Appendix
Description of Individual Parameters

The following is a brief description of each parameter, its possible determination or prediction:

A—Maximal Specific Runoff—q_{max}(m^3 s^{-1} km^{-2})

In Slovakia, for the calculation of runoff from the catchment area, the most commonly used tool is the regional equation according to Dub and Nemec (1969), which gives the maximal specific runoff (A.1):

$$q_{\max} = \frac{A_0}{(S_p + 1)^{n_0}} (1 \pm o_1 \pm o_2) \tag{A.1}$$

q_{max}—maximum specific runoff ($m^3.s^{-1}.km^{-2}$), A_0, n_0—coefficients which express the contribution of a particular territory in Slovakia to runoff (−), S_p—the catchment area (km^2), o_1—coefficient which express the influence of forest cover on runoff conditions (−), o_2—coefficient which express the influence of the shape of the basin on runoff conditions (−).

The individual coefficients can be determined on the basis of the literature, such as Dub and Nemec (1969), Mosný (2002) or Jakubis et al. (2005).

B—100-year Maximum Flow—Q_{100}(m^3 s^{-1})

Maximum flow with a return period of 100 years is the flow in the stream which may be reached or exceeded on average once in one hundred years. The value of flow with a return period of 100 years for each profile is determined by the Hydrological Service of the Slovak Hydrometeorological Institute on the basis of hydrometric observations.

C—Designated Flow—Q_n(m^3 s^{-1})

Flood-protection structures are proposed according to hydrodynamic calculation with respect to the designated flow. The value of the designated flow rate depends on the value in the area which is going to be protected. For the protection of a rural area (extravilan), the designated flow Q_1–Q_5 (return period from 1 to 5 years) is used, and exceptionally Q_{20}, while a built area (intravilan) is protected from the flow Q_{50}–Q_{100} (return period from 50 to 100 years) (Vlasák and Seidl 2010).

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Table A.1 Designated flow for the implementation of flood-protection structures (Švecová and Zeleňáková 2005)

Type of land use	Q_n for river bed capacity
Continuous built area, industrial area, significant roads and railways	Q_{50}–Q_{100}
Very valuable land, e.g. vineyards, hop fields	Q_{20}
Arable land	Q_5–Q_{20}
Meadows and forests	Q_2–Q_5

The designated flow in a channel is based on the required protection of adjacent lands, which corresponds to their use. Account is also taken of the impact of the proposed action on the flow in the river basin. According to the recommendations (STN 75 2102: 2003; Švecová and Zeleňáková 2005), depending on the nature of land use adjacent to the channel of water flow, the level of proposed flood control should be determined according to Table A.1.

D—Average Annual Precipitation—H_z(mm)

Annual precipitation is the amount of water in liquid and solid form which falls on the horizontal plane at the location in one year. It is expressed as the height of the water column in mm. Figures for this indicator for the study area can be obtained from the Slovak Hydrometeorological Institute; for the Slovak Republic it can be read from the map in Fig. A.1 (produced by the SHI) that is available online as the Atlas of the Landscape of SR (MoE and SEA 2002).

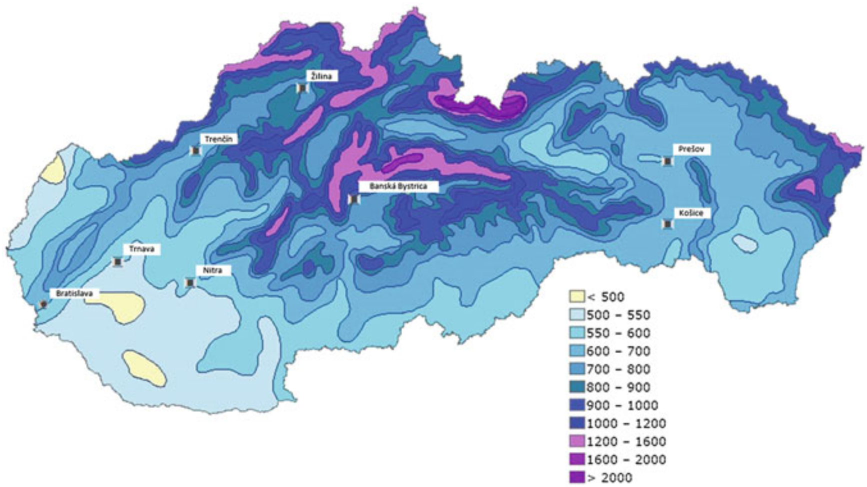

Fig. A.1 The average annual precipitation in Slovakia (MoE and SEA 2002)

***E*—Forestation—*l*(%)**

Forestation l means the proportion of forested area to the total catchment area, expressed as a percentage. It can be determined using formula (A.2):

$$l = \frac{S_L}{S_p}100 \tag{A.2}$$

where: l–forest cover (%), S_p—catchment area (km^2), S_L—forested catchment area (km^2).

For the Slovak Republic, it is possible to determine forest cover on the basis of the publication Hydrological Conditions issued by The Staff of the Hydrological Service of HMI (1965). The value is reported in whole tens of percent, so that e.g., 0% presents values from 0 to 4, 10% presents values from 5 to 14, 20 … from 15 to 24%, etc.

***F*—Coefficient of Basin Saturation—*S*(mm)**

The saturation capacity of a river basin is an important factor in the origin of floods. This coefficient is calculated using Eq. (A.3) (Jakubis et al. 2005):

$$S = 254\frac{100 - CN}{10CN} \tag{A.3}$$

where: CN—number characterizing the catchment area with regard to water retention (−), S—the maximum potential retention capacity of the basin ≈ (mm).

The CN value is determined for various types of land use, e.g., from the table *of Medium values of CN curves corresponding to individual hydrologic groups of soil* presented in Jakubis et al. (2005).

***G*—Character of the Water Course (−)**

In addressing a proposal for flood protection-structures, questions come into focus as to which category, in terms of the flow—critical flow and specific energy—in which the stream is classified. To address these issues, the criteria of supercritical flow can be used (Škopek 1984). The criterion for the classification of the flow, as a whole or in its parts, is defined as the coefficient of supercritical flow K_b. Its value is calculated using Eq. (A.4) (Jakubis et al. 2005):

$$K_b = \frac{qOV_sPE\sqrt{S_p + 1}}{L\sqrt{S_L + 1}} \tag{A.4}$$

where: ρ—density of river network (km^{-1}), O—length of catchment border (km) V_s—height difference between the source and the mouth of the stream (−), P—coefficient of medium soil permeability (−), E—coefficient of erosion susceptibility of basin (−), S_p—catchment area (km^2), L—length of the stream (km), S_L—forested catchment area (km^2).

Table A.2 Ranking of flows according to the criteria of supercritical flow (Mosný 2002)

Coefficient of supercritical flow	Category
$K_b < 0.1$	I. Water stream
$0.1 < K_b < 0.4$	II. Supercritical flow
$0.4 < K_b < 0.7$	III. Medium supercritical flow
$0.7 < K_b < 1.0$	IV. Strong supercritical flow
$1.0 < K_b$	V. Very strong supercritical flow

According to the coefficient of supercritical flow, a stream is classified into categories according to Table A.2.

The coefficients *P* and *E* characterizing the catchment area, as well as the necessary formulas to calculate other characteristics are published for example in Mosný (2002). Determination of flow according to the criteria of supercritical flow produces one of the suggested indicators—the character of the water course. Flows with a very strong character of critical flow—low depth and high specific energy—are characterized by high-flow velocities and are therefore considered a higher risk of flash floods.

H—Average Longitudinal Slope of the Stream—$\mathbf{i}_t$(%)

The average longitudinal gradient of the stream i_t (bottom or level) is calculated from the relationship between elevation and the length of the stream. It is reported as a percentage or promille (‰) according to the equation (Mosný 2002):

$$i_t = \frac{\Delta H}{L} \tag{A.5}$$

where: i_t—average longitudinal gradient of the stream (%), ΔH—elevation of the stream (m), L—length of the stream (m).

I—Shape of the Basin (−)

The shape of the basin, according to Table A.3, is determined based on the coefficient of the shape of the basin α;

$$\alpha = \frac{S_p}{L^2} \tag{A.6}$$

where: α—coefficient of the shape of the basin (−), S_p—catchment area (km^2), L—length of the stream (km).

Table A.3 The criteria for determining the shape of a river basin (Mosný 2002)

Shape of the basin	$S_p < 50$ km^2	$S_p > 50$ km^2
Elongated	$\alpha < 0.24$	$\alpha < 0{,}18$
Transitional	$0.24 < \alpha < 0.26$	$0.18 < \alpha < 0.20$
Fanlike	$\alpha > 0.26$	$\alpha > 0.20$

J—Catchment Area—S_p(km^2)

The catchment area of a stream in a certain profile is that part of the basin bounded by the watershed relating to the profile in question. The value of this indicator is determined from water management maps or the publication by the Slovak Hydrometeorological Institute (The Staff of the Hydrological Service of HMI 1965), or calculated using a digital planimeter from a map in scale 1:10,000, or obtained by digitization in geographic software.

K—Soil Type (−)

According to the percentages of particular grain fractions in soil, it is possible to distinguish soil types. Several national and international classifications have been compiled for this purpose. For expressing the soil granularity in Slovakia, the Novak classification is most often used. This classifies soils into seven types according the content of coarse clay (fraction below 0.01 mm). The advantage of this classification is good clarity for users in practice. It allows quite accurate classification of soil types directly during field investigations. The categorization of the types of soil according to the content of particles <0.01 mm and representation of the types of soil in agricultural land in Slovakia are shown in Fig. A.2 (Soil Portal 2013).

L—Slope of the Basin—i_s(−)

The average slope of a river basin is characterized by basin-slope conditions and can be directly quantified as follows:

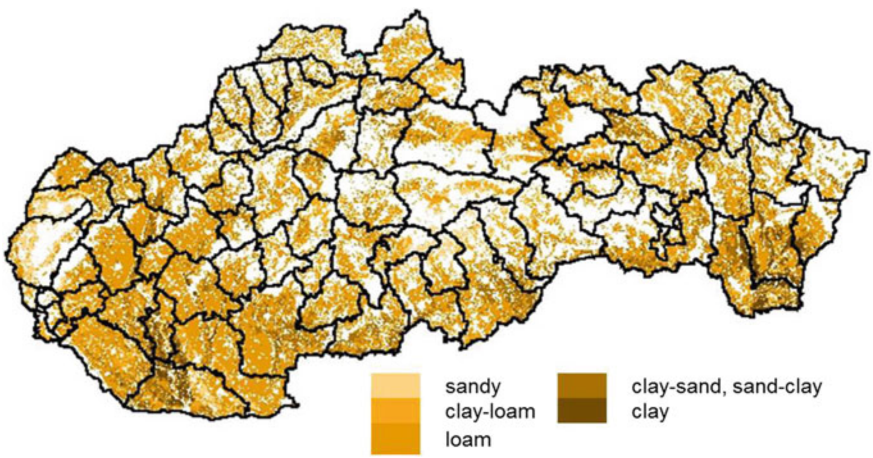

Fig. A.2 Representation of soil types (Soil Portal 2013)

$$i_s = \frac{\Delta H}{S}\left(\frac{L_0}{2} + \sum_{i=1}^{n} L_{v_i} + \frac{L_n}{2}\right) \quad \text{(A.7)}$$

where: L_v—length of the ith contour (m), ΔH—height difference between contour lines (m), S_p—catchment area (km^2).

M—Ecological Significance of the Area (−)

The ecological significance of the area depends on the presence of protected areas, elements of TSES and other eco-stabilizing elements in the landscape. Eco-stabilizing elements are considered to be forests, shrub vegetation, heterogeneous agricultural areas and various grasslands that are not counted as protected areas, or as elements of TSES. They can be characterized in their mutual combinations; e.g., the territory of Slovakia can be characterized into 9 categories: from the most ecologically significant areas to ecologically insignificant areas (MoE and SEA 2002). The ecological significance of the area, according to the map in Fig. A.3, can be divided into the following classes:

- very small (area with the first degree of protection)
- small (area with the second degree of protection)
- large (area with the third degree of protection)
- very large (area with the fourth degree of protection)
- extremely large (area with the fifth degree of protection).

N—Vulnerability of Protected Species of Fauna, Flora and Biotopes (Number)

The effects of the proposed activity on plant structure and the occurrence of particular species need to be considered objectively. This indicator therefore reflects

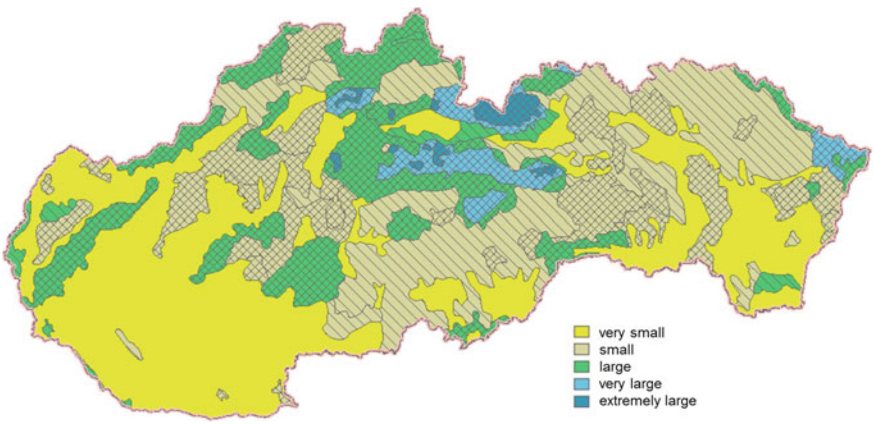

Fig. A.3 The ecological significance of the area (MoE and SEA 2002) the number of protected plant and animal species that may be affected by the proposed activity.

O—Change in the Landscape (−)

The assessment of impacts on the landscape is based in principle on four states: (i) current state without faults, (ii) current state with failures, (iii) planned activities without faults, (iv) planned activities with the risk of failure (Jančura et al. 2010). This indicator is therefore based on the following criteria:

- *current impact assessment*:
  - preserved harmonious landscape, without interference,
  - presence of symptoms, disturbing elements in the landscape;
- *preventive impact assessment* plan for the future appearance and character of the landscape:
  - without interference,
  - risk of negative interference.

P—Cultural and Historical Significance of the Area (−)

The cultural and historical importance of the area is evaluated according to the occurrence of selected combinations of phenomena, surfaces and objects that are registered in the Central List of Cultural Heritage, as well as the occurrence of sites not included in this list (e.g., a compact area of rural settlements, areas with significant historic residential and solitary dominants, historical infrastructure, and preserved landscape) (MoE and SEA 2002). According to these criteria, the districts in Slovakia have been classified into four levels of cultural and historical significance:

- international and national,
- national and supra-regional,
- national,
- regional.

The geographical representation of this classification for the study area is found in Fig. A.4, available online as the Atlas of the Landscape of SR (MoE and SEA 2002).

Q—Vulnerability of Archaeological and Paleontological Sites and Important Geological Sites (Number)

It is important to know the number of affected archaeological and paleontological sites and important geological sites. This value is determined by the occurrence of these sites in the study area.

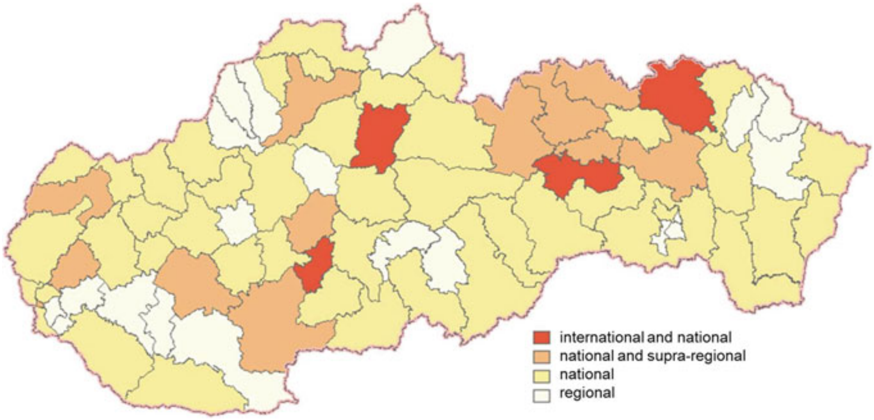

Fig. A.4 Cultural and historical significance of each district of SR (MoE and SEA 2002)

R—Permanent Residents in the Area (Number)

This value represents the number of people who reside in the study area; they may be at risk from flooding.

S—Coefficient of Built-up Area (%)

The coefficient of built-up area in a village is the ratio of built-up area to the total area of the village territory, expressed as:

$$KZO = \frac{ZUO}{CV} \tag{A.7}$$

where: *KZO*—coefficient of built area in the study area (−), *ZUO*—built-up area in the village (m^2), *CV*—total area of the village territory (m^2).

The higher the coefficient of built area, the greater the likelihood of damage caused by potential flooding and thus the higher the flood risk.

Input data for calculation of this coefficient is available on the website of the Cadastral Portal (2013). It is also possible to generate an overview of the economic value of land types for the selected cadastral area.

T—Type and Importance of Transport (Points)

The type and significance of local transport is expressed by scoring (point evaluation) and is given by the sum of all detected means of transport in the study area. The point's scores are given in Table A.4.

U—Infrastructure of the Area (Points)

Infrastructure in a municipality is expressed by scoring and is given by the sum of the identified facilities in the study area. Each group in Table A.5 (I.–VIII.) can be

Table A.4 Allocation of points for the indicator: type and importance of local transport

Type and significance of transport	Points
Roads	
• Local • District and regional • Regional and national	1 2 3
Railways	
• Regional • National	3 4

Table A.5 Allocation of point values for groups of objects

Groups and type of buildings	Points
I. Administrative buildings and shops	1
II. Cultural facilities	1
III. Hotels, restaurants, catering and tourist facilities	1
IV. Warehouses	1
V. Educational facilities	1
VI. Sports facilities	1
VII. Hospitals and social care facilities	1
VIII. Other	1

assigned only one point, even though there may be several kinds of facility falling within the group.

Similarly, the more points are awarded in the study area, the higher the flood risk is, because of higher vulnerability in the area.

V—Production Activity in the Area (Points)

Production activity in a municipality is expressed by scoring and is given by the sum of the existing production activities in the study area. Each type of production activity is scored only once, according to Table A.6.

Table A.6 Type of production activity

Production activity	Points
I. Agriculture	2
II. Craftwork	2
III. Industry	2
IV. Services	2
V. Others	2

W—Degree of Environmental and Human Damage

This indicator refers to the protection of the population and the environment against floods, the population's awareness and preparedness for floods, and the perceived likelihood and expectations of damage to the environment and health of the population.

X—Total Cost of the Proposed Activity (EUR)

This amount represents all funds to be spent on building the proposed flood-protection structures, i.e., the construction budget; or if there are no measures proposed, then this fact is also considered.

Y—Distance of the Location of Proposed Activity from Built-up Areas (km)

This criterion represents the potential for damage to existing infrastructure and the health of the population. It is based on the distance of the proposed flood-protection structure from the nearest built-up area (buildings).

Z—State of Flood-protection Structures (−)

This is a simple classification of existing and proposed measures for flood protection into five categories based on the assessor's decision.

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