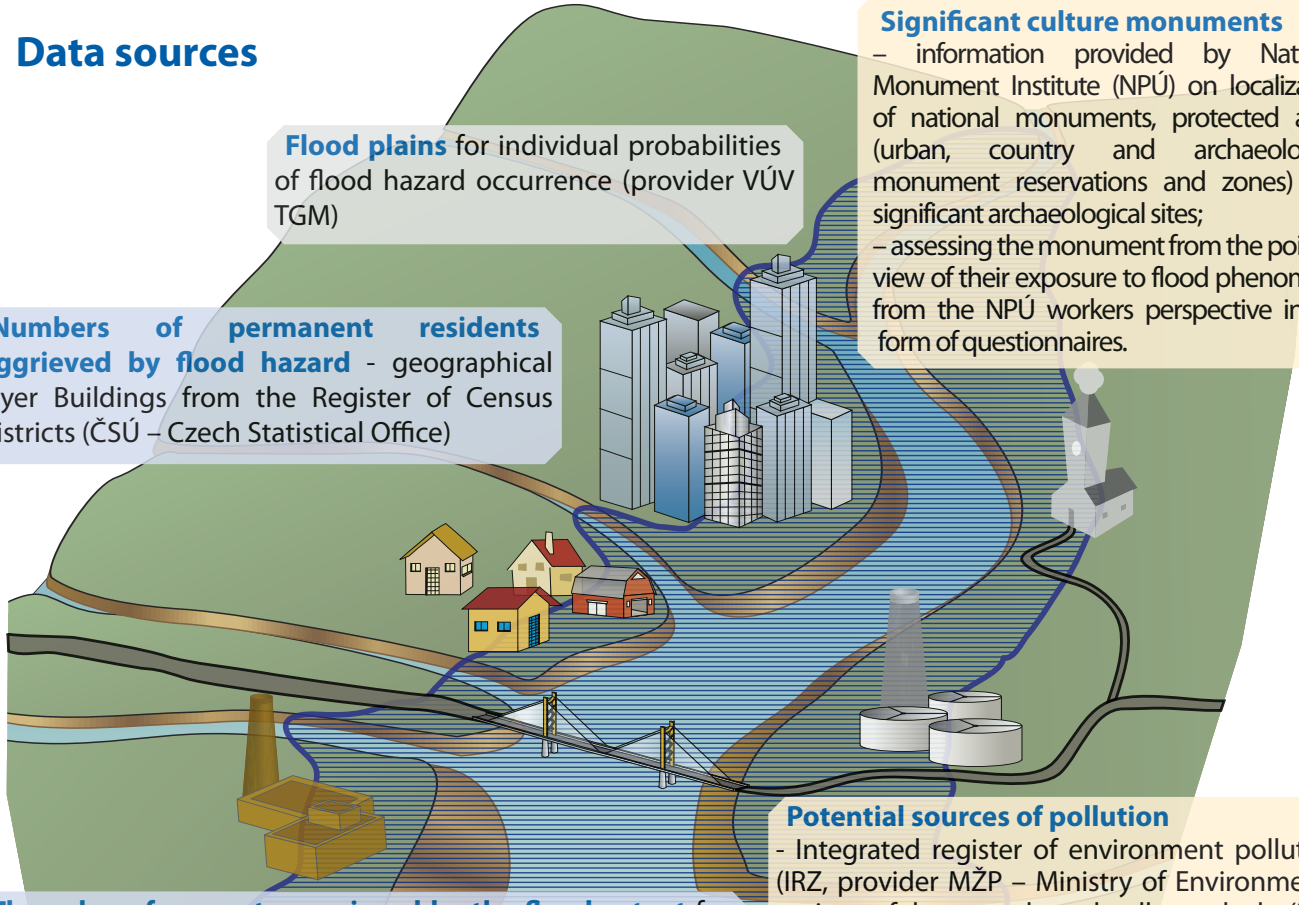
Data sources



Flood plains for individual probabilities of flood hazard occurrence (provider VÚV TGM)

Significant culture monuments
– information provided by National Monument Institute (NPÚ) on localization of national monuments, protected areas (urban, country and archaeological monument reservations and zones) and significant archaeological sites;
– assessing the monument from the point of view of their exposure to flood phenomena from the NPÚ workers perspective in the form of questionnaires.

Numbers of permanent residents aggrieved by flood hazard - geographical layer Buildings from the Register of Census districts (ČSÚ – Czech Statistical Office)

The value of property aggrieved by the flood extent for the individual hazard scenarios
- level of fixed assets (value of intangible and tangible assets) in flood plains (ČSÚ);
- built-up areas and lengths of road transport infrastructure;
- objects of ZABAGED geodatabases (ČÚZK - Czech Office for Surveying, Mapping and Cadastre): Building; Block of buildings; Purpose-build development; Power station; Airport; Car park; Roads and motorways; Street; Roads.

