MICROCLIMATE MONITORING FOR EVALUATION OF MANAGEMENT EFFECT ON MOHELNO SERPENTINE STEPPE

Hana Středová[1,3], Jaroslav Knotek[1], Tomáš Středa[2, 3]
[1]Department of Applied and Landscape Ecology, Faculty of Agronomy, Mendel University in Brno, Zemědělská 1, 613 00 Brno, Czech Republic
[2] Department of Crop Science, Breeding and Plant Medicine, Faculty of Agronomy, Mendel University in Brno, Zemědělská 1, 61300 Brno
[3]Czech Hydrometeorological Institute, branch Brno, Kroftova 2578/43, 616 67 Brno

Abstract
Relief, geological substrate, mesoclimatic conditions and historical management contribute to specific microclimatic conditions National Nature Reserve Mohelenská Serpentine Steppe (MSS). Long-term development of mesoclimate and effects of anthropogenic activities (construction of the nearby waterworks in the 80s of the 20th century aminy others) on the temperature and precipitation conditions are evaluated for the period 1961 - 2014. Data from the nearest climatological station Hydrometeorlogical Czech Institute (Dukovany) were used. Steppe vegetation in MSS has been recently reduced by spreading vigorous trees and grasses. Current MSS care plan thus includes intense management measures (grazing, removal of shrub and tree layer). Management impacts on climatic conditions MSS will be quantified through monitoring, founded in 2014. The article evaluated the results of temperature and humidity monitoring at seven monitoring points on the MSS. Heterogenity of surface temperatures using thermal imaging is laso included.

Key words: land-use, management plan, protected areas, air temperature, air humidity

Introduction

National Nature Reserve Mohelenská serpentine steppe NNR MSS (GPS 49.1075622N, 16.1853075E, near the village Mohelno, Czech Republic, Central Europe) was established in 1933 on an area of over 50 hectares on a plateau (Fig. 1) and rocky slopes (Fig. 2b) that fall along the left bank of the Jihlava River at an altitude of 260-385 MASL. Uniqueness of the steppe is given by microclimate conditions (hot, dry climate) significantly influenced by geological substrate - heating rocky surface, morphology of the terrain and its exposure and oligotrophic environment. Rock and turf steppe provides ecotope for specific animal and plant species. Botanical unique traits of steppe plants are dwarfs and nanisms.

Care plan of NNR MSS involves removing of non-native tree species, reduction of pines and shrubs, mowing and grazing. The project "Implementation of measures under the plan of care NPR Mohelenská serpentine step", funded by the OPE also supports monitoring activities (among others systematic measurement of meso and micro-climate) for the evaluation of the measures.

The aim is to (i) evaluate the long-term development mesoclimate in the area, including the impacts of anthropogenic activities (construction of dams Dalešice and Mohelno in the 80s of the 20th century); (ii) evaluate the climatic conditions MSS and their heterogeneity and specificity for (iii) the subsequent evaluation of stand management impact to MSS microclimate conditions.

Fig. 1: National Nature Reserve Mohelno Serpentine Steppe – the steppe part

Materials and methods

Climatological characteristics

According Quitt (1971) the area belongs to the moderately warm climate MT11, which is characterized by dry, warm and long summer. Transitional periods are short, with slightly warm spring and autumn. Winter is relatively short, dry and slightly warm. According to Culek et al. (2013) the higher parts belongs into a slightly warm area MT9 and the highest into slightly warm area MT5. The warmest part of the bioregion is southeast edge that falls into a warm area T2. The river valleys are characterized by significant temperature inversions attended by extreme climate with dry and very warm southern cliffs. The northern slopes (especially on foot) are cold and wet.

Mesoclimatic and microclimate monitoring

Long-term climatic conditions evaluations employs the data of average monthly air temperature and monthly precipitation totals for the period 1961 - 2014 of Czech Hydrometeorological station Institute (Dukovany station, distance of about 4 km).

MSS microclimate evaluation using data from seven meteorological points established in the summer of 2014. Control climatological stations (hereinafter as „I“) on the steppe area of the valley monitors in a ten-minute step: air temperature in radiation shield at a height of 2 m above the ground (sensor DS18B20 1-Wire, Dallas Semiconductor), humidity at 2 m above the ground (sensor Honeywell HIH 4000), ground air temperature (sensor DS18B20 1-Wire, Dallas Semiconductor without radiation shield) and sensor HOBO U23 Pro V2 in radiation shield (hereinafter as „II“), ground humidity (HOBO U23 Sensor Pro V2 in radiation shield), soil temperature at 3, 5 and 8 cm (sensor DS18B20 1-Wire, Dallas Semiconductor), rainfall (automatic shuttle gauge with a resolution of 0.34 mm and collecting area of 200 cm^2), the wind speed at a height of 2 m above the ground (W1 anemometer Tlusťák Praha), soil moisture at a depth of 8 cm (AMET sensors VIRRIB Great Bílovice), a global solar radiation (RT sensor Minikino - Global radiation). Data are continuously available on-line through the web site (Fig. 2a). Meteopanel will set up information for visitors, informing about current weather conditions in comparison with neighboring meteorological stations.

Further six sensors HOBO U23 Pro V2 in radiation shield (hereinafter as „III“ to „VIII“) monitor ground temperature and humidity in ten-minute step were placed in the center of MSS on the rocky and wooded slopes (Fig. 2b). Sensor III - located in rocky area with scattered shrubs, sensor IV above partly grassed rocky surface, sensor V in the rocky area with scattered trees, sensor VI in area with dense seeding shrubs and trees, sensor VII in juvenescent pines canopy and sensor VIII above the grass surface in the forest of full-grown pines.

In addition to point measurements, for primary thermal surveying and for identifying sites with different temperature conditions for each season Fluke Ti55 IR fusion technology IR camera Fluke Ti55 was used (Středová et al., 2014).

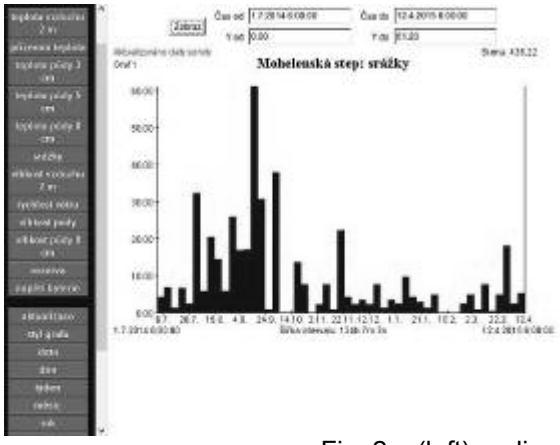

Fig. 2a: (left) on-line output of climatic monitoring
Fig. 2b: (right) sensors of microclimatic monitoring

Results

The „normal“ (i.e. 1961 – 1990) annual air temperature is 8.3°C and normal annual precipitation is 494.2 mm. This means the site is one of the driest in the country.

Air temperature trend (Fig. 3 and Table 1) corresponds to the climate development in the Czech Republic, including acceleration increasing air temperatures in recent decades (Center et al., 2011; Pokladníková et al., 2009; Rožnovský et al., 2010). The average annual rainfall in the reporting period

have not clear trend. The longest dry period occurred in the period 1988 - 1994. During the seven-year period the below average annual precipitation totals were recorded.

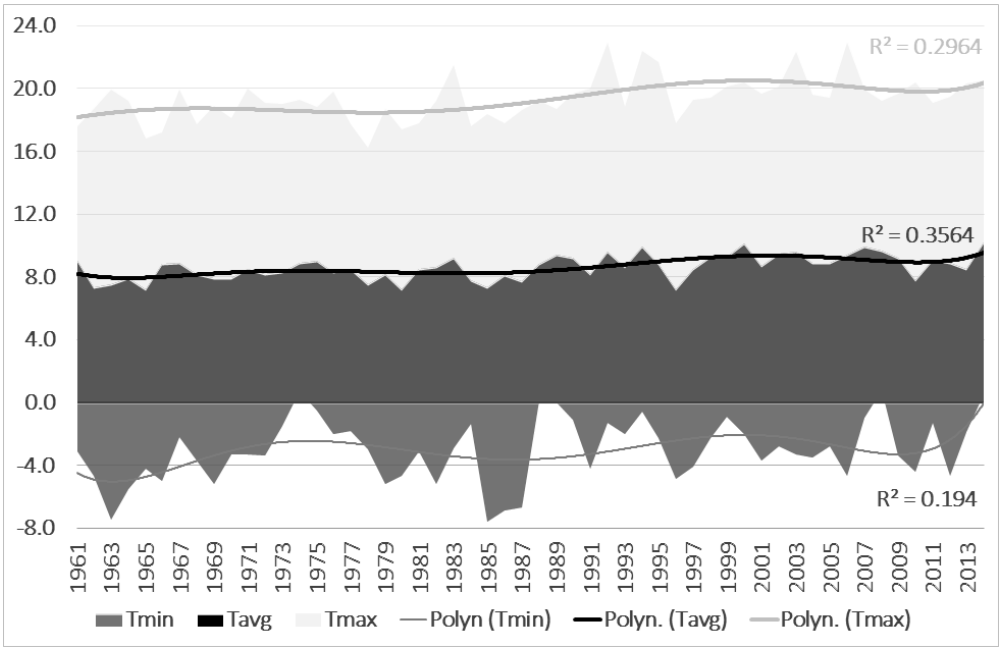

Fig. 3: Mean annual air temperature (Tavg), minimum annual mean monthly air temperature (Tmin) and maximum annual mean monthly air temperature (Tmax) on reference climatological station Dukovany, 1961 – 2014

Tab. 1: Mean annual air temperature (Tavg), minimum annual mean monthly air temperature (Tmin) and maximum annual mean monthly air temperature (Tmax) and mean annual precipitation total on reference climatological station Dukovany; decade averages

	1961-1970	1971-1980	1981-1990	1991-2000	2001-2010
Tavg	8.1	8.3	8.5	9.0	9.2
Tmin	-4.4	-2.5	-3.5	-2.5	-2.9
Tmax	18.4	18.6	18.9	20.3	20.3
Precipitation	524.9	467.5	490.2	463.7	516.5

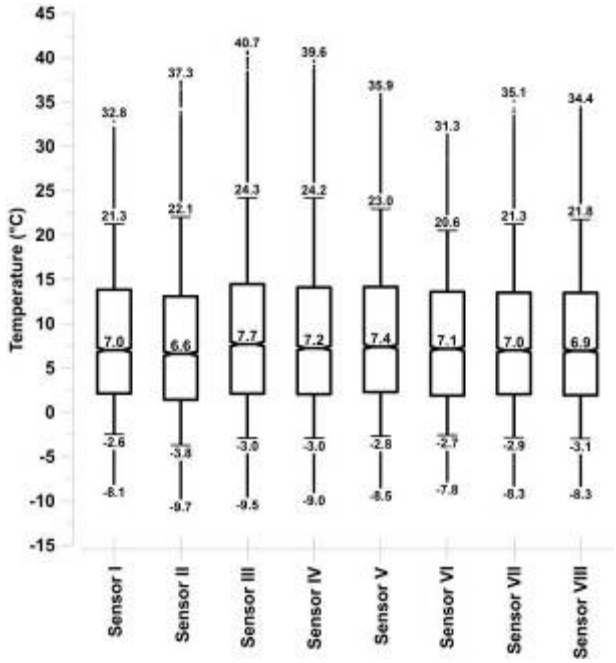

Fig. 4: Basic statistic parameters (minimum, maximum, median, 5 and 95 percentil) of air temperature in various sites of MSS

Conclusion
MSS microclimate evaluation using data from seven meteorological points established in the summer of 2014. Minimum varies from -9.7 (II) to -7.8 (VI) and maximum from 31.3 (VI) to 40.7 (III). Locality III in rocky area with scattered shrubs thus proved the biggest amplitude. Contrary sensor VI in area with dense seeding shrubs and trees measured more stable temperature regime. Thermal image shows different surface conditions even in autumn when intense of solar radiation and subsequent heating of rock is not as high as in summer.

References
Culek, M., Grulich, V., Laštůvka, Z., Divíšek, J., (2013): Biogeografické regiony České republiky [in Czech]. Masarykova univerzita, Brno. 447 p., ISBN 978-80-210-6693-9.
Pokladníková, H., Fukalová, P., Rožnovský, J., Středa, T. (2009): Specifics of temperature extremes in the conditions of the urban climate. In: Sustainable development and bioclimate. Stará Lesná: Geophysical Institute of the Slovak Academy of Sciences and Slovak Bioclimatological Society of the Slovak Academy of Sciences, p. 217-218. ISBN 978-80-900450-1-9.
Quitt, E., (1971): Klimatické oblasti Československa [in Czech]. Geografický ústav ČSAV, Brno. 86 p.
Rožnovský, J., Středa, T., Litschmann, T., Pokladníková, H., Fukalová, P. (2010): Mesoclimate as a part of recreation potential of the landscape on the example of the Moravian Karst. In: Recreation and Environmental Protection. Krtiny: Mendel University in Brno, p. 60-64. ISBN 978-80-7375-398-6.
Středová, H., Středa, T., Vysoudil, M. (2014): Cave rock surface temperature evaluation using non-contact measurement methods. Acta Carsologica. 43, 2-3, p. 257-268.
Středová, H., Středa, T., Chuchma, F. (2011): Climatic factors of soil estimated system. In: Bioclimate: Source and Limit of Social Development. Nitra: Slovak Agricultural University, p. 137-138. ISBN 978-80-552-0640-0.

Acknowledgement
The paper was supported by project of National Agency of Agricultural Research (NAZV) Ministry of Agriculture No. QJ1230056 „The impact of the expected climate changes on soils of the Czech Republic and the evaluation of their productive functions“.

Souhrn
Charakter reliéfu, geologický podklad, mezoklimatické podmínky a historický management přispívají ke specifickým mikroklimatickým podmínkám Národní přírodní rezervace Mohelenská hadcová step (MHS). Dlouhodobý vývoj mezoklimatu v oblasti a dopady antropogenní činnosti (mimo jiné výstavba blízkých vodních děl v 80. letech 20. století) na teplotní a srážkové podmínky jsou hodnoceny pro období 1961 – 2015. Použita byla data z nejbližší klimatologické stanice Českého hydrometeorologického ústavu (Dukovany). Stepní porosty MHS jsou v posledních desetiletích redukovány rozrůstáním dřevin a šířením vzrůstných druhů trav. Součástí aktuálního plánu péče jsou tak intenzivní managementová opatření (pastva, odstraňování keřového a stromového patra). Dopady managementu na mikroklimatické poměry stepi budou kvantifikovány prostřednictvím monitoringu, založeného v roce 2014. V článku jsou také hodnoceny dosavadní výsledky teplotního a vlhkostního monitoringu na sedmi monitorovacích bodech na území MHS. Součástí mikroklimatických analýz je plošné měření heterogenity teplot povrchu pomocí pozemního termálního monitoringu IR kamerou.

Contact:
Ing. Hana Středová, Ph.D.
Phone: +420 545 132 408, e-mail: hana.stredova@mendelu.cz

MONITORING OF THE NON-WOOD FOREST PRODUCTS IN THE CZECH REPUBLIC

Jiří Kadlec[1], Jitka Fialová[2]
[1]Department of Forest and Forest Products Technology, Faculty of Forestry and Wood Technology, Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic,
[2] Department of Landscape Management, Faculty of Forestry and Wood Technology, Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic

Abstract
Non-wood forests products (NWFPs) are wide group of forest products which are obtained from forest ecosystems. The aim of research is monitoring of utilisation of the NWFPs in the Czech Republic. We are looking for products which are actually utilised by inhabitants or which are on market. We make monitoring of the NWFPs in literature and actual usage of these products by consumers. Result of our research is database which can help to user in orientation in NWFPs and support decision making of forest owner in management of these products.

Key words: mushrooms, berries, greenery, medicinal plants

Introduction

The FAO definition (FAO, 2015) non-wood forest products (NWFPs) are of "biological origin other than wood derived from forests, other wooded land and trees outside forests". NWFPs offer wide range of many different products. NWFPs can be derived from trees, understory plants, fungi or animals. They are collected from natural forests, or produced in plantations and agro forestry systems.
Non-wood forest products start to grow in importance for rural development in many parts of Europe. Many people are dependent on NWFPs in their livelihood or as a source of their income. Many new products and especially extracts are promising new sources for pharmacy and food industry. Super foods are new trend in human nutrition. Forest fruits and plants belong to super food concept. (Anonymous, 2013)
Šišák (2006) described importance of non-wood forest products for Czech households in his research. Picking of non-wood forest products is important activity of tourists and they are frequently looking for mushrooms and forest berries as declare Blaj (2013).
The aim of the paper is introduction of European project which deals with NWFPs and similar project in the Czech Republic.

Materials and methods

There is description of two projects concerning with non-wood forest products. First project description introduce European COST project with its aims and structure. Description of project aims of Czech project dealing with non-wood forest products is shown in the second part of the paper.

Results and Discussion

The aim of the Action COST FP1203 is to build a multidisciplinary European-wide network of NWFP researchers and managers, who will review current knowledge, highlight existing innovation, share information, identify research topics, seek research synergies and generally increase European knowledge about NWFP ecology, modelling, management and economics.
Specific objectives of this Action are:
i) to identify and describe existing NWFPs for the major types of forested ecosystems in Europe;
ii) to review knowledge on NWFPs ecology and the potential threats or changes that might be expected for each group of NWFP in relation to climate change across Europe;
iii) to compile existing data and models on NWFPs and identify gaps in data and devise new protocols for NWFP data collection and modelling;
iv) to conceptualise NWFPs production systems, discussing the management of NWFPs in relation to traditional forest management systems for timber production and the need of an integrated forest management considering the MSFM paradigm;
v) to address the economics, social/cultural aspects, tenure rights and legal frameworks of NWFPs including valuation, marketing, and policies, as well as, their role for the Green Economy.
vi) to highlight existing innovation on NWFPs and their production systems in Europe within the work to be carried out by research area and by NWFP group.
Action is divided into four working groups and four task forces.
Working Group 1: Mushrooms and truffles; will select species where the work to be carried out by the Working Group will be based on and taking into account their importance in the European context.

Working Group 2: Tree products; will select which NWFPs of tree origin the most important to be carried out, taking into account their importance in the European context.
Working Group 3: Understory plants; will select which NWFPs of plants will be the focus of the work to be carried out, taking into account their importance in the Europe.
Working Group 4: Animal origin; will be focusing on animal products from hunting, fishing and insect products.
Task force 1: Identification and ecology of NWFPs in Europe; will make a review of the state of the art and identification of knowledge gaps in the ecology of European NWFPs.
Task force 2: NWFP data and models; will work on a review of European NWFP data and models, including identified data needs.
Task force 3: Optimising co-production of NWFPs; will identify different management models for optimizing NWFP production under different forest management conditions.
Task force 4: Economics, marketing and policies for NWFPs; will collect data on national level (institutional frameworks) as well as in empirical case studies.
Results of the Action will be a database of European NWFPs, a database of European NWFPs stakeholders and a book on “Sustainable management of European non-wood forest products” summarising the main findings and conclusions of the Action.
Project COST LD14054 Non-wood forest products in the Czech Republic is aimed to collect data for main European Action.
Many different products are harvested from the forest stand across Europe. In the Mediterranean are part of the young shrubs and mosses collected for ornamental purposes and aromatic species of wild plants are collected to obtain essential oils, which are used in the food industry and perfumery. Medicinal plants are collected in Central and Eastern Europe and forest fruits are harvested in the countries of Northern Europe, in both cases, both for commercial and non-commercial purposes. However, the lack of data on the actual quantities harvested and sold biological and environmental issues, production and modelling the impact of the collection on long-term protection of the ecosystem. This project, both at national and European level, will contribute to sustainable forest use and encourage biological diversity, where NWFPs are an essential part of forest ecosystems. The importance of NWFPs for the development of rural areas is very high and the results of the project should be a very useful source of information for rural development. Some of NWFPs have the potential for commercial use on a national, or European level, and thus to economic benefits in the regions. However, there is the lack of accurate data on individual NWFPs, which are necessary for its own sustainable use of NWFPs. The project should eliminate this information gap.
Project results will be professional publications, which will raise awareness of the professional community in general and specifically about NWFPs possibilities of their utilization, management and ecology. Awareness of the scientific community can indirectly encourage further research, which will be followed by the creation of the database. They can inspire further research especially in the use of extracts of forest trees and plants that have their potential applications in the pharmaceutical, cosmetic and food industry.
Results of the project (database) can be potentially utilisable by state and local governments for their decisions in the regions. This project results may contribute to the development of regions, increasing their economic independence, contribute to reducing unemployment in marginal rural areas. These marginal localities are especially in mountainous forested areas of the Czech Republic, with great potential for the use of NWFPs.
The user base for the application of the results is very wide. It is a scientific community that the results of the project will encourage their further research. The second major groups are forest owners and managers, who can use the results of the project for decision-making in forest management and use other products from the forest in their commercial activities to increase the revenue of the forest. The third group of users of the project may constitute employees of state and local governments, who will use the results to check sustainable resource use of NWFPs in the territory.
We focused on gathering information on the use of non-timber forest products in the Czech Republic during 2014. Basis of literature search that identify non-wood forest products, which have been used historically, and partly in the present, was created in the first stage of the project. Literature search will be extended next year by another currently used non-wood forest products and foreign sources, where we focus on products that were not described at Czech publications. We processed data for preparation of European NWFPs database in 2014 and we will continue in cooperation on collecting data for developing of European NWFPs database in 2015.

Conclusion
European action is opened to all people who are engaged in any field of non-wood forest products. Final European database will be open to anyone who would like to know details about NWFPs in any European region. Project results of the Czech project will be open to anyone who would like to know more information about specific non-wood forest product.

References
Anonymous (2013): 12 "superfoods" you should be eating. Harvard women's health watch, Vol. 20, Is. 7, p. 1-7. ISSN 1070-910X
Blaj, R. (2013): The forest and forest products - basis for sustainable tourism. 15th International Conference "Romanian rural tourism in the context of sustainable development: present and prospects", Vatra Dornei, Romania, 23-25 May 2013; p. 149-154. ISBN 978-606-687-017-7.
FAO. *What are non-wood forest products?* Rome: Food and Agriculture Organization http://www.fao.org/forestry/nwfp/6388/en/, accessed 22.2. 2015
Šišák, L. (2006): Importance of non-wood forest product collection and use for inhabitants in the Czech Republic. *Journal of Forest Science,* Vol. 52, Is. 9, p. 417 - 426. ISSN: 1212-4834.

Acknowledgement
The paper was written with the support of the Research programme of the Ministry of Education, Youth and Sports, COST LD14054 - Non-wood forest products in the Czech Republic.

Souhrn
Nedřevní produkty lesa jsou velkou skupinou plodů, hub, léčivých rostlin a různých částí dřevin, jež se používají k dekoračním účelům. Cílem projektu, který se zabývá mapováním nedřevních produktů lesa, je shromáždit informace o produktech, jenž se v České republice využívají pro osobní potřebu tak I v komerční sféře. Výsledkem projektu bude databáze produktů, které lze získat z lesního ekosystému a bude přístupná na hlavních webových stránkách evropského projektu, jehož cílem je propojit znalosti o nedřevních produktech v celé Evropě. Výsledky projektu budou sloužit nejen vědecké obci, pro kterou mohou být impulzem pro výzkum v dané oblasti, ale také pro vlastníky a správce lesů, jimž usnadní rozhodování v případě využívání nedřevních produktů lesa.

Contact:
Ing. Jiří Kadlec, Ph.D.
Phone: +420 541 134 152, e-mail: jiri.kadlec@mendelu.cz

Ing. Jitka Fialová, Ph.D.
Phone: +420 541 134 096, e-mail: fialka.jitka@atlas.cz

NEW METHODS OF SURFACE AND TERRAIN MAPPING AND ITS USE IN LANDSCAPE AND NATURE CONSERVATIONS

Tomáš Mikita
Department of forest management and applied geoinformatics, Faculty of Forestry and Wood Technology, Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic

Abstract
Within the paper is presented the method of airborne laser scanning (ALS) with focus on the use of processed ALS data in landscape and nature protection. ALS allows detailed remote mapping of land surface and terrain with all natural phenomena. On the example of ALS data from the area of Moravian Karst are described methods of detection and identification of karst formations and rock outcrops in forests based on processing of Digital Terrain Model (DTM) of high accuracy in GIS environment. After verification are results of such detection useful for detailed mapping of such phenomena and may improve its protection and increase tourist importance and recreational potential of area.

Key words: airborne laser scanning, karst, outcrops, GIS

Introduction

The increasing capabilities of GIS (Geographic Information Systems) and accuracy of geographically referenced data has provided the basis for more detailed terrain analysis and modeling. Research on terrain-related surface features is highly dependent on terrain data collection and the generation of digital models (Melinda et al., 2013). New remote sensing technologies such as airborne laser scanning (ALS) increases the accuracy of generated terrain models.

The ALS system or LIDAR (light detection and ranging) is based on the principle of the analysis of laser pulses which are emitted from an aircra□ft, moving at a certain distance from the scanned object. At the same time for each laser pulse emitted from a source its current position in the space is recorded by means of differential GPS and inertial navigation unit (INU). The laser pulse hits an object and it is reflected in the form of an echo back to the sensor and the distance it travelled is measured. The pulse is reflected from each area surface of an object which creates an echo string – from the highest (closest to the sensor) area surfaces to the lowest ones, in order to create a dense field of geographic coordinates in places where laser pulses were reflected from the surface (Baltsavias, 1999).

Airborne laser scanners emit short laser impulses (ca. 10 ns) with the wave length of mostly 1040–1060 nm and divergence < 1 mrad towards the earth's surface in a plane perpendicular to the flight direction. Depending on the flight height, a reasonable diameter of footprint of laser on the earth surface may vary from 10 cm to as much as 4 m. The field of vision throughout the flight depending on the scanner type varies from 45° to 75°. ALS can be used both by day or night, in cloudy weather or where there is a thin coat of snow. However, it is not possible to be used when it is raining or snowing. When a laser pulse from the LiDAR sensor encounters a soft target such as a forest canopy, a portion of the laser beam continues downward; the last returns recorded by the sensor represent the elevation of the ground, or "bare earth" surface. This characteristic of ALS allows to create highly detailed and accurate terrain models even in heavily wooded areas (Jacobsen et Lohmann, 2003).

Laser scanning imposes high demands on processing possibilities of available technology as there is a large amount of data at high accuracy of scanning. The gained data (point cloud) is usually processed by two basic methods: filtration (its task is to separate points corresponding to a required object) and classification (where individual surfaces are separated). These processes may be automatic or semi-automatic; a fully automatic filtration and classification does not always provide the best results. It is used in zonal and global filters while the biggest differences are between types of land cover representing urban area and continuous vegetation (Jacobsen et Lohmann, 2003).

As technology evolves, there is also the progressive use in forestry and agriculture, as this data can be a good source for creating accurate DMT, which become effective tools in forest management and planning. Until recently, the data were acquired and provided exclusively by private entities and mainly based on the order. Since 2009 is carried ALS across our country in a joint project of Czech Office for Surveying, Mapping and Cadastre (COSMC), Ministry of Defense and Ministry of Agriculture called "Project of New Altimetry of Czech Republic". The outcome of this project is to create a new altimetry of the Czech Republic in the form of so-called Digital Elevation Models of 4th and 5th generation (DMR 4G and DMR 5G) and also to create Digital Surface Model of first generation (DMP 1G). Currently is ongoing data processing and data are already available for more than half of the territory.

In the last decade GIS has been recognized as a powerful tool for geographic analysis and has become a useful tool for cave and karst studies (e.g., Szukalski et al., 2002). GIS analysis of karst terrains have been used in various studies to delineate karst development Florea et al. (2002), Denizman (2003), Taylor et al. (2005), Melinda et al. (2013). Through spatial interpolation of available LiDAR data, depressions associated with karsting can be delineated and classified over terrains using geoanalytical methods. Research on terrain-related surface features is highly dependent on terrain data collection and the generation of digital models. Particularly in forests is identification of these objects difficult due to the lower quality and accuracy. Traditional methods such as field surveying and photogrammetry can yield accurate results; however, they are limited by time and physical constraints. ALS provides an alternative for high-density and high-accuracy three-dimensional terrain point data collection (Liu, 2008).

Materials and methods

Possibilities of ALS data for identification of karst formations and rock outcrops were investigated in the surrounding of the village Babice nad Svitavou, that lies on the territory of Moravian Karst (fig 1). Moravian Karst is a Protected Landscape Area (PLA) and is the largest and the most important karst area in the Czech Republic. The karst area consists of Devon limestone lying northward from Brno. The landscape character is formed by plateaus with many sinkholes separated by deep canyon grooves (Moravian Karst, 2015).

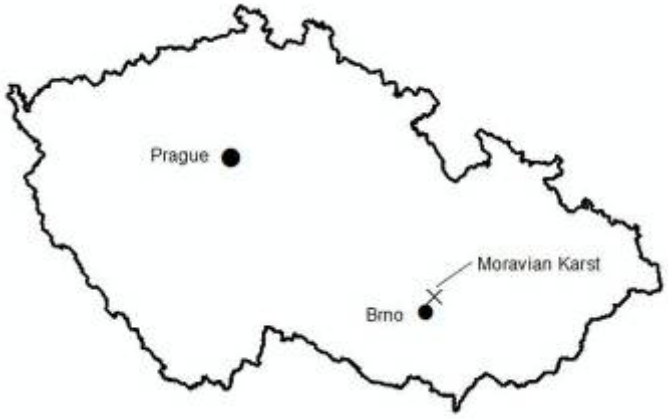

Fig. 1: Location of Moravian Karst

For analysis was used data from so called DMR 5G in the form of pointcloud conducted by COSMC. The average density of pointcloud was 1 point per square meter. After filtration were all ground points interpolated into digital terrain model (DTM). Due to scanning period outside the growing season has DTM in forest stands high density of points reflected from the ground, especially in deciduous forest stands. Created model has finally 1 meter resolution.

Identification of depressions and sinkholes

Identification of terrain depressions and sinkholes were conducted by analysis of DTM based on hydrological modeling. Sinkholes are endorheic basins and in the terms of GIS a cells or set of spatially connected cells whose flow direction cannot be assigned one of the eight valid values in a flow direction raster. This can occur when all neighboring cells are higher than the processing cell or when two cells flow into each other, creating a two-cell loop (ESRI, 2015).

GIS analysis were made in ArcGIS 10.3 software with Spatial Analyst extension. To identify closed depressions within the study area, the flow direction and flow length tools were used to find basin without drain. Once the depressions were identified, the fill tool was used to create a filled DTM raster without closed depressions (fig.2). The original DTM was subtracted from the filled DTM to identify only the closed depression features (Stafford et al., 2002). Depression features were delineated so that their spatial attributes could be measured and classified for further analysis. The boundaries for the depressions were created in several steps:

1. Subtraction of DTM and filled DTM
2. Conversion of depression raster to polygons as sinkholes
3. Calculation of sinkholes deepness and area
4. Selection of appropriate sinkholes based on area (larger then 5 square meters), deepness (deeper then 0,5 meter) and spatial intersect with identified endorheic basins.

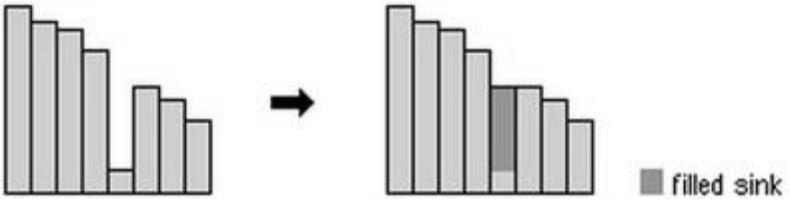

Fig. 2: Filling of sink in DTM (ESRI, 2015)

Rock outcrops identification

Rock outcrops are defined as visible exposure of bedrock or ancient superficial deposits on the surface of the Earth (Wikipedia, 2015). As well as sinkholes, all these objects are not yet recorded on the maps due to the low resolution of altimetry in forests. New altimetry based on ALS brings new opportunities for identification even such objects.

To identify rock outcrops within the study area, the focal statistics of elevation value range with combination of curvature classification was used. On the basis of curvature is possible to classify convex and concave terrain formations and by elevation range in surrounding of each cell we can find shifts in terrain. Final rock outcrop locations were created by combination of places with high convex curvature and high range of elevation. Finally these locations were delineated

Results and discussion

Results of study show that the ALS data are suitable source for interpolation of terrain models with high resolution and the resulting models are also useful for detecting of very small objects. Used altimetry conducted by COSMC proved sufficient point density and final precision. The usage of these data for the chosen purpose may be limited by scanning period, because according to information of COSMC, the data in the study area was scanned outside the growing season. Scanning on other location with coniferous trees or during the growing season may lead to a significant reduction of terrain points due to canopy crowns and thereby may be reduced the density of points and accuracy. It was not possible yet to verify results of the research in the field, however, on the basis of visual analysis of shaded relief is possible to conclude that the identified sites correspond to terrain depressions and rock outcrops (fig. 3 and 4). Besides the identification based on the suggested methods it may be also determined the basic parameters of these objects such as area and rock crops height or depth of sinkholes. On the basis of visual evaluation, it was found that the largest errors or incorrect identification of objects is near human-made structures such as buildings, roads or ditches and for successful identification should be such objects filtered out. To verify the accuracy of selected identification methods will be necessary to carry out a verification of observed phenomena in the field.

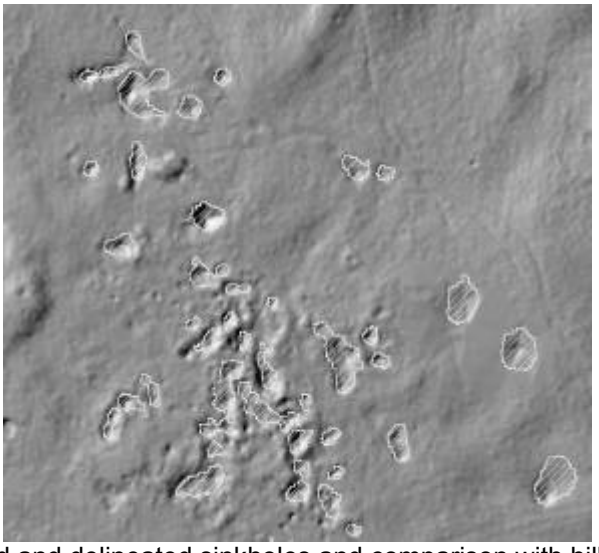
Fig. 3: Identified and delineated sinkholes and comparison with hillshaded terrain

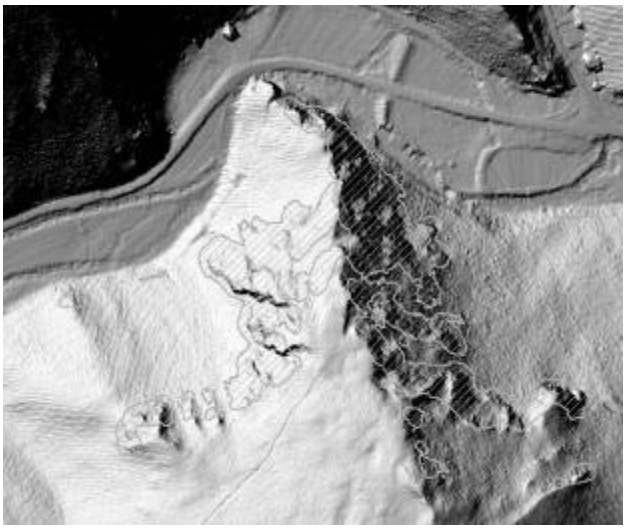

Fig. 4: Identified and delineated rock outcrop locations and comparison with hillshaded terrain

Conclusion

This study utilized LiDAR data to identify depression and outcrop features in Moravian Karst in surroundings of Babice nad Svitavou village. The results of this work don´t solve evaluation of detected phenomena but concerns more on creation of suitable data processes for identification of such objects. The results show a high success rate of the selected methods for identification of sinkholes and rock outcrops and prove that the ALS data is suitable source for this kind of GIS analysis. After field verification the results can be used in nature and landscape conservation for accurate mapping of these phenomena, modification of forest management and increase the tourist attractiveness and recreational potential of area.

References

Baltsavias, E. P. (1999): Airborne laser scanning: existing systems and firms and other resources. *ISPRS Journal of Photogrammetry and Remote Sensing, 54*: 164–198.

Denizman, C. (2003): Morphometric and spatial distribution parameters of karstic depressions, lower Suwannee River basin, Florida: *Journal of Cave and Karst Studies, v. 65*, no. 1, p. 29–35.

Esri 2015, ArcGIS Desktop 10 Resource Center. Available from: http://help.arcgis.com/en/arcgisdesktop/10.3/ help/index.html# (accessed March 2015).

Florea, L.J., Paylor, R.L., Simpson, L., and Gulley, J. (2002): Karst GIS advances in Kentucky: *Journal of Cave and Karst Studies, v. 64*, no. 1, p. 58–62.

Jacobsen, K., Lohmann, P. (2003): Segmented filtering of laser scanner DSMS. *International Society for Photogrammetry and Remote Sensing, vol. XXXIV, part 3/W13. Dresden*, ISSN 1682-1750.

Liu, X. (2008): Airborne LiDAR for DEM Generation: Some Critical Issues, Progress. *Physical Geography 32 (1)*: 1-49.

Melinda G. Shaw-Faulkner. Kevin W. Stafford and Aaron W. Bryant. (2013): DELINEATION AND CLASSIFICATION OF KARST DEPRESSIONS USING LIDAR: FORT HOOD MILITARY INSTALLATION, TEXAS. In Land L, Doctor DH, Stephenson JB, editors. *Sinkholes and the Engineering and Environmental Impacts of Karst: Proceedings of the Thirteenth Multidisciplinary Conference, May 6-10, Carlsbad, New Mexico: NCKRI Symposium 2. Carlsbad (NM): National Cave and Karst Research Institute*. ISBN 978-0-9795422-7-5.

Moravian Karst. (2015): available from: http://www.moravskykras.net/en/moravian-karst.html, (accessed March 2015).

Stafford, KW, Rosales-Lagarde L, Boston PJ, (2002): Castile Evaporite Karst Potential Map of the Gypsum Plain, Eddy County, New Mexico and Culberson County,Texas: A GIS Methodological Comparison. *Journal of Cave and Karst Studies 70 (1)*: 35-46.

Szukalski, B.W., Hose, L.D., and Pisarowicz, J.A., eds., (2002): *Cave and karst GIS: Journal of Cave and Karst Studies*, v. 64, no. 1, 93 p.

Taylor, C.J., Nelson, H.L., Hileman, G., and Kaiser, W.P. (2005): Hydrogeologic-framework mapping of shallow, conduit-dominated karst — components of a regional GIS-based approach, in *U.S. Geological Survey Karst Interest Group Proceedings, Rapid City, South Dakota, U.S. Geological Survey Scientific Investigations Report 2005–5160*, p. 103–113.

Wikipedia. (2015): Outcrops. Available online at: http://en.wikipedia.org/wiki/Outcrop (accessed March 2015)

Acknowledgement
This article was prepared as a part of the research project of Faculty of Forestry and Wood Technology of Mendel University in Brno IGA 84/2013 “Dynamics of natural forest recovery in ecological conditions of forest gaps in the exaple of Training Forest Enterprise Křtiny.

Souhrn
V rámci příspěvku jsou řešeny možnosti využití dat leteckého laserového skenování (LLS) pro identifikaci krasových jevů (především závrtů) a skalních výchozů na území Moravského krasu v okolí obce Babice nad Svitavou. LLS umožňuje detailní mapování povrchu zemského a na základě filtrace a klasifikace bodů LLS je možné vytvářet velmi přesné a detailní modely povrchu a terénu. Cílem příspěvku je proto ukázat metody zpracování dat LLS (dat digitálního modelu reliéfu 5.generace – DMR 5G od Českého úřadu zeměměřického a katastrálního) v prostředí GIS za účelem identifikace krasových jevů a skalních výchozů na základě analýzy digitálního modelu terénu s rozlišením 1 metru. Zvlášť pro závrty a pro skalní výchozy byly odděleně vytvořeny metody automatické identifikace na základě hydrologického modelování a analýzy okolí. Výsledky na základě vizuálního hodnocení vykazují velmi vysokou úspěšnost, vzhledem k absenci terénního šetření však nebylo doposud možné provést ověření. Výsledky rovněž dokazují, že v rámci ČR celostátně dostupná data nového výškopisu (DMR 5G) jsou kvalitním produktem se širokým rozsahem použití. Na základě terénního ověření bude následně možné využít automatické postupy při mapování těchto jevů a následně při ochraně přírody a krajiny, pro úpravu lesnického hospodaření nebo ke zvýšení turistické atraktivity a rekreačního potenciálu území.

Contact:
Ing. Tomáš Mikita, Ph.D.
Phone: +420 545 134 021, e-mail: tomas.mikita@mendelu.cz

NUMBER OF TOURISTS AS FACTOR INFLUENCING TRAILS´ CONDITION

Juraj Švajda[1], Peter Bačkor[2], David Zahradník[3], Marek Banaš[3]
[1]Department of Biology nad Ecology, Faculty of Natural Sciences, Matej Bel University; Tajovského 40, 974 01 Banská Bystrica, Slovak Republic
[2] Institute for Nature Conservation, Slovak Republic
[3] Faculty of ecology and environmental sciences, Faculty of Science, Palacký University, Šlechtitelů 241/27, 783 71 Olomouc – Holice, Czech Republic

Abstract
Tatra National Park with 738 km^2 and 600 km of hiking trails along with 3-4 million visitors, makes it one of the most visited national parks in the Slovakia. This paper examines impacts of trampling on the vegetation and soil along selected trails. The research involves the application of trail condition assessments to 9,6 km of trails with different visitation based on variety of inventory and impact indicators and standards to determine baseline condition of trails. These data can then be used for future comparison and evaluation of development trends. Trail widening and soil loss are the most important types of trail degradation. Correlational analyses of the collected data can also identify the role and influence of various factors (e.g. use level and topography). Insights into the influence of these factors can lead to the selection of appropriate management measures to avoid or minimize negative consequences.

Key words: visitors, impact, trampling, trail, indicator, Tatra National Park & Biosphere Reserve

Introduction

National parks are generally established for conservation purposes, however at same time they belong to most attractive places for recreation in the world. Tatra National Park (TNP) is considered as the most visited protected area in Slovakia (Švajda, 2009). Striking a balance between preservation of natural resources and opportunities for public recreation often forces responsible authorities to make compromises between visitation impacts and protection.

Number of direct and indirect effects (impacts) to resources from visitor use were described in literature – e.g. ground vegetation loss, soil compaction and erosion, shift to trampling resistant species, increased water runoff and soil temperature, reduced soil fauna, disturbance of animal species (Cole, 1989; Marion et al., 2011; Zwijacz-Kozica et al., 2013; Griffin et al. 2007). Degraded resource conditions on trails and number of visitors can have significant impacts also on perceptions of visitors (Leung & Marion, 2000; Manning et al., 2000; Streberová & Jusková, 2015).

This paper presents research and assessment of visitor-related impacts to the natural resources of the park. Research involved application of trail condition assessments (Marion et al., 2011) in two valleys with different level of visitation.

Results can serve as baseline for future update and the inventory of the existing trail system, assessment of the condition of the trail sections, suggestion of periodic trail system maintenance program, application of the visitor experience resource protection and other similar frameworks or establishment of visitor carrying capacities for study areas.

Visitor impacts on the ecological conditions of an area are influenced more by visitor behavior, park infrastructure, and the resilience of soil and vegetation and less related to overall use levels (McCool & Lime, 2001). The research is an example of visitor impact assessment methods and procedures including indicators used for trail monitoring. Relational analyses of the collected data can identify the role and influence of casual factors (e.g. type and amount of use) and non-casual but influential factors (e.g. topography). Insights into the influence of these factors can lead to the selection of more effective actions.

Material and methods

TNP is situated in the highest mountains of Carpathians Mts. along Slovak-Polish border. The major part is located in Slovakia and in 1948 was declared as national park with an area of 738 km^2. In 1993 it was included in a network of biosphere reserves, together with the Polish part. Annually it is visited by about 3 – 4 million visitors (Švajda et al., 2013). The network of hiking trails with a length of 600 km is particularly popular.

The study areas are two valleys – Malá Studená (MSV) accessible by trail from south with higher human impact and visitation (including mountain huts Téryho and Zamkovského chata) and Javorová (JV) accessible from northern part with low number of visitors (see fig. 1). There is marked touristic trail (green colour) starting near Zamkovského chata (elevation 1460 m asl) reaching the highest point

Sedielko (2376 m asl) after 5,9 km in MSV. On the other side there is again green tourist trail starting near Pod Muráňom (elevation 1080 m asl) reaching saddleback Sedielko after 9,2 km in JV. Both areas are situated in national nature reserves with the highest level of protection according Slovak Act on nature and landscape protection.

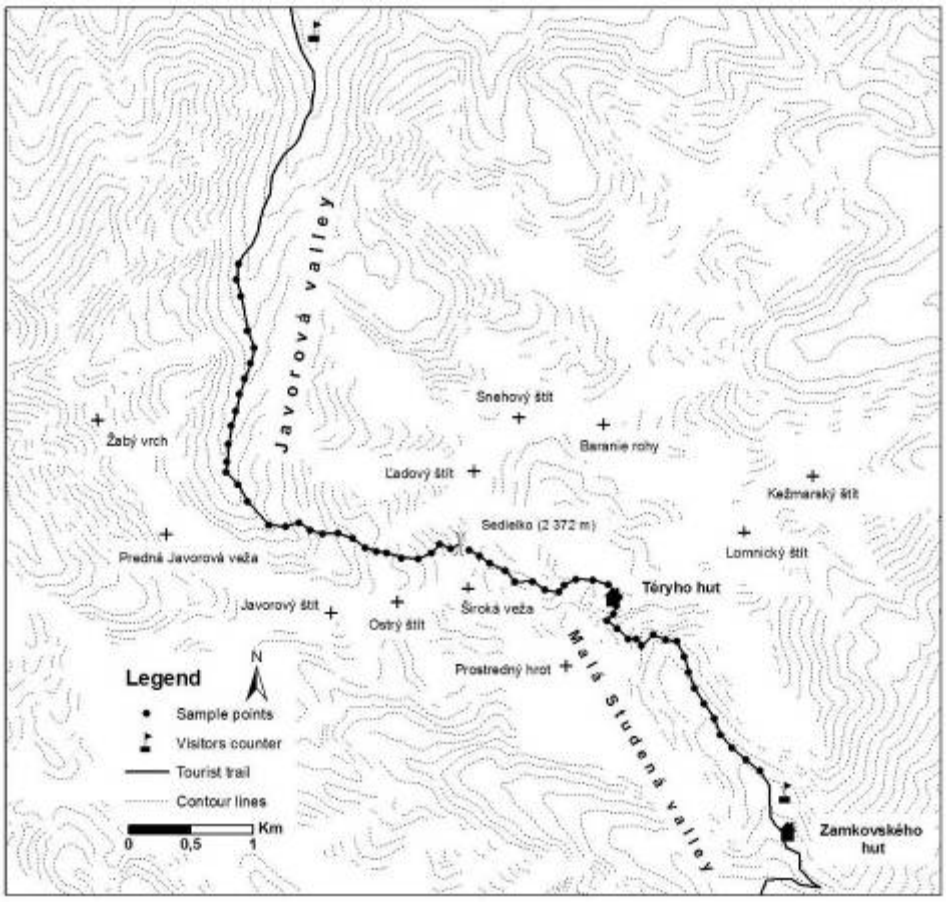

Fig. 1: Location of trails in two study areas – MSV and JV in TNP

In order to quantify exact number of tourists and confirm assumptions about differences in visitation of two study valleys, a direct data collection method was used to monitor visitor numbers in the selected test area (Muhar et al. 2002). We used pyro-electric sensors Linetop with one direction records of passages in hour interval were installed at the entrance points to study areas (fig. 1). Installation, measurement, control calibration and de-installation were realized between 7.7.2014 and 26.9.2014.
During October 2014 we applied impact assessment procedures (Marion et al., 2011) to two study trails. Spatial data were transferred from GPS to EasyGPS. Statistical data were transferred to Microsoft Excel for further analysis.

Results

We assessed 64 sample points along a total length of 9,6 km for two trails within TNP (tab. 1).
Trail grade and trail slope alignment angle were two important inventory indicators assessed in the survey (Dissmeyer & Foster, 1984; Aust et al., 2004;).
Approximately 9% of the trails are located on flat terrain (0-2% grade), 50% of the trail in MSV and 56% in JV has grades exceeding 15% and 22 % resp. 28% of the trails have grades exceeding 30% (see tab. 2). The mean grade of trails in both valleys is 19% and 22%. It should be noted that many of the excessively steep alignments have constructed rock steps or ascend exposed rock faces, which are not susceptible to soil loss.
Regarding trail's slope alignment angle, only 28% of trail in JV and no sample points in MSV valley are aligned within 22° of the landform aspect or fall line (tab. 3), the path naturally taken by water running down a mountain slope. Once a fall-aligned trail becomes incised, water trapped on the tread is exceptionally difficult to direct off and can build in volume, substantially increasing its erosion. The level of erosion also increases exponentially with trail grade, though the natural rockiness of TNP´s trail treads and stonework can limit erosion. In flatter terrain, such trail alignments are susceptible to

muddiness and widening. Fall-aligned trails with higher grades frequently require significant investments in rockwork and ongoing maintenance to keep them sustainable. Water can drain under or over such work, though freezing winter temperatures can increase danger to trail users or harm and loosen the rockwork. Mean elevation of the evaluated points is 1888,60 resp. 1756, 31 m above sea level.

Tab. 1: Inventory and impact indicators summarized by trails

Trail	Length	Sample count	Inventory Indicators							Impact Indicators		
			Elevation (m asl)	Trail grade (%)	Landform grade (%)	Slope Alignment Angle (°)	Use Levels (visitors/day)	Slope Ratio (%)	Rugosity (cm)	Trail Width (cm)	CSA (cm^2)	Maximum Incision (cm)
	m	N	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
MSV	4800	32	1888,59	19,47	35,47	59,38	626	0,57	2,30	111,50	389,38	6,92
JV	4800	32	1756,31	21,78	27,06	38,13	46	0,79	2,13	80,66	276,09	6,20

Tab. 2: Trail Grade – MSV / JV (Mean = 19,47 / 21,78%; Median = 15,50 / 16,50%; Range = 0-100%)

Grade	Number of sample points MSV	Totals	Number of sample points JV	Totals
0-2%	3	9	3	9
2-6%	7	22	4	12
6-10%	3	9	1	3
10-15%	3	9	6	19
15-20%	6	19	5	16
20-30%	3	9	4	12
30-100%	7	22	9	28
Totals	32	~100%	32	~100%

Tab. 3: Trail Slope Alignment – MSV / JV (Mean = 59,38° / 38,13°; Median = 60° / 40°; Range = 0-90°)

Slope Alignment	Number of sample points MSV	Totals	Number of sample points JV	Totals
0-22°	0	0	9	28
22-45°	7	22	13	41
45-68°	14	44	8	25
68-90°	11	34	2	6
Totals	32	100%	32	100%

Tab. 4: Elevation – MSV / JV (Mean = 1888,60 / 1756,31 m asl; Median = 1899,13 / 1674,25 m asl; Range = 1419-2326 m asl)

Elevation	Number of sample points MSV	Totals	Number of sample points JV	Totals
-1440 m asl (forest zone)	0	0	3	9
1440-1800 m asl (subalpine zone)	13	41	17	53
1800- m asl (alpine zone)	19	59	12	38
Totals	32	100%	32	100%

Tab. 5: Number and percent of sample points by impact indicator category

Indicator	Sample points MSV / JV	Percentage MSV / JV
Trail Width (cm)		
0-60	1 / 8	3% / 25%
60-90	5 / 12	16% / 38%
90-120	19 / 11	59% / 34%
120-150	4 / 1	13% / 3%
150+	3 / 0	9% / 0%
Mean = 111,50 / 80,66; Median = 110 / 80; Range = 39-168;		
Maximum Incision (cm)		
0-2,5	3 / 1	9% / 3%
2,5-7,5	16 / 23	50% / 72%
7,5-12,5	12 / 6	38% / 19%
12,5+	1 / 2	3% / 6%
Mean = 6,92 / 6,20; Median = 5,75 / 5,50; Range = 1,5-17;		
CSA Soil Loss (cm^2)		
0-250	13 / 18	41% / 56%
250-500	12 / 10	37% / 31%
500+	7 / 4	22% / 13 %
Mean = 389,30 / 276,09; Median = 322,50 / 235,00; Range = 35-1230;		
Mean Trail Depth (cm)		
0-2,5	18 / 15	56% / 47%
2,5-7,5	13 / 17	41% / 53%
7,5-12,5	1 / 0	3% / 0%
12,5+	0 / 0	0% / 0%
Mean = 3,1 / 2,8; Median = 2,4 / 2,6; Range = 0,6-8,2;		

Trail width ranged from 39 to 168 cm with a mean of 111 cm in MSV and 80 cm in JV. Less than 10% of the trails (and only in MSV) exceed 150 cm in width. According historical norm used in Tatras (1,3 ± 0,2 m), trails are generally wide as it is intended by park management. From these numbers also the total area of intensive trampling disturbance for the trail system can be calculated (based on extrapolating mean trail width to the total length of TNP trail system).
Maximum incision ranged from 1,5 to 17 cm with a mean of 6,92 resp. 6,20 cm. Cross-sectional area soil loss measurements (CSA) ranged from 35 to 1230 cm^2, with a mean of 389 resp. 276 cm^2. Extrapolating this measure by the trail system length can yield an estimated aggregate soil loss totally in m^3 or on a per-km basis in m^3/km.
A more representative measure of trail incision is provided by calculating mean trail depth from the vertical measures recorded to compute CSA. This measure ranged from 0,6 to 8,2 cm with a mean of 3,1 resp. 2,8 cm.
Finally, assessments of the tread substrate as a proportion of transect width are used to characterize the typical trail system substrates described in fig. 2. The predominant tread substrate on both trails is rock, followed by gravel and soil

Discussion
Results suggest that trail width is predominantly a function of use level. Some authors (Wimpey and Marion, 2010) investigated also relation of trail width with trail and landform grade and trail slope alignment which may help to restrict lateral dispersion of hikers (e.g. with increasing trail grade). Important factors are also behavior of tourists and absence of trail borders. Tread rugosity can widen trails when hikers often looking for easier passage along trail sides. To address these problems managers can manipulate with level of trail use, create trail boarders or educate visitors how to decrease their impact on trails.
Soil loss was assessed for trails using three measures: mean trail depth, maximum incision and cross-sectional area. Some studies revealed influence of level of trail use, trail grade and trail slope alignment angle to soil loss (e.g. Wimpey & Marion, 2010). Managers may have little control over level of use but could consider relocations of trail segments that are excessively steep or that are aligned closely to the fall line (landform aspect) of mountain slopes. Other option is regular maintenance and higher attention towards these sections of trails (Birchard & Proudman, 2000). Some authors commonly recommend to prevent soil loss keep grades of less than 10-12% (Hooper, 1988; Hesselbarth et al., 2007), trail slope alignment higher than 22° (Olive & Marion, 2006) and trail slope ratio less than 0,5 (IMBA, 2004). Soil erosion would be much higher than assessed were it not for the substantial amount of granitic rock in the soils and the extensive use of rock steps.

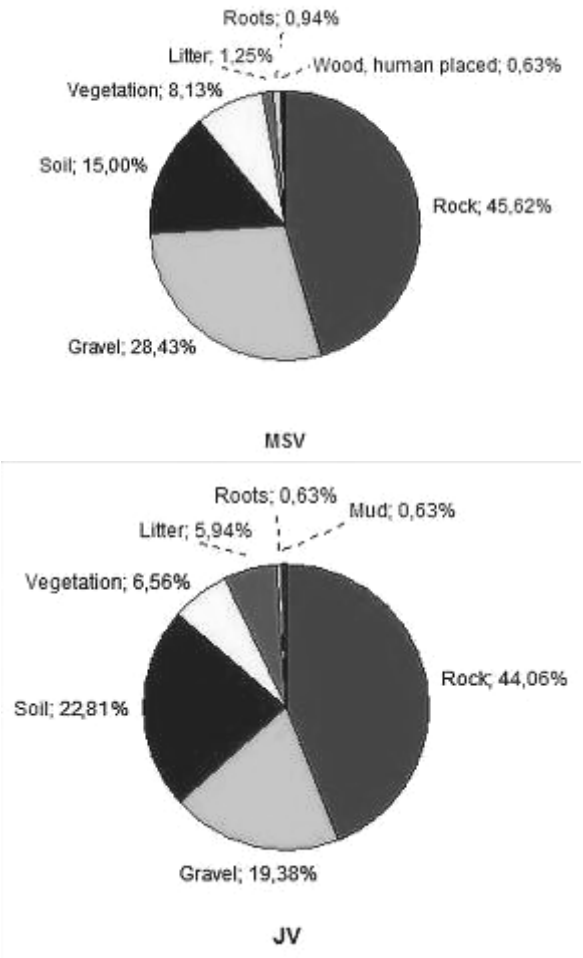

Fig. 2: Mean trail substrate cover as a proportion of transect (tread) width

Conclusion

National parks should provide appropriate opportunities for recreation, protection and preservation of park resources and natural processes. This research provides information and basis for management of visitors and recreational impacts on resources. Variety of inventory and impact indicators and standards have been documented as baseline data about the current condition of trails, but this can also be used for future comparison and evaluation of trends. Trail widening and soil loss are the most important types of trail degradation.

References

Aust M.W., Marion J.L. & Kyle K. (2004): Research for the Development of Best Management Practices for Minimizing Horse Trail Impacts on the Hoosier National Forest. Management Report. USDA, U.S. Forest Service, Final Report, Bedford, IN. 77 p.

Birchard W. & Proudman R.D., (2000): Appalachian Trail Design, Construction, and Maintenance. (2nd Ed.). Harpers Ferry, WV: Appalachian Trail Conference.

Cole D. N. (1989): Low-impact recreational practices for wilderness and backcountry. General Technical Report INT-265. Intermountain Research Station, USDA Forest Service, 131 p.

Dissmeyer G. E. & Foster G. R., (1984): A guide for predicting sheet and rill erosion on forestland. USDA For. Serv. Gen. Tech. Publ. R8-TP 6. 40 p.

Griffin S.C., Valois T., Taper M.L & Mills S., (2007): Effects of Tourists on Behavior and Demography of Olympic Marmots. *Conservation Biology* 21(4): 1070–1081.

Hesselbarth W., Vachowski B. & Davies M.A., (2007): Trail construction and maintenance notebook. Tech. Rpt. 0723-2806-MTDC, USDA Forest Service, Missoula Technology and Development Center, Missoula, MT.

Hooper L., (1983): National Park Service Trails Management Handbook. Denver, CO: USD1 National Park Service, Denver Service Center. 53 p.

IMBA, (2004): Trail Solutions: IMBA´s guide to building sweet singletrack. The International Mountain Bike Association, Boulder, CO.

Lance, A.N., Baugh, I.D., & Love, J.A., (1989): Continued footpath widening in the Cairngorm mountains, Scotland. *Biological Conservation* 49, 201-214.
Leung Y.F. & Marion J.L., (2000): Recreation impacts and management in wilderness: A state of knowledge review. USDA Forest Service Proceedings RMRS-P-15-VOL5:23-48.
Manning R., Valliere W., Minteer B., Wang B. & Jacobi C., (2000): Crowding in parks and outdoor recreation: A theoretical, empirical, and Managerial Analysis. *Journal of Park and Recreation Administration*, 18 (4), 57-72.
Marion J.L., Wimpey J. & Park L., (2011): Informal and formal trail monitoring protocols and baseline conditions: Acadia NP. Final report. U.S. Geological Survey, Virginia Tech Field Unit, College of Natural Resources and Environment, 95 pp.
McCool S.F. & Lime D.W., (2001): Tourism Carrying Capacity: Tempting Fantasy or Useful Reality? *Journal of Sustainable Tourism* Vol. 9, No. 5, p. 372-388.
Monz C.A., (2000): Recreation resource assessment and monitoring techniques for mountain regions. In P.M. Godde, M. Price, & F.M. Zimmermann (Eds.), *Tourism and development in mountain regions* (pp. 47-68). Oxon, UK: CABI Publishing.
Muhar A., Arnberger A. & Brandenburg C., (2002): Methods for Visitor Monitoring in Recreational and Protected Areas: An Overview. In: Arnberger, A., Brandenburg C. & Muhar A. (eds.), *Monitoring and Management of Visitor Flows in Recreational and Protected Areas. Conference Proceedings:* 1-6. Vienna.
Olive N.D. & Marion J.L., (2006): The Influence of Use-Related, Environmental and Managerial Factors on Soil Loss from Recreational Trails. *Journal of Environmental Management* 90, 10.
Streberová E. & Jusková Ľ., (2015): Standards of quality for outdoor recreation in Tatra National Park: a contribution to integrated visitor monitoring and management. *Eco.mont* 7(1): 56-65.
Švajda J., (2009): Contribution for improvement of visitor monitoring in the Tatra National Park. *Eco.mont* 1 (2): 13–18.
Švajda J., Getzner M. & Považan R., (2013): Visitors' perceptions and economic effects of the Tatra National Parks in Poland and Slovakia. In: Šauer P., A. Dvořák & A. Lisa (eds.), *Visegrad countries – Environmental Problems and Policies*: 118–126. Prague.
Zwijacz-Kozica T., Selva N., Barja I., Silván G., Martínez-Fernández L., Illera J.C. & Jodłowski M., (2013): Concentration of fecal cortisol metabolites in chamois in relation to tourist pressure in Tatra National Park (South Poland). *Acta Theriologica* 58(2): 215–222.
Wimpey J. & Marion J. L., (2010): The Influence of use, environmental and managerial factors on the width of recreational trails. *Journal of Environmental Management* 91: 2028-2037.

Acknowledgement
This research was supported by the VEGA project no. 1/0411/14 Tourist visitation as a factor influencing the diversity of organisms in protected area, UNESCO MAB Young Scientist Award 2014 and Monitoring návštěvnosti Ltd.

Souhrn
Tatranský národní park se 738 km^2 a 600 km turistických stezek, spolu s 3 až 4 miliony návštěvníků, z něj činí jeden z nejnavštěvovanějších národních parků na Slovensku. Tato práce se zabývá dopady pošlapávání na vegetaci a půdu po vybraných trasách. Výzkum zahrnuje aplikaci posuzování stavu 9,6 km stezek s různou návštěvností na základě různých ukazatelů. Tyto údaje pak mohou být použity pro budoucí porovnání a vyhodnocení vývojových trendů. Rozšíření stezek a ztráty půdy jsou nejdůležitějšími typy degradace. Pomocí korelační analýzy získaných dat lze také identifikovat úlohu a vliv různých faktorů (např. úroveň využití a topografie). Pohled do vlivu těchto faktorů může vést k výběru vhodných opatření pro minimalizaci negativních důsledků.

Contact:
Ing. Juraj Švajda, Ph.D.
Phone: +421-48-4467106, e-mail: juraj.svajda@umb.sk

OPTIONS OF ENSURING SAFE USE OF BEACH SHORES

Miloslav Šlezingr, Petr Pelikán, Lenka Gernešová
Department of Landscape Management, Faculty of Forestry and Wood Technology,
Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic

Abstract
Bank damage caused by deflation has appeared in nearly all world reservoirs. However, bank stabilization is mostly seen as a solution and implemented only when bank damage occurs.
In this case, there is a unified scheme used - a stone bank toe is constructed and the (eroded) bank sloping is restored in place of the erosion wall. Imperiled are also recreational use of the banks – beaches

Key words: stabilisation, recreation, bank, beach, erosion

Introduction

Basic, yet significant issue of almost every water reservoir that is being managed in the long-term is the insurance of its bank stability. Important in this matter is the minimization of the soil loss and sediment yields to the reservoir, the prevention of bank erosion (Galas, 2008, Jedlička, 2010, Linhart, 1954).
The negligence of proper bank stabilization can be the basic problem with following shoreline retreat and its transformation. The shoreline retreats mostly as a result of the progressing bank erosion. The emerging abrasion cavern becomes dangerous for buildings close to the shoreline (Kotaskova, 2010, Soldo, 2010). The shoreline retreat causes an irreversible forest and agriculture soil loss and has a significant negative effect on any activities present in the riparian zone (recreation, bankside stand establishment, cruise etc.).

Current state

From the perspective of the conference topic - very important is the negative effect on the recreation function of the reservoir, as the potential movement for people as well as vessels is limited in the riparian zone, use of beaches.
It is fundamental to be aware of the problem. The most important thing when projecting a dam is of course the full functionality of the dam and other components that ensure that the purposes of the water work are met. However, after the commissioning of the dam its body is filled with water and the wave effects start to take place (Korytárová, 2007, Šlezingr, 2010, Šoltész, 2007). The filling of big reservoirs can take several weeks or month (oftentimes even more). During this period, it is possible to focus on the stabilization of those parts of the shoreline that are most prone to bank erosion (which is oftentimes done) and subsequently on other endangered areas (Synková, 2009).

Fig. 1: Abrasion damaged bank of reservoir – limited of recreational uses
(reservoir Brno, area Osada, foto M. Šlezingr 2012)

Possible solutions

In these areas, it is imperative to design and subsequently construct stabilization measures. There are two main types of bank protection (Šlezingr, 2002, Šlezingr, 2010):

- passive protection includes all stabilization measures that are realized directly in the protected reservoir bank (Šlezingr, 2010)

- active protection is provided by breakwaters. These can be placed either close to the bank or potentially several meters away from an already damaged bank on the abrasive platform (Šlezingr, 2010, 2007).

Reed planting or planting of suitable shrubs of willow species on the abrasion platform can be used in certain cases. It is important to use exclusively autochthonic species and their possible diversity.

Fig. 2: Adjusted Beach - suitable for recreational uses
(reservoir Zemplínská Šírava, foto M. Šlezingr 2013)

Conclusion

The most important is the prevention of bank deterioration in the very beginning. It is often sufficient to plan and use suitable biological or biotechnological stabilization measures (Synková, 2009, Šlezingr, 2010). After the abrasion cavern has been formed (viz the Factors leading to the origin and following progress of bank abrasion), the following shoreline retreat can be very fast under favorable conditions. It can reach up to tens of meters per year.

References

Galas S., Król E. (2008): Indicators for environmental-spatial order assessment on the example of the Busko and Solec spa communes. Gospodarka Surowcami Mineralnymi, 24: 95-115

Jedlička, L., Šlezingr, M. (2010): Bankside trees and shrubs, In.: *Colloquium on Landscape Management Brno MENDELU*, Brno, 14–17

Kotaskova, P., Hruza, P., (2010): How to make unknovn location more attractive, In.: Conference on Recreation and Conservation, Krtiny, p. 89 - 91

Korytárová J., Šlezingr M., Uhmannová H. (2007): Determination of potential damage to representatives of real estate property in areas affliced by flooding. Journal of hydrology and hydromechanics, 55: 282-285

Linhart, J., (1954): Intenzita abrazní činnosti hladiny Kníničské přehrady, In *Sborník ČS společnosti zeměpisné, no.4.*, 185–194

Soldo, B., Oreškovič, M., Aniskin, A., (2010): Example of water waves impact on the bank slope, *Journal of Landscape Management*, no.2, 40–43.

Synková J. (2009): Possibility of utilization of direction construction in river revitalization [Možnosti využití usměrňovacích staveb v rámci revitalizace toku] 2009 Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis 57(5):279-284.

Šlezingr, M., (2002): Bank erosion – prognosis of the retreat of bank line of reservoirs, *Journal of hydrology and hydromechanics,* 2002, p. 311–319, vol. 50,

Šlezingr. M., Jedlička. L., (2010): Accompanying vegetation – grasslend, In. *Conference on Recreation and Conservation p. 17*-18

Šlezingr, M., Foltynova, I., Zeleňáková, M., (2010): Assesment of the current condition of riparian and accompanying stands, In. Colloquium on Landscape Management, Brno, p. 24 – 27

Šlezingr,M. (2007): Stabilisation of reservoir banks using an "armoured earth structure“, Journal of hydrology and hydromechanics, no.1/2007,
Šlezingr, M. (2011): Břehová abraze, monograph, p. 174 , FOLIA MENDELU 2011, ISBN 978- 80-7375-566-9
Šlezingr, M., Zeleňáková, M., (2010): Natural processes of the self purification in rivers, Journal of Landscape Management, no.1 2010, 63–66
Šoltész, A., Baroková, D., Hašková, L. (2007): Optimalizácia vodného režimu na Medzibodroží. In: Acta hydrologica slovaca, 2007, 212 – 214.

Souhrn
Poškození břehů rozplavováním postihuje celou řadu nádrží včetně těch světových. Stabilizace břehů jsou vnímány pouze jako nezbytná řešení a realizována jsou až tehdy, pokud dojde k samotnému poškození břehu. Přitom stačí použití jednoduchého řešení: v patě největšího poškození břehu umístit kamennou patku a upravit sklon erodovaného břehu, tak aby se dále eroze nerozšiřovala. Břehy je nutné chránit, protože erozí jsou poškozeny i břehy užívné k rekreaci – pláže.

Contact:
prof. Dr. Ing. Miloslav Šlezingr
Phone: +420 545 134 520, e-mail: miloslav.slezingr@mendelu.cz

PLACES WITH ICE IN PROTECTED AREAS AND VISITORS

Václav Ždímal
Department of Applied and Landscape Ecology, Faculty of Agronomy, Mendel University in Brno, Zemědělská 1, 613 00 Brno, Czech Republic

Abstract
Moravský Kras is the largest karst area in the Czech Republic and is important place for recreation activities. Moravský Kras is known primarily by caves. There are more then 1100 caves registered in Moravský Kras. The following five caves are opened to the public: Punkevní, Kateřinská, Balcarka, Výpustek and Sloupsko-šošůvské. About 400,000 people visit them every year. Deep valleys with inverse locality are interesting for tourists either. The Holštejn valley near Stará Rasovna cave belongs to the coldest sites of the Moravian Karst, which is determined by forest stand in the surroundings and by the valley orientation. Into this valley flows the cold air and snow accumulates here, which lies here significantly longer time than in the surroundings. It is terminated by the labyrinth of small phreatic tunnels and a stack of blocks leading into the half blind Holštejn valley near the sink of the river Bílá voda. These localities with ice decoration, which lasts for a few months of the year, are very attractive for visitors. The crawling through these localities is dangerous for visitors and destroys plant and animal communities.

Key words: Moravský kras, visitors, ice decoration, inverse locality

Introduction

Research of karst areas is today mainly amateur issue. People do it at their free time as recreation activities. Moravský Kras is the largest karst area in the Czech Republic and is important place for recreation activities. There are more then 1100 caves registered in Moravský Kras. The following five caves are opened to public: Punkevní, Kateřinská, Balcarka and Sloupsko-šošůvské. About 400,000 people visit them every year. The other caves are closed for public.
Except for caves there are other interesting karst forms for tourist in Moravský kras. One of them are Deep valleys with inverse locality and snow accumulates.
Microclimate of deep valleys is an important element of their formation and existence and it influences many karst and biological processes. Air circulation, temperature and humidity influence the creation of specific environment.
Measurement of microclimate in inverse locality is no easy issue. This climate is frequently regarded as really constant, because its changes are small compared to the outer temperature. Thus measurements in these places require adequate equipment with necessary precision and long time, because the changes may occur in an unexpected moment too.

Materials and methods

Local topographical features enhance the formation of inversions, especially in valley locations. Temperature and air humidity were measured in the Stará Rasovna valley. This valley is very interesting for visitors. The Stará Rasovna valley lies in north-eastern part of the Moravian Karst, which belongs to the geomorphological unit Drahanská vrchovina Highland (Štogr and Kučera 1997; Vít 1998). The valley system was created in Devonian limestone of the Macocha Formation. The valley lies near the village Holštejn in the Hradský valley in altitude 462 m a. s. l. It is terminated by a labyrinth of small phreatic tunnels and a stack of blocks leading into cave Piková dáma. Stará Rasovna valley is the end of the half-blind Holštejn Valley near the disappearance of the Bílá voda River. The Holštejn Valley near Stará Rasovna Cave belongs to the coldest sites of the Moravian Karst, which is determined by forest stand in the surroundings and by the valley orientation. Into this valley flows the cold air and snow accumulates here, which lies here significantly longer time than in the surroundings.
Air temperature and relative humidity were measured due to character of the valley during winter season from December 27, 2013 to April 29, 2014. Measurement interval was set on 15 minutes. In the valley was located CEM DT-171 Data Logger (Shenzhen Everbest Machinery Industry Co., Ltd.; Range: Temperature: