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Soil Characteristics of the Otava River Basin and Relations to Floods

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Abstract

The paper assesses the role of the river basin land cover in eliminating extreme precipitations. Its comprehensive approach involves assessment of significant soil characteristics of monitored soil types, subtypes, and classes in terms of potential water infiltration and retention and focuses on land use and relief slope and curvature. The main working method is an analysis of soil units, 1 : 50 000 soil maps, and potential risks of degradation processes. We pay a specific attention to different methods of flood plains delimitation based on pedological, geological and geomorphological principles and their relations to peak overflow values during the 2002 flooding. The whole river basin is divided into three main zones – catchment, outflow, and inundation zones. Results are linked to individual sub-river basins and compared in terms of soil types representation in the form of triangle charts. The main output involves synthetic units of soilscapes showing such combinations of soil, substrate, relief, and land use characteristics that most contribute to studies of internal landscape differentiation in terms of natural risks like floods.

Key words: land cover, soil type and class, infiltration, retention, soilscapes

1. Introduction

To appreciate the importance of the soil cover effects on retardation or elimination of extreme precipitations in river basins, it is vital to summarise main soil functions. The soil capacity to absorb and accumulate rainfall waters varies in individual soil types identifiable from reference soil profiles. In terms of spatial development, the soil cover is a continuum showing only unclear lines of reference units and therefore the amount of transitional (hybrid) units on the lowest classification level is quite high. Such transitions impossible to describe plausibly in pedological terms aren't even reflected in maps. The whole soil cover is made of rather fuzzy structures best described in by associations with heterogeneous content.

Soil is an activated layer of the Earth mantle rock where mineral and organic material forms structural particles forming a porous system allowing for water percolation and accumulation. The soil water volume depends on binding patterns (gravitational and capillary water being the most important) and varies greatly subject to soil texture, porosity, and biological activity. The soil water volume can be expressed through many variables in terms of soil type, bulk density, height of the water column accumulated in the profile, water capacity, or pF curves.

2. Material and Methods

The runoff balance depends on current water infiltration and natural retention in the river basin determined by a) the soil cover natural characteristics, b) the level of functional damage or modification by direct or indirect anthropogenic degradation of individual soil units, and c) soil use. We focus only on those identifiable from available soil and geological maps and typical for monitored units.

The natural character of the soil cover, as a category, reflects a synthetic approach to physical characteristics of individual monitored soil units distributed in the landscaped according to principles of the soil cover structure. Such a structure is subject to effects of soil-forming factors, mainly the geological base, relief, and the original vegetation cover. The natural character is not defined as such with respect to its original state, but to the current state. Monitored units were originally delimited in detailed maps of the Comprehensive Agricultural Land Research (KPZP), scale 1: 5000, or 1: 10 000 forest maps, but in line with the first paragraph, the units have to be evaluated as associations of various soil subtypes, mainly with respect to their location in the topographic catena of different concave and convex parts.

The soil capacity to absorb extreme precipitations depends mainly on infiltration and retention.

Infiltration

Infiltration and soil permeability (or water mobility in the soil environment) are strongly determined mainly by the following factors:

- Soil profile texture – generally, the lighter the soil, the higher the infiltration.
- Horizons or soil profile layers of different texture or different physical properties (compacted layers) – above luvic, compacted and double substrate horizons water infiltration stagnates.
- Soil (profile) structural state – stable aggregate structure, mainly in case of epipedons, eliminates poor infiltration capacity of heavy soils.
- Soil depth (to the bedrock, to the ground water level).
- Mineralogical composition of clay affecting soil volume changes when swelling and contracting (montmorillonite – significant swelling; illite, kaolinite – poor or no swelling), and fissures.
- Pore characteristics – size and distribution, the most important role is attributed to macropores carrying gravitational water and activity of macroedaphone.
- Humus content and its characteristics (fractional structure, age).

A significant role is played also by texture and mineralogical composition of fine fractions, soil profile stratigraphy or texture heterogeneousness and distribution of horizons marked by different texture properties. In terms of texture, optimum soils are medium-heavy soils (sand-loamy or loamy soil) which physical characteristics ensure (due to lower bulk density, good aeration and biological activity) an optimal development of other functions including humification, sorption saturation, and structural patterns. The category of medium-heavy soils comprises most of chernozems and luvic soils made of eolian Pleistocene sediments with heavier subsoil, deep

Cambisols of a flat relief free of gravel, and other types and subtypes in deep foothill colluvial sediments. Sandy and clay soils don't have the same properties. Sandy soils often create xerophyte conditions in southern areas; show a high infiltration and low retention, high permeability and proneness to lose important bases and nutrients. Clay soils have high retention capacities and poor surface infiltration, unfavourable profile conditions and are prone to waterlogging.

We have to take into account that infiltration and permeability strongly depend on the soil water volume, i.e. whether infiltration and water processes occur in an environment already saturated by water. In such case, infiltration and permeability are much slower due to volume changes in soil (swelling), but it is easier to determine infiltration and permeability parameters. Water processes in an unsaturated environment are more complicated and difficult to quantify.

The issues of infiltration and permeability are very broad and therefore we mention the main works we build on (Sumner M., 2000, Baize D., 2000, *Référentiel pédologique* 1995, Duchaufour P., 1997, Němeček, Kutílek and Smolíková, 1990, Janderková J. et al., 2000).

Infiltration is measured by the speed of water infiltration into soil in millimetres per a time unit and strongly depends on the surface agrotechnical conditions, slope, and gravel content.

Retention

It is the capacity to retain water in the soil profile and to release it gradually in the evapotranspiration process. Similarly as infiltration, it depends on the texture (the heavier the category, the greater the capillary capacity), depth, gravel content (gravel reduces retention space), and humus and organic substance content in the overlying humus horizon (O) of forest and hydromorphic soils. By water retention we refer mainly to capillary water. Soil retention gradually changes into geological bedrock retention, depending on the rock type, fissure system, and weathering level. This type of retention can be derived from hydrological maps.

Damage is caused mainly by changes in soil functions resulting from long-term farming and related degradation. The main processes are listed below.

Erosion and accumulation – by redistributing soil particles from the divide to flood plains, erosion and accumulation processes change texture and profile thickness.

Compaction – significantly decreases infiltration by building up the bulk density and reducing porosity and macropores.

Reduction of edaphon and its diversity – leads to loss of living conditions of many significant classes of macroedaphon. The macroedaphon activities form a macropore network allowing mobility of gravitational water.

Drainage – speeds up runoff from the river basin changing significantly abiotic conditions in the landscape and modifying conditions prerequisite for ecosystem existence (e.g. ecosystems linked to wetlands).

Less significant processes involve acidification and debasification changing considerably the soil structure and indirectly affecting a broad range of soil characteristics.

As the original state of soil characteristics isn't available, we assess the scale of damage as a potential proneness or vulnerability to degradation. Current agricultural policies unfortunately don't provide for any significant differences in approaches to soil (agricultural activities are intense, large-scale, environmentally unfriendly, and employ the same agrotechnical methods), and degradation is a common phenomenon in most of agricultural areas.

Methods of soil use are very important and can be assessed in a simplified way by studying deviations (anthropogenic transformation) from the natural climax vegetation cover and functionality, or existence of technical facilities in the area. We therefore assume that the original soil cover under the original vegetation cover (mostly broadleaved or mixed central European forests) had optimal characteristics in terms of ecological functions and water runoff. All changes from agricultural colonisation to so-called ameliorative technical-agricultural modification involving underground and surface drainage, plot consolidation, watercourse regulation, and changes in soil use expanding arable land to the maximum lead to deterioration of main soil functions.

Drawing on databases of the Land Register, we determine three main categories of soil use. However, the category "Other" (involving built-up areas and soils in their natural and primitive development states unsuitable for agricultural activities, or forests) has totally different functions. Such areas may form significant landscape invariants like rock outcrops, ridges, hedgerows, boulder fields etc. significantly moderating surface runoff.

2.1. Information Source and Data Interpretation

2. 1. 1. Soil Maps

We make the maximum use of the most detailed soil maps and descriptions of individual soil monitoring units. As soil maps of 1:50 000 aren't available for the whole territory, we work with detail soil ecological units (BPEJ) despite their lower informative value.

First of all, we need to decide how to use BPEJ. There are two clear-cut opinions on their usability that have to be dealt with in the methodological part (Janderková et al., 2001).

- BPEJ are universal and in the form of a GIS thematic layer cover the whole territory. In technical terms, they are optimal to use, assess agricultural soil with sufficient precision in economical and ecological terms according to soil and external ecological properties. They are universal enough to allow easy transformation free of major errors into forest typological units as is stated in *Rukověť projektanta* (Löw J., 1995), their point assessment is more objective than the official price list, but the correlation of points and price is very high.
- Work with BPEJ is marked by a high error rate due to the impossibility of any statistical processing of individual characteristics. The units are associations of KPZP typological units formed according to a similar production response under the normal current type of agricultural activities. We don't know the spatial representation of different types within BPEJ and in assessing functional criteria are

forced to operate with interval means of analytical data (pH, humus, gravel content etc.) with a huge spread. Similarly, some ecological characteristics don't suit to our needs. Mainly climate and slope data should be replaced by current data from new geomorphological research sources.

The assessment of forest soils draws on supporting materials used for 1: 50 000 soil maps produced by the Forest Management Institute (ÚHUL) Brandýs n. L. and 1: 200 000 maps of soil associations.

Other soil types aren't so far assessed by any specific methods because the Surveying Institute materials don't allow for their localisation.

2. 1. 2. Geological Data Sources

In general, we build on 1: 50 000 maps and in specific cases use more detailed maps and older reports on geological research in the monitored area over the recent years. We aim at putting into context geological soil bedrocks and parent materials with soils because soil, the mantel rock and covered rocks create a system of mutually affecting components. Without taking into account any further significant layers of a purely geological character, soil assessment to the depth of 120–150 cm could be marked by a high error rate, mainly in terms of retention assessment, due to the fuzzy line between soil and ground water.

It is vital to compare geological and pedological maps and to define units of the same characteristics as *fluvial sediments and Fluvisoils, deluvial-fluvial sediments and Gleysols* and take into account different approaches to classification of Quaternary sediment types and related soil types, e.g. eolian sediments, terrace gravel layers etc.

2. 1. 3. Other

We work with land use and relief classifications. Significant amounts of surface runoff water are produced by unrecorded surface categories formed by environmentally unfriendly approaches to soil and landscape, mainly the road network built in areas within the agricultural land and forest resources disregarding original roads indicated in land register maps. Drawing on the field mapping results, such areas represent a significant source of runoff water due to their zero infiltration. In forests, roads cause one of the few types of soil erosion, so-called technical-transportation erosion. Density is indicated by current aerial photos.

3. Results and Discussion

3. 1. Landscape Assessment in Individual River Basins

Partial river basins, fundamental geographic entities, are delimited by a divide and limnigraphs. We characterise river basins with respect to the internal structure of pedosphere, biosphere and relief characteristics to obtain comparable and graphically represented results. Individual categories conditioning infiltration, retention and other properties (relief, land use and proneness to degradation risks) are assessed in three categories. This approach facilitates a graphical depiction in triangles and establishment of a simplified soilscape typology. Three-grade scales can be further differentiated by applying different weights.

Collecting and assessing data, it is important to compare approaches to mapping of significant landscape segments adopted by geologists, geomorphologists, pedologists, and hydrologists.

3. 1. 1. Flood Plains Delimitation

Flood plains, or alluviums, form a significant landscape element originated and developed in a causal relation with erosion, inundation and land colonisation in the Holocene era. Flood plains may be defined in geomorphological terms by delimitating the flat valley bottom and slope bases, in hydrological terms as the valley bottom under the influence of overflow during floods, in geological terms as fluvial Holocene sediments, in pedological terms as extension of Fluvisols, the most recent soil types, made of flood sediments, and in geobotanical terms with respect to vegetation structure.

We view flood plains as an ecosystem, i.e. an abiotic deposition on the valley bottom and related vegetation and animal communities.

Different flood plain delimitations made in relation to examples of cross sections on several tracks of the Otava and Blanice rivers draw on field mapping results, pedological probing, analysis of found excavation works for technical facilities, and erosion furrows (Vilímek & Langhammer, 2006).

The Otava flood plains are characterised by irregular width documented in Chart 1 depicting the width in relation to the distance from the spring. This is related to main patterns of the Otava valley structure (and applies also to other watercourses in south-western Bohemia). Holocene flood plains burry limnic Tertiary layers in broad depressions and thresholds of crystalline rocks and such "rejuvenation" of the valley close to Střelské Hoštice and Katovice suddenly narrows the whole profile (Sekyra J.; 1957). The Otava originally meandered in these broad areas and Histosols horizons in relics of abandoned river branches are still visible as well as the levee of the Otava bank 0.5–1m above the flood plain borders. In such cases, hydromorphism is distributed unevenly and the soil cross profile has a similar character as depicted in Figure 1 reflecting conditions above the mill in Poříčí close to Střelské Hoštice. Lateral minor streams often flow to the main flood plain through alluvial cones and fluvial sediments of the main valley and lateral watercourses are gradually transformed into deluvial-fluvial sediments. On minor watercourses, such sediments form the main filling along thalwegs.

We illustrate different approaches to flood plains delimitation on several cross profiles. Pedological and geological approaches should be identical because they use recent fluvial sediments as the main distinguishing feature. Geologist, geomorphologists and pedologists focus mainly on surface morphology as probing is conducted preferentially in representative sites in flood plains centre. Comparison of results shows significant similarities in alluvium delimitation despite that the methodology of currently made 1: 50 000 soil maps explicitly requires unification of Fluvisols and fluvial sediments. The greatest differences (e.g. the broad flood plain below the town

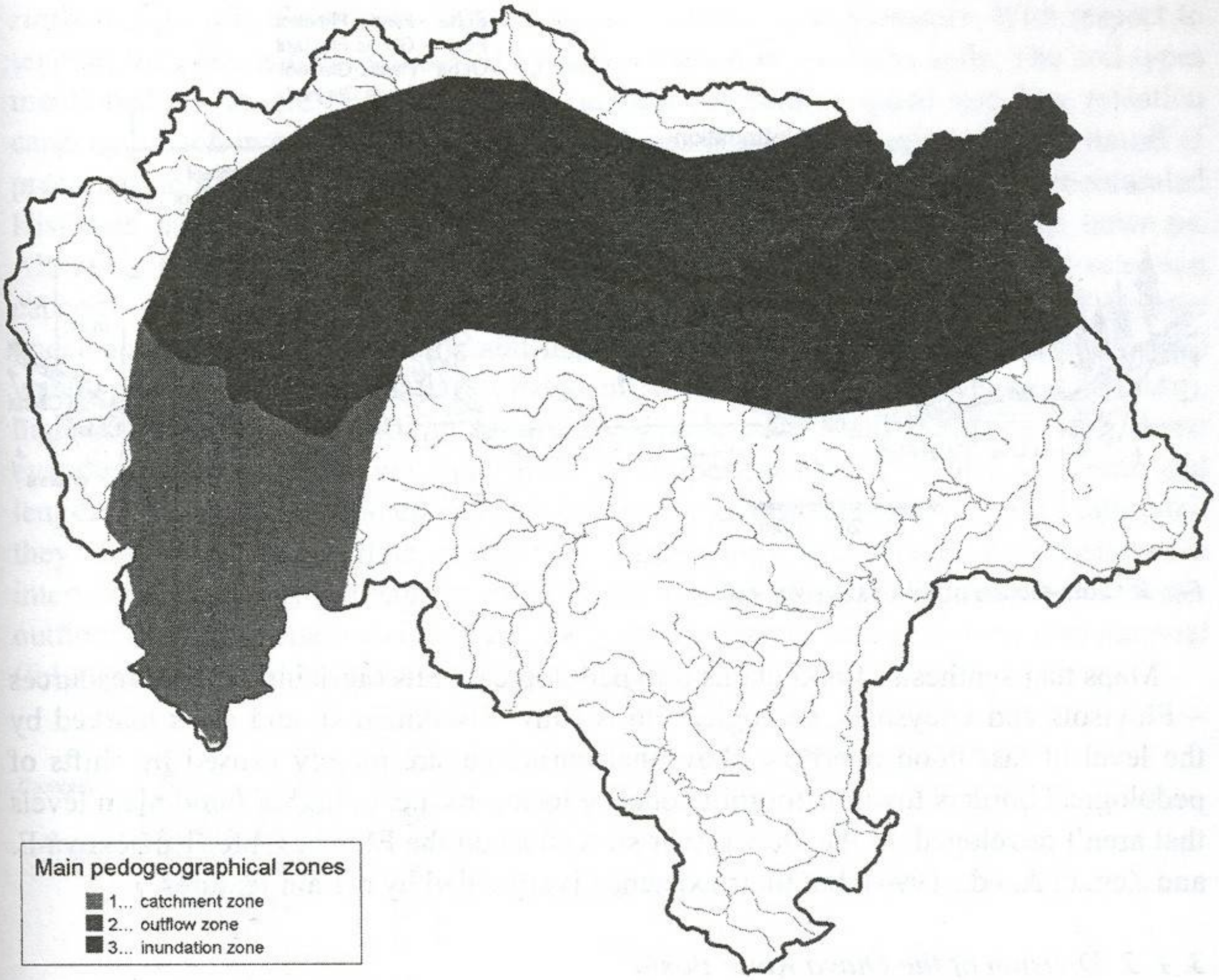


Fig. 1 Main pedogeographical zones of Otava river basin

of Poříčí on the confluence with the Březový stream left-hand tributary) are found in areas where the flood plain morphology is not distinct and gradually changes into deluvial slope sediments. Where no excavated profile is available, clear distinction of fluvial and deluvial-fluvial sediments based on probing strongly depends on mapping personnel's (pedologists or geologists) subjective views. Opportunities to study pedological-geological profiles in technical excavations are rare. One of the exceptions is the Brložský stream lateral flood plain where the cross profile was open for water pipeline installations. The diagram attached (Figure 2) shows items we aren't able to identify in a regular field research, e.g. flood plain sediments thickness over 3m, clay character of the whole profile changing into kaolinized migmatite upon contact with the bedrock, older than Holocene upper layers of fluvial sediments in flood plain borders (covered by gravel and boulder slope deposits – periglacial sharp rough weathering residues of gneiss and migmatites) apparently from the last glacial age.

Therefore, differences in flood plain definitions based on the traditional method described in the previous paragraphs and those based on the maximal flood afflux are driven by various factors. They result mainly from anthropogenic (technical) modifications of the flood plain surface leading to changes in the valley profile flow capacity.

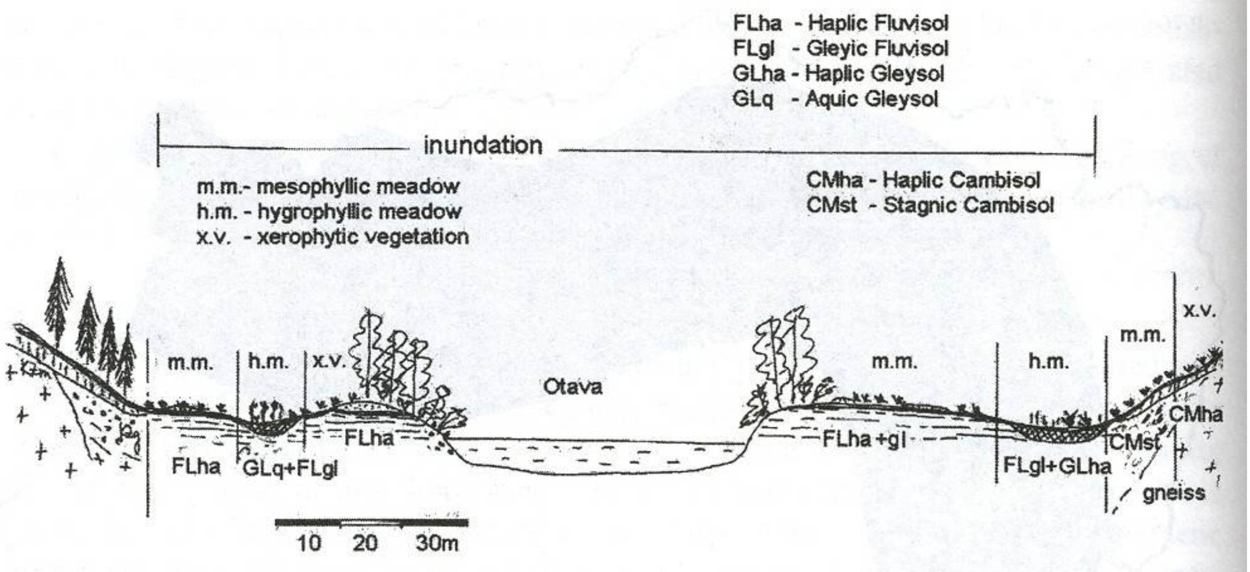


Fig. 2 Cross-section of the Otava river valley

Maps that synthesise flood plains into pedological units (agricultural land resources – Fluvisols and Gleysols), geological units (fluvial sediments), and units marked by the level of last flood overflow show that variations are mainly caused by shifts of pedological borders towards foothill concave locations, i.e. to higher flood plain levels that aren't developed on the Otava river so well as on the Elbe or Ohře (Růžičková E. and Zeman A. ed., 1994), but their existence is signalled by certain features.

3. 1. 2. Division of the Otava River Basin

We divide the Otava river basin by its relief, land use types, and soil units into *catchment, outflow,* and *inundation zones*. To characterise the land cover, we draw on pedogeographical classification of Bohemia (Němeček J. and Tomášek M. 1983) adapting the names of soil units to the current soil classification (Němeček et al. 2001).

The **catchment** zone is located at a medium or high height above the sea level (over 600 m above the sea level) in areas with intensive farming, large representation of permanent grass, and domination of forests. The medium slope is 7–10°. In the Otava river basin, spruce monocultures prevail in the zone and forests in total are represented by over 80%. In terms of the soil cover, this is an area of Combisols rich in alkaline substances and rankers on steep slopes and of entic Podzols or Podzols in association with dystric Combisols in highlands with frigid temperature regimes. The headstream areas (the Modrava and Vydra river basins) are further dominated by associations of hydromorphic soils and Histosols in flat and accumulation areas. Soil associations are mainly characterised by a relatively high contrast of soil types resulting from slope differences, and by association heterogeneity. Individual soil types cover unweathered rocks or are marked by a low development level, which indicates a shallow or medium-deep profile (up to 60 cm) with the main category of skeletonisation between 25–50%. The profile is transformed relatively sharply into the parental material (alterite or solid crystalline or metamorphic rocks). In typological terms, there are mainly *rankers, Litosols, Cambisols, entic Podzols, Podzols,* and *Histosols*. With respect to texture, the zone is mostly covered by light or medium-skeleton soils. The soil types mentioned above are characterised by a high infiltration speed and low retention capacity, which in combination with steep slopes conditions a relatively fast runoff of precipitation waters in surface watercourses. Runoff is accelerated by water-saturated Histosols and underdeveloped soils in boulder fields, debris, and rock outcrops. Although Histosols have huge water retention potential, once saturated, retention capacity drops to zero. A significant damping factor modifying the runoff balance under normal rainfall conditions and increasing the amount of retained precipitation waters is a high interception (varies between 10–40% according to the class structure), high capacity of the overlying humus to absorb water, and generally high forest evapotranspiration. However, such positive properties change with the volume and length of precipitations and upon a certain level of pedosphere and biosphere saturation they don't have any effect. Runoff is significantly accelerated by ameliorative interventions, mainly drainage of agricultural and forest areas by open ditches. Water outflow from this zone is mostly free of any floating matter and rich in organic material (fulvic and humic substances).

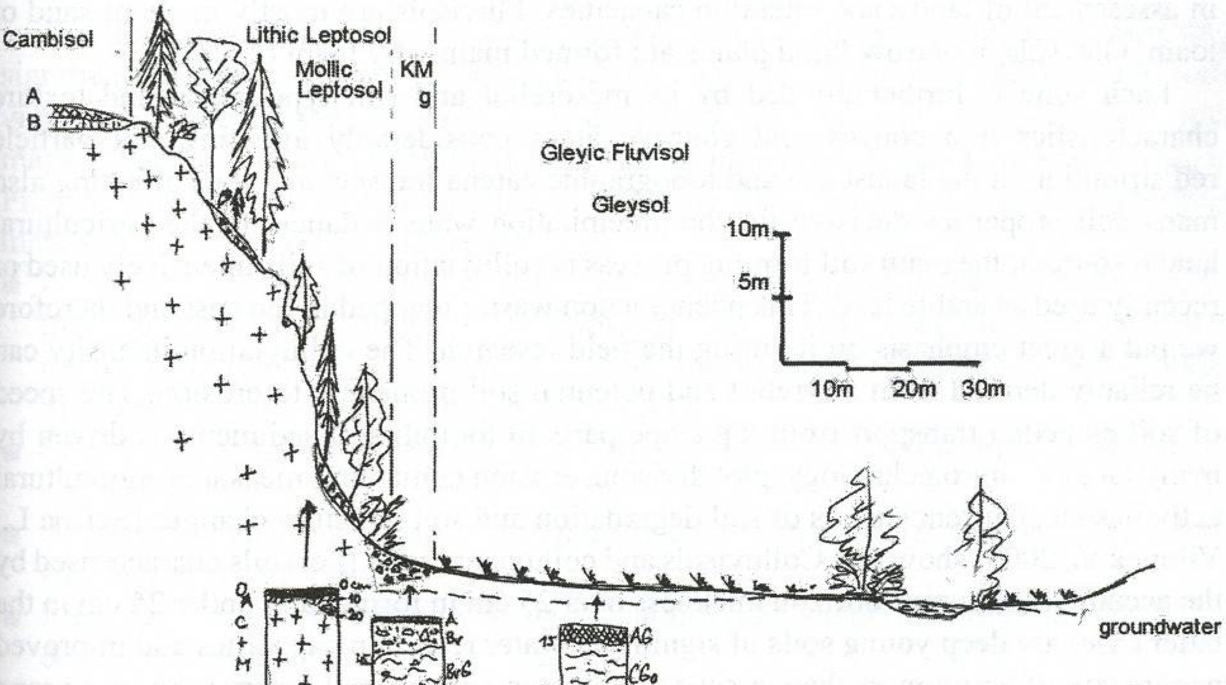


Fig. 3 Cross-section of the Brložský creek flood plain

The **outflow** zone is located at a lower height above the sea level (under 600 m) in Šumava foothills and is characterised by a large representation of agricultural land comprising 60% of arable land (today it's slightly less). This is an area of Cambisols low in alkaline substances, Stagnosols and hydromorphic soils (Stagnosols and gleyic Stagnosols) covering flat and accumulation areas, and of dystric Cambisols and rankers found on steep slopes. Soil types are quite variable and logically structured into soil sequences by the topographic catena and soil-forming substrates. The variety of parent material and relief division leads to significant soil contrasts. In terms of the substrate, we find various terrace gravels, sands, coarse weathering residues mainly of granite rocks and their deluviums, and Tertiary limnic sediments with a variable content of clay and sand. Soils are largely drained and are highly vulnerable to degradation processes like erosion, compaction, acidification etc. This is a source area of soil-originated floating matter.

The **inundation** zone is located at the lowest height above the sea level and is used for agricultural purposes. It terms of the soil cover, it forms a pedogeographic base of the river basin made of Fluvisols and hydromorphic soils linked to fluvial and deluvial-fluvial sediments of alluviums and valleys of minor watercourses. Substrates are mostly formed by fluvial sediments and partially by terrace gravels, sands and Tertiary limnic sediments filling broad valleys of the downstream Otava, Volyňka, and Blanice. The substrate diversity results from type diversity playing a significant role in assessment of landscape retention capacities. Fluvisols are mostly made of sand or loam; Gleysols in narrow flood plains are formed mainly by loam or clay.

Each zone is further divided by its mesorelief and soil typological and texture characteristics into convex and concave areas considerably affecting soil particle redistribution in the landscape and topographic catena transect and thus affecting also many soil properties decisive for the precipitation water balance. In the agricultural land resources, the main soil forming process is colluviation of soils intensively used or recently used as arable land. This phenomenon wasn't mapped in the past and therefore we put a great emphasis on it during the field research. The colluviation intensity can be reliably derived from the relief and potential soil proneness to erosion. The speed of soil epipedon transport from top slope parts to foothill soil sediments is driven by many factors – agrotechnology, plot division, erosion combating measures, agricultural activities etc. Current studies of soil degradation and soil structure changes (Šefrna L., Vilímek V., 2003) show that Colluvisols and colluviated soils (i.e. soils characterised by the accumulated humus horizon thickness over 25 cm in former and under 25 cm in the latter case) are deep young soils of significant water retention capacities and improved parameters of sorption exchange capacity, humus content and reserve, but are prone to some degradation processes due to disturbing pedogenesis and profile stabilisation effects.

3. 1. 3. River Basin Characteristics

Firstly, individual river basins are assessed in triangle charts to compare relative proneness or resistance to runoff accelerating or decelerating factors, to identify the volume of retained water, and the scale of potential soil cover degradation because such dynamics deteriorate most of the hydrological balance parameters. The size of points is proportional to the agricultural land resources representation in the river basin.

We assess the following river basin aspects:

a) Representation of hydromorphic soils (Gleysols, gleyic Stagnosols, Histosols), semihydromorphic soils (Stagnosols and gleyic subtypes) and Fluvisols indicative of soil water retention,
b) Representation of hydromorphic, semihydromorphic and anhydromorphic soils indicative of waterlogging in the river basin,
c) Representation of soils of high, medium and low infiltration capacity (Janderková et al., 2000),
d) Representation of deep soils (in most of Quaternary sediments – terraces, deluviums, alluviums, and Tertiary limnic sediments), shallow soils and soils with an extreme gravel content (mainly soils in poorly weathered rocks which profile is limited by unweathered rocks of 30–60 cm and where gravel content exceeds 50%), and soils on extremely steep slopes (i.e. over 12%),
e) Representation of important land use categories classifying land use units by rainfall water retention; the lowest – built-up areas, roads and water areas, medium – arable land, high – forest, permanent grass land, orchards, and gardens.

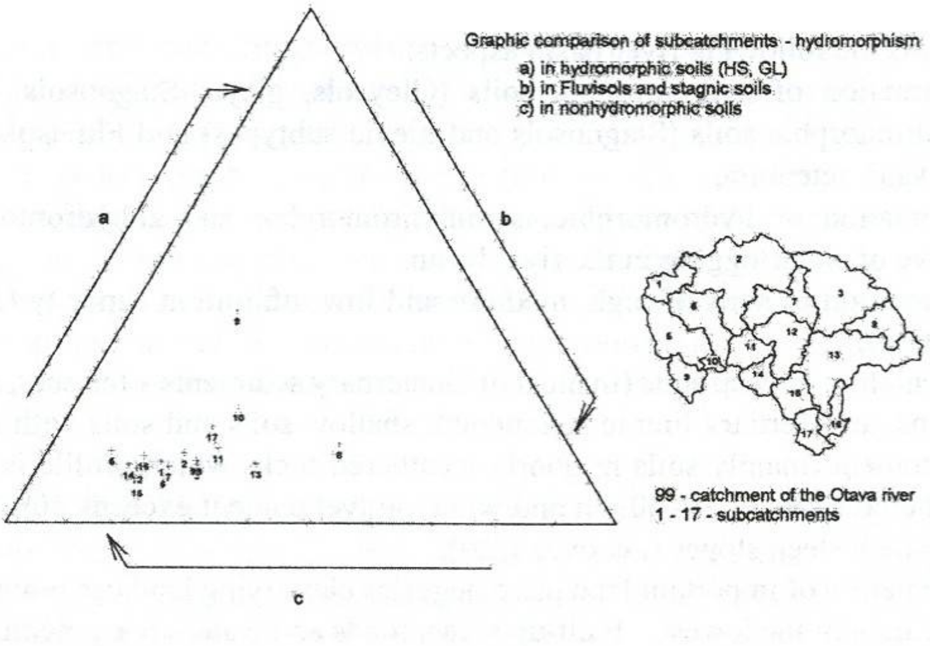
3. 2. Representation of Individual Geological-Pedological Comprehensive Units

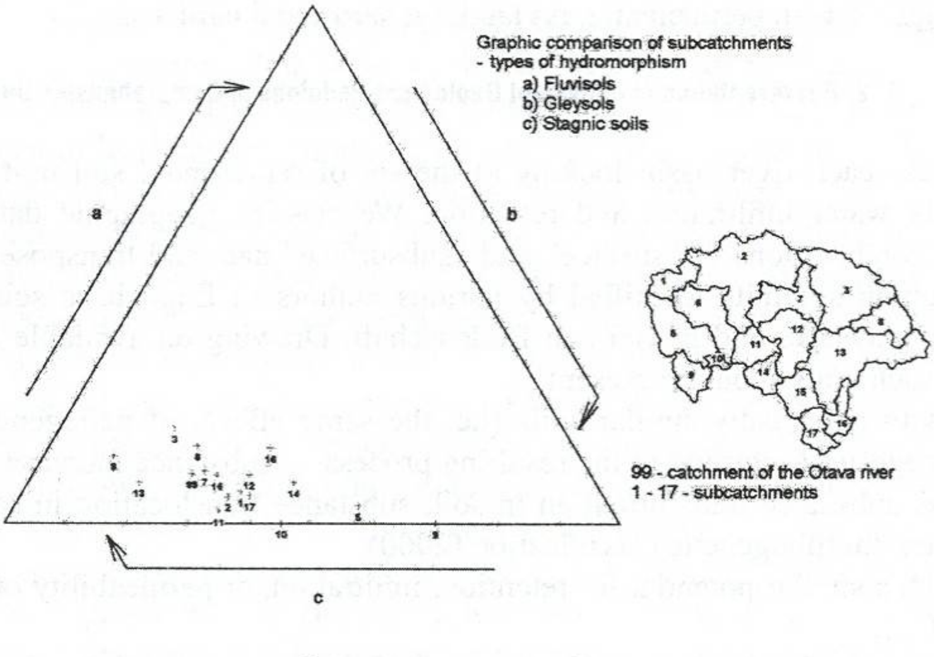
We assess each river basin looking at the set of represented soil units affecting significantly water infiltration and retention. We classify geographic data on soils viewed as combinations of "surface" and "subsurface" data and transpose them into maps obtaining soilunits identified by various authors in English as soilscapes, in French pedopaysage, and in German Bodenschaft. Drawing on available supporting materials, such units should represent

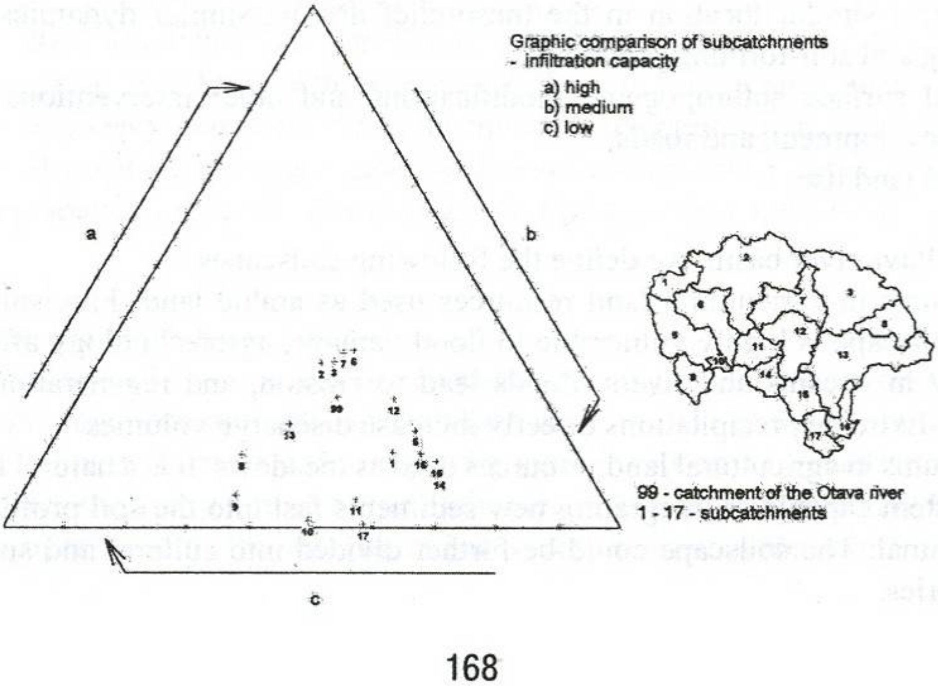
- Areas with genetically similar soils (i.e. the same effects of pedogenesis on the main categories according to the resulting process – "substance increase, substance decrease, substance transformation in soil, substance translocation in soil") under the current morphogenetic classification (2000),
- Soils with a similar potential for retention, infiltration, or permeability of profile or soil surface,
- Areas of a similar location in the mesorelief driving similar dynamics of relief--forming and soil-forming processes,
- Identical surface anthropogenic modifications and other interventions including dams, development, and roads,
- Identical land use.

In the Otava river basin, we define the following soilscapes:

1. Alluviums in agricultural land resources used as arable land, Fluvisol-type soil. The soilscape is highly vulnerable to flood damage, agrotechnology affects water quality in streams and rivers, floods lead to erosion, and regeneration is rather costly. Extreme precipitations directly increase discharge volumes.
2. Alluviums in agricultural land resources used as meadows. It is a natural flood plain ecosystem capable of integrating new sediments fast into the soil profile. Erosion is minimal. The soilscape could be further divided into cultural and spontaneous categories.


Graphic comparison of subcatchments - hydromorphism
a) in hydromorphic soils (HS, GL)
b) in Fluvisols and stagnic soils
c) in nonhydromorphic soils


Graphic comparison of subcatchments
- types of hydromorphism
a) Fluvisols
b) Gleysols
c) Stagnic soils


Graphic comparison of subcatchments
- infiltration capacity
a) high
b) medium
c) low

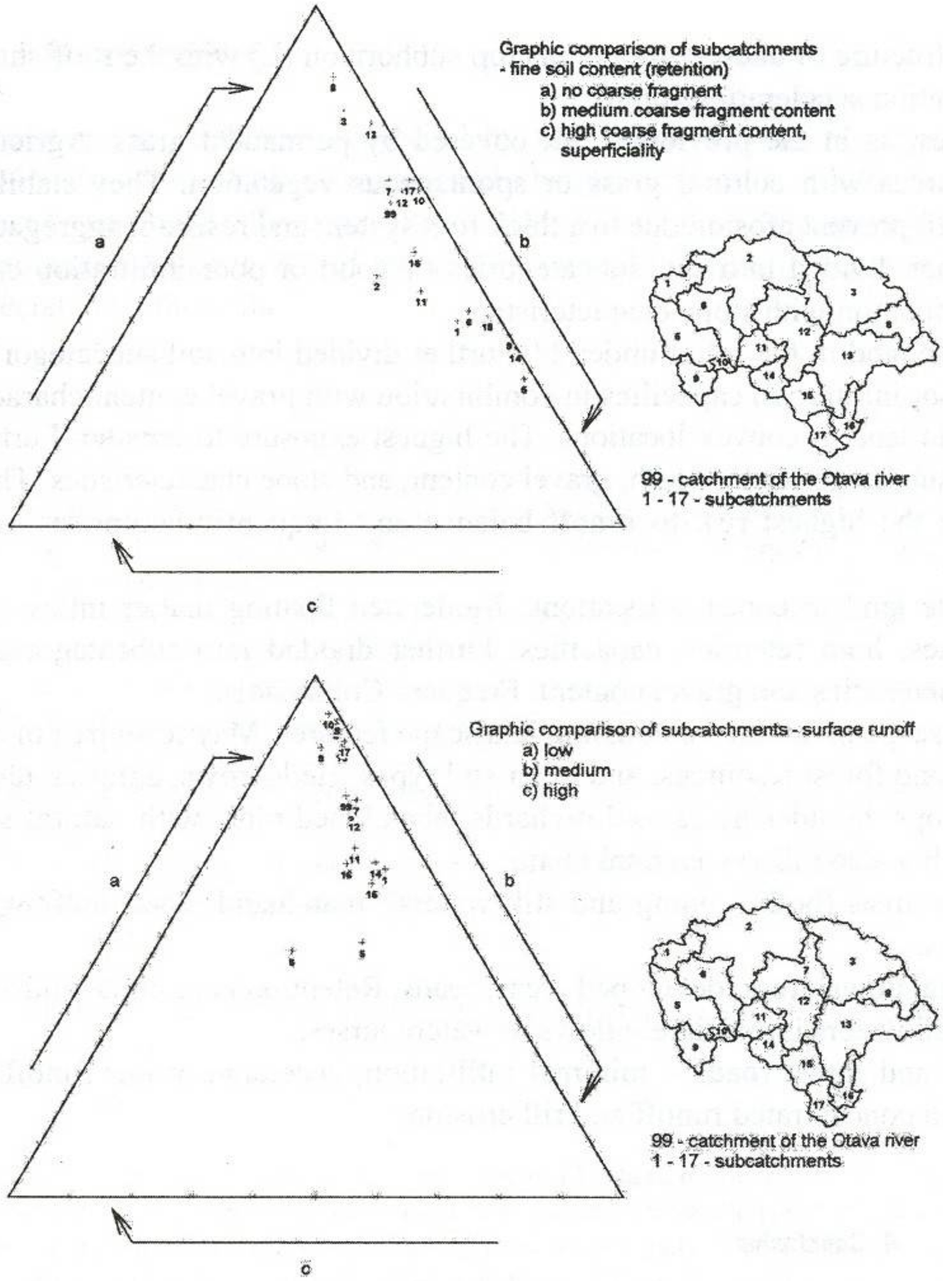


Fig. 4 Comparison of soil characteristics in subcatchments

3. Alluviums and alluvial forests. Further divided into natural and cultivated subcategories. They have a higher retention capacity than previous soilscapes due to larger reserves of organic material and perception.
4. Tributary valley bottoms with hydromorphic soils, mainly Gleysols and gleyic Fluvisols. Their inundation depends on local floods; inundation consequences aren't manifested along the main watercourse. Soils are heavier and mostly covered by meadows.
5. Forests from valley slopes to drainage divides. Subcategories of broadleaved and coniferous forests. Viewed as stabilising elements in the landscape with no significant surface runoff. Soil and underlying humus retention considerably decreases discharge volumes. Despite normally high interception, coniferous monocultures increase the risk of surface runoff under extreme precipitation conditions due to

the structure of underlying humus top subhorizon (L) with the roof-shaped needle formation accelerating runoff.

6. Slopes, as in the previous case, covered by permanent grass. Agricultural land resources with cultural grass or spontaneous vegetation. They stabilise surface runoff, prevent erosion due to a thick root system and resistant aggregate structure. Further divided into soil subcategories of good or poor infiltration capacities in combination with slope characteristics.
7. Arable land in flat relief under 3°. Further divided into soil subcategories of good or poor infiltration capacities in combination with gravel content characteristics.
8. Arable land in convex locations. The highest exposure to erosion. Further divided into subcategories by depth, gravel content, and slope characteristics. The soilscape poses the highest risk to runoff balance and frequently comprises undeveloped soils.
9. Arable land in concave locations. Moderated floating matter inflow into watercourses, high retention capacities. Further divided into subcategories by slope characteristics and gravel content. Frequent Colluvisols.
10. Landscape invariant – stabilising landscape features. May form part of agricultural land and forest resources, and other soil types. Hedgerows, agrarian terraces, rock outcrops, boulder fields, old orchards, abandoned plots with natural seeding etc. Possibly also railway embankments.
11. Water areas (both running and still waters), marshland. Total outflow of rainfall waters.
12. Central urban areas, developed areas, roads. Retention is minimal and 90–100% of rainfall waters immediately flows to watercourses.
13. Field and forest roads – minimal infiltration, accelerate water runoff, and often launch concentrated runoff and rill erosion.

4. Conclusion

The analysis of soil types and their links to other significant landscape characteristics as relief (slope steepness and shape), land use and land cover provide useful data to assess the land cover role in surface runoff formation. We have defined specific soilscapes, mapping units, synthetically reflecting the Otava river basin physical and geographical aspects of a key significance for the runoff balance assessment. In this respect, the most important soil characteristics involve texture, soil thickness, soil horizons number, mineralogical composition of clay fractions, pore character, soil structural state with activation, and humus content. With the exception of surfaces with anthropogenically covered or removed soil, rainfall waters get into contact with soils and flow to receiving watercourses in the manner depending on infiltration, percolation, and retention capacities of the soil profile. The assessment of soil physical characteristics is conducted drawing on an analysis of soil evaluation units within agricultural land resources. Once 1:50 000 soil maps are finished, it will be possible to perform the analysis for the whole soil cover without considering use aspects.

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References

NĚMEČEK, J., SMOLÍKOVÁ, L., KUTÍLEK, M. (1990): Pedologie a paleopedologie. Academia, Praha.

MAUSBACH, M. J. – TUGEL, A. (1997): Soil Quality – a Multitude of Aproaches. Kearney Foundation Symposium, Berkeley, California. 13 s.

LÖW, J. et al. (1995): Rukověť projektanta ÚSES. MŽP a fa Löw a spol., spol. s r.o., Brno.

DUCHANFOUR, P. (1997): Abrégé de Pedologie. Masson Paris, 291 s.

JANDERKOVÁ, J. – MACKOVČIN, P. – ŠEFRNA, L. – MACKŮ, J. – SÁŇKA, M. – TOMÁŠEK, M. – NOVÁK, P. (2000): Systém komplexního hodnocení půd. Závěrečná zpráva projektu VaV 640/3/99. AOPK ČR Brno 2000, 91 s.

RŮŽIČKOVÁ, E., ZEMAN, A. (Ed.) (2001): Holocene flood plain of the Labe river, 116 str. GLÚ AVČR Praha.

VILÍMEK, V., LANGHAMMER, J. (2006): Assessment of Flood Course and Consequences. Acta Universitatis Carolinae – Geographica, 38, 2, 203–217.

PEDOLOGICKÁ CHARAKTERISTIKA POVODÍ OTAVY VE VZTAHU K POVODNÍM

Résumé

V článku je hodnocena role půdního krytu povodí Otavy z hlediska možné eliminace extrémních srážek. Komplexní přístup hodnotí jak důležité půdní vlastnosti mapovaných půdních typů, subtypů a druhů z hlediska potenciální infiltrace a retence, ale hodnotí i roli způsobu využití půd a reliéf podle sklonu a zakřivení.

Analýza půd a jejich propojení s dalšími důležitými krajinnými charakteristikami jako reliéfem (sklony a tvary svahů) a způsobem využití ploch (v kategoriích land cover a nebo land use) nám poskytuje užitečný podklad ke zhodnocení role půdního krytu při formování povrchového odtoku. K tomuto účelu jsou sestaveny mapovací jednotky půdní krajiny, ve kterých jsou synteticky zachyceny fyzicko-geografické aspekty povodí Otavy, důležité pro hodnocení odtokové bilance. Za nejdůležitější půdní vlastnosti považujeme v tomto ohledu zrnitostní složení, mocnost půd a počet půdních horizontů, mineralogické složení jílové frakce, charakter pórů, strukturní stav půd s oživením a obsah humusu. Srážková voda (až na případy povrchů s půdou antropogenně překrytou či odstraněnou) přichází do styku s půdou a v závislosti na infiltračních, perkolačních a retenčních schopnostech půdního profilu odtéká do recipientu.

Pracovním postupem je analýza bonitačních jednotek a mapových podkladů půdních map 1:50 000 a potenciální ohrožení půd degradačními procesy. Speciálně je vyhodnocen různý přístup k vymezení nivy podle pedologického, geologického a geomorfologického principu a vztah těchto objektů k maximálnímu povodňovému rozlivu v r. 2002. Celé povodí je rozděleno na tři základní zóny sběrnou, odnosovou a záplavovou. Výsledky jsou dále vztahovány k jednotlivým subpovodím, které jsou porovnávány z hlediska plošného zastoupení jednotlivých půd v trojúhelníkových grafech.

Jako hlavní výstup jsou navrženy syntetické jednotky půdní krajiny, které se svou kombinací půdních, substrátových, reliéfových a land use nejvíce přispívají k poznání vnitřní diferenciace krajiny z hlediska přírodních rizik, jako například povodní.

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