Potential sources of pollution
- Integrated register of environment pollution (IRZ, provider MŽP – Ministry of Environment): register of data on selected pollutant leaks (into atmosphere, water, soil), transports of pollutants in wastes and waste waters and transports of quantities of wastes, which are annually reported for individual business premises bases on criteria determined by respective legal regulations;
- Register of industrial sources of pollution (RPZZ, provider VÚV TGM).

Expressing the risk

Quantitative expression of the parameters of the basic aspects of preliminary flood risks assessment is based on the definition of a risk, it means combination of occurrence probability of adverse phenomenon (floods, hazard scenarios) and its adverse impact on human health, environment, culture heritage and economic activities. The risk is, within the approach, defined as n-tuple of vectors (Tichý, 1994): $R_i \equiv (Sc_i, D_i, P_i),\ i = 1, ..., n$

Where S_c is a hazard scenario, D consequences (harm, damage), P is occurrence probability of a hazard scenario, expressed in suitable units.

All the values are time dependent since both the hazard scenario and the probability of its occurrence and also the damage can change during the time. In accordance with the above stated definition, if the continuous distribution of consequences and probability distribution of causes is known, it is possible to determinate the risk according to the relationship:

$$R(D) = \int_0^\infty D(u|O) \,.\, g(u) \,.\, du$$

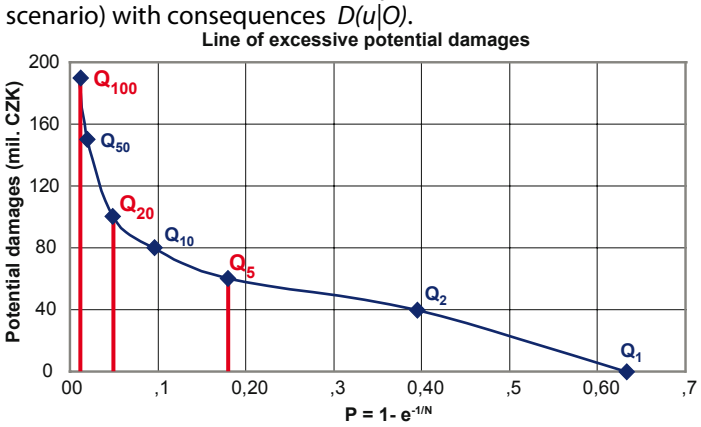
$D(u|O)$ is a function of consequences, u is a quantifier of an event dependent on the vector of measures and decisions O (the height of the protective barrier along the river, early evacuation etc.), which influences the consequences of an extreme event, $g(u)$ is probability density of the occurrence of an event (hazard scenario) with consequences $D(u|O)$.

Respectively partial risk R_i following from the implementation of the n-th hazard scenario can be determined for example from the relation: $R_i = D_i \,.\, P_i$

Then the total risk R from implementation n of statistically independent hazard scenarios is determined by the relation:

$$R = \sum_{i=1}^{n} D_i \,.\, P_i, \text{ where } P_i = 1 - e^{-\frac{T}{N}} \text{ and the period of time } T=1 \text{ year}$$

Graphically, the risk, or the year loss, can be expressed by the area delimited by the line of excessive potential impacts and the axis x and y. In case of approximation of flood risk we are limited by the data available for the elaborated hazard scenarios, implicitly for Q5, Q20, Q100.



Process of delimiting the areas of potential flood risk

1st step

Quantification of parameters of main aspects was performed for individual flood hazard scenarios; it means calculation of the number of permanent residents in the aggrieved municipalities and the value of property aggrieved by flooding. Unit values of fixed assets groups were used for calculation of property value (CZ data for 2006).

2nd step

Determining criteria for delimiting a significant flood risk. Within the negotiation of interdepartmental work group (Ministry of Environment, Ministry of Agriculture) for implementation of Flood Directive in the Czech Republic the combined criterion for the two stated main aspects for the first selection of areas with a significant flood risk was: 25 and more residents aggrieved by flood hazard a year in a municipality or the value of 70 and more million CZK of the property aggrieved by flood hazard a year.

- delimiting river segments of the streams in the cadastre of municipalities exceeding the selected parameters of main aspects.

3rd step

The sources of pollution have been localized (IRZ, RPZZ) in flood plains. Those river segments were added to the selection from the 2nd step, which seemed potentially risky from the view of possible pollution during floods.

4th step

Respecting the presence of significant culture monuments in flood plains. Only information on location of national culture monuments, protected areas (urban, country and archaeological monument reservations and zones) has been used.

5th step

Specification of the river segments in the areas of a significant flood risk – 1st stage (2010) and 2nd stage (March 2011). It represents 2 966 km of river stretches together.

Flood hazard maps and flood risk maps are creating for these river segments now.

Ministry of the Environment of the Czech Republic

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Proposed river segments with potential significant flood risk