ECOSYSTEM SERVICES OF SMALL WATERCOURSES IN THE CZECH REPUBLIC

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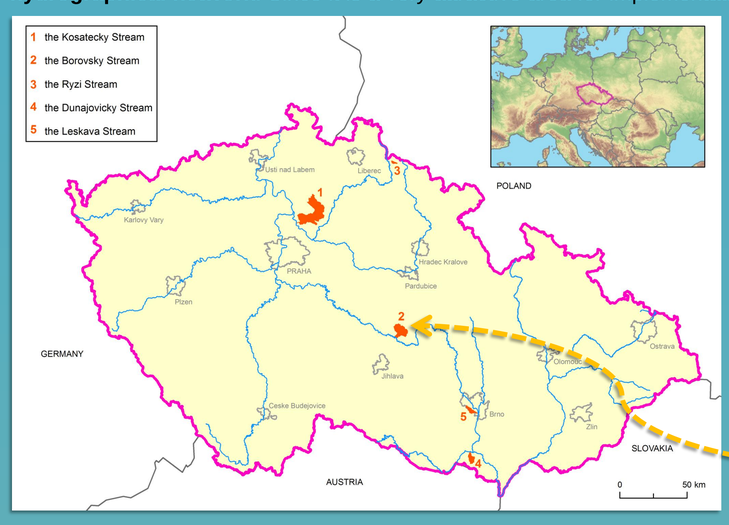
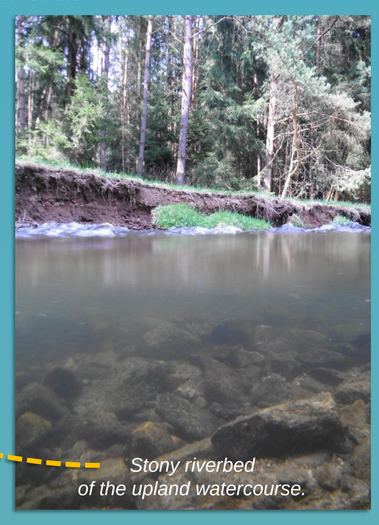
CONTEXT & STUDY AREAS

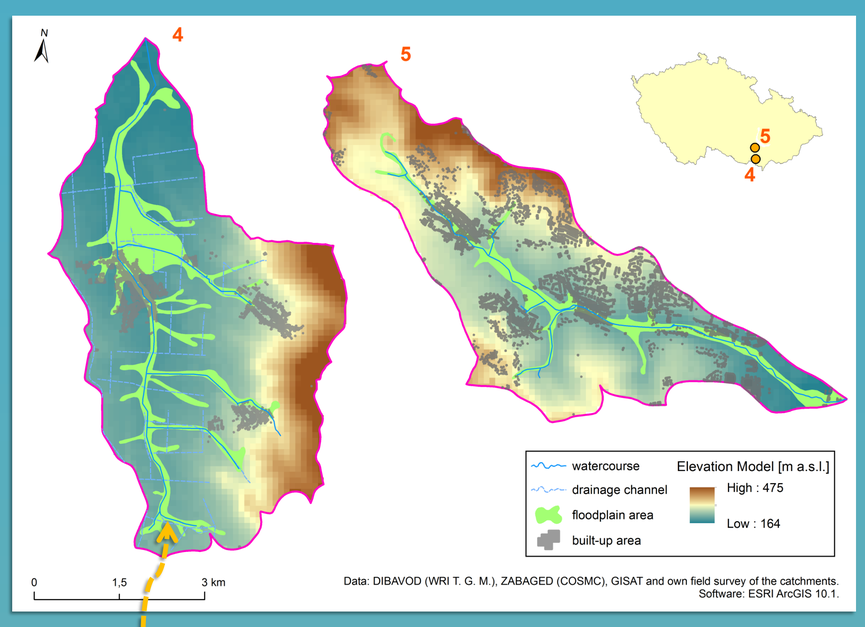
The issue of **ecosystem services** represents a hot topic especially in connection with quantitative expression of their **values** and research of functions, which the landscape provides to the human society. The question of ecosystem values research is solved with a focus on **the river landscape**, defined as the ecosystem along watercourses whose functioning is directly conditioned by presence of the **hydrographical network**. Since it is a very attractive area for implementation of the human needs, there is often regarded a **conflict** between activities of the **human society** and the effects of **natural processes**. As the model sites were selected the catchment areas of **small watercourses** in the Czech Republic which are specific by mutually different intensity of **anthropogenic pressure** on the landscape.




Stony riverbed of the upland watercourse.

These are the catchments of small watercourses differing from one another mainly in terms of the nature and intensity of **land use**, prevailing **environmental properties** or **hydrological variables** of watercourses themselves. The catchment areas in the lowland, intensively utilized regions, as well as upland and highland locations are represented. There are studied river basins in the large cities typical for occurrence of **urban stream syndrome**, up to the **rural catchments** with the presence of a limited number of small settlements scattered in the landscape.

The fundamental hypothesis is that there is a demonstrable, statistically significant **relationship** between the rate of **watercourse degradation** (expressed using the expert-defined set of status indicators of morphological parameters) and **environmental conditions**, usually within the river landscape area.



The area of **river landscape** to a large extent overlaps with a **floodplain area** and is defined based on **soil conditions** (especially soil types developed under the influence of river water).

DATA & METHODS

Hydromorphological parameters of the watercourses are used as a good source of information, directly related to the **environmental values** of the monitored area and their **spatio-temporal development** - mostly in the form of representation of **ecologically stable cultures**, increased values of **biodiversity** and occurrence of **specific landscape features**. The importance of this issue can be seen especially in the development of knowledge about the **ecosystem services** and forming possible approach to the **watercourses management** within the context of **sustainable development**.

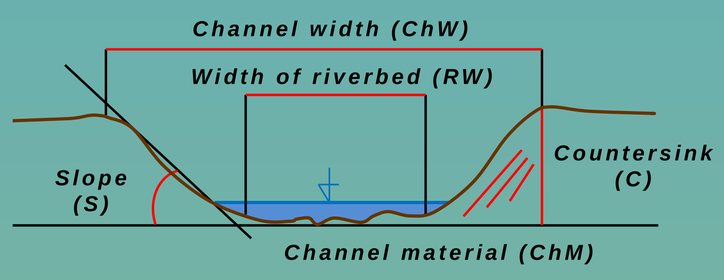


Figure above shows a **diagram of the watercourse channel** (cross-section) and morphometric characteristics measured for the purposes of subsequent analysis. Following parameters were measured on the monitored streams: **the channel width** (such as a distance of the opposite shores) [**ChW**], **the riverbed width** [**RW**], **the countersink of the channel** [**C**], **the slope of the banks** (average for both sides) [**S**] and **the channel material** which forms the shores and bottom of the watercourse [**ChM**]. All parameters of channel morphometry were measured using a laser distance meter. These characteristics were detected in **a pre-defined profiles** that best represent the morphological status of the channel in a stream segment. Each segment has relatively **homogeneous properties** in terms of stream morphology.

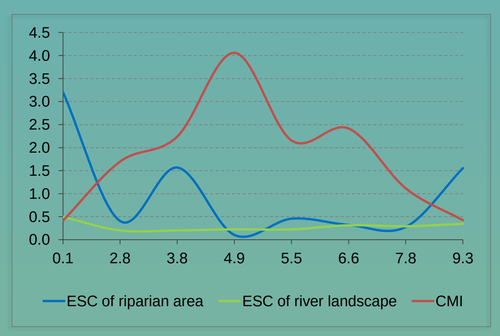
$$CMI = (ChW - RW + C) * \frac{S}{100} * ChM$$

$$CCC = AW_1 + BW_2 + CW_3 + DW_4 + EW_5 + FW_6$$

A … undersized bridge (W_1 = 1,5)
B … barrier within the channel (W_2 = 1,2)
C … reduced channel capacity (W_3 = 1,4)
D … narrow inundation area (W_4 = 1,3)
E … unsuitably situated buildings (W_5 = 1,0)
F … alternation of artificial and natural channel (W_6 = 1,1)

The acquired data entered into the calculation of a pair of indicators that provided information on the status of **channel morphometry** and its **patency**.

It is a calculation of the **Channel Morphology Index** (CHMI) and the **Channel Capacity Coefficient** (CCC). Both indicators can serve as a source of information about the potential for emergence of **flood situation**, since they include a number of variables which may affect the process of flooding. The aim of the CCC calculation is to identify the **critical locations** of hydrographic network, where **floods** easily occur in the case of high discharge. Generally the higher value of CCC indicates reduced capacity of the channel and the **higher risk of flooding**.

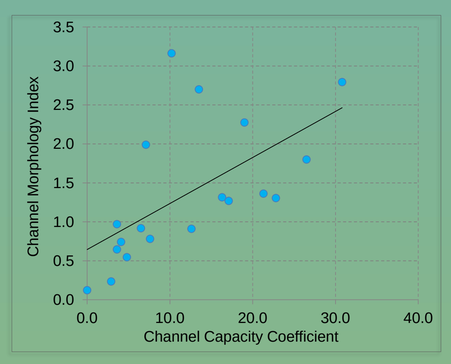


Channel material	Weight
Natural channel	0,1
Modified channel in the natural bedrock	0,2
Channel covered by stone blocks	0,3
Artificial channel covered by sediments	0,4
Cobblestoned channel	0,5
Channel made up of prefabricate	0,6
Concrete channel	0,8
Canalised (hidden) channel	1,0

The values of **CMI** observed in the longitudinal profile of the Dunajovický Stream and the **ESC** for the corresponding segments of the **river landscape** and **riparian area** brings the left graph. The existence of a non-linear dependence was confirmed on the basis of studies on the morphology of small watercourses in intensively exploited, lowland landscape of South Moravia.

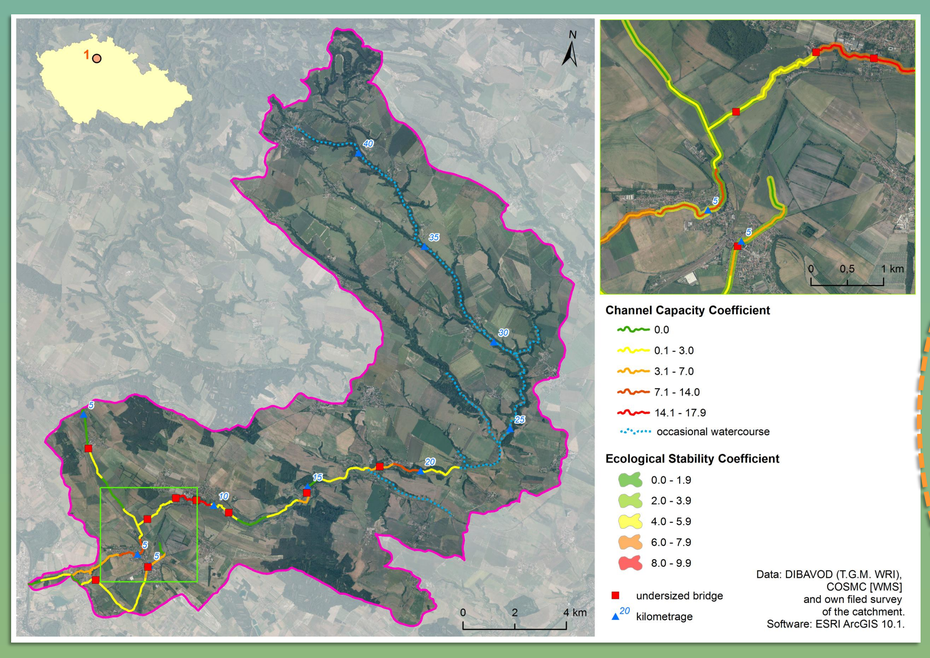
RESULTS & DISCUSSION

With regard to issues of **relations** between **fluvial environment disturbances** and **morphological properties** of the streams raises the question about status of water bodies and their **naturalness**. The morphology of natural watercourses is dependent on the **interaction** between the **flowing water** and **eroded material** in the site of the riverbed, which is shaped by processes of erosion and accumulation. However morphological characteristics of stream represent currently the result of a wide range of **other variables**, which have considerably contributed to the effect of **loss of natural state**.



Concrete-lined channel of the Leskava Stream.

The relationship between the values of CMI and CCC confirms existence of the **correlation** between the **amount of anthropogenic intervention** into the river landscape and **morphological state** of the streambed. The more degraded morphological channel state, the more barriers of natural flow are located in the riparian zone of monitored streams. Graph above shows the amount of each **type of barriers** in the **natural flow**. The barriers are counted in sections of the watercourse defined on the basis of relatively homogeneous conditions in terms of **channel morphology**.



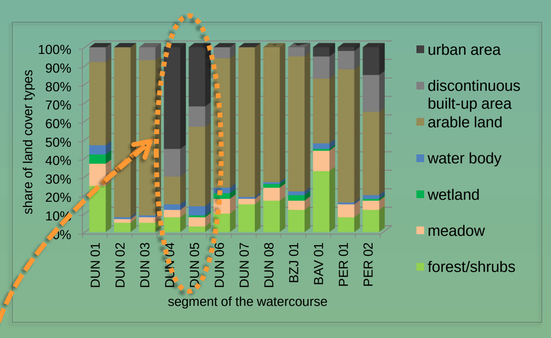
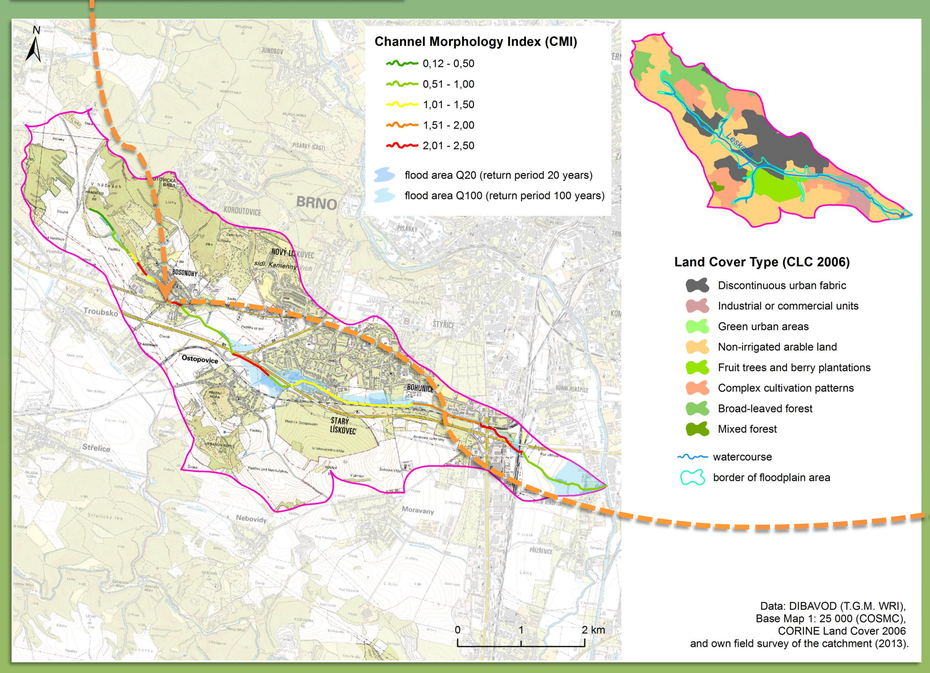
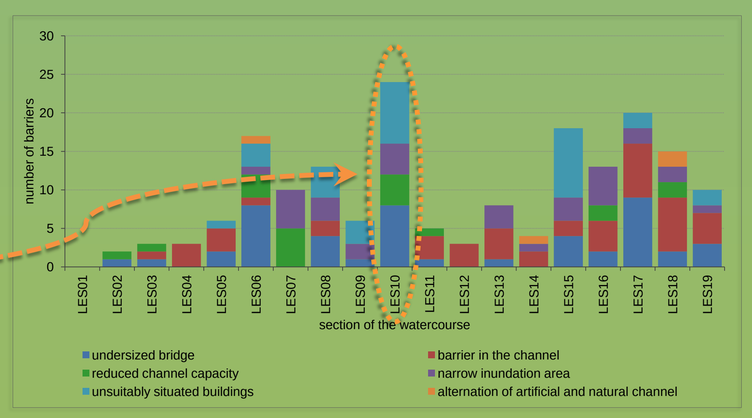


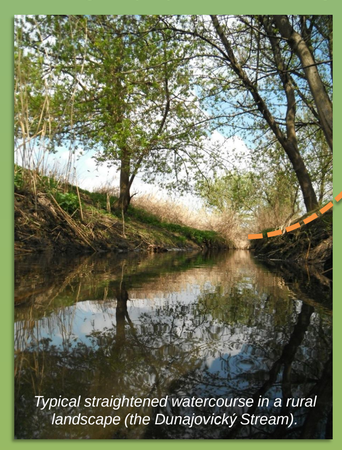
Figure above shows the share of individual types of land cover in the longitudinal profile of the Dunajovický Stream floodplain. It is obvious that this is a catchment with prevailing arable land more significantly are also represented urban areas and also discontinuous built-up areas. It is therefore an intensively used **rural landscape** with **low ecological stability**, which also corresponds to the condition of the watercourses.

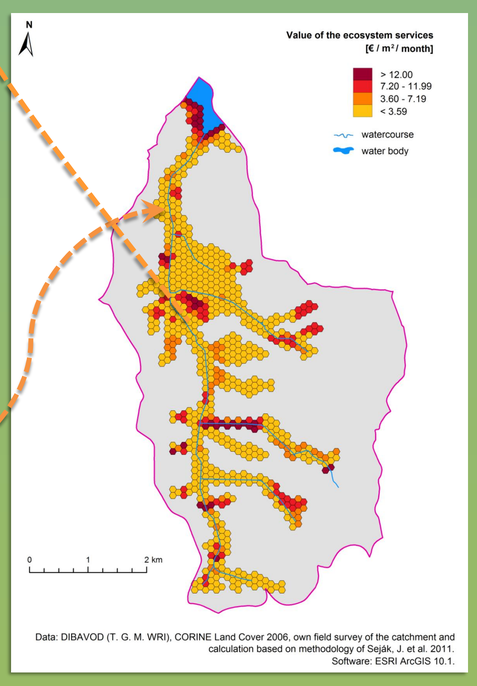


Map above shows the **spatial variability** of the Channel Capacity Coefficient on the example of the Košátecký Stream catchment. The value of **Ecological Stability Coefficient** (ESC) for riparian area is also displayed. Coefficient was calculated as a simple **ratio of ecologically stable areas to ecologically unstable areas**. The less natural areas along the watercourse, the higher the values of the Coefficient.

On the map bottom right you can see the **financial value** that provides **ecosystem of river landscape** to the **human society**. The value for each hexagon (1 ha) was expressed on the basis of application of methodology developed by Seják et al. (2010). Highest values are achieved at sites with the largest proportion of **nearly natural ecosystems** that are able to perform their primary function.




Typical straightened watercourse in a rural landscape (the Dunajovický Stream).



CONCLUSION

It is especially the **character** of the **current hydrographical network** or the **degree of modification** of the natural channel and riparian zone state that can be regarded as a valuable information resource about the **state of fluvial environment**. Another important variable is the intensity of the **anthropogenic pressure**, to which the landscape is subjected in a long-term period. The essence of the research comes from the fact that any change in a single variable which affects morphology of the river environment may cause a series of **channel pattern changes**, in addition with the feedback in the form of further secondary modifications in the channel parameters. Based on this information we can carry out steps to **improve the environmental conditions** of the current river landscape and to ensure greater **landscape security** for the human society.

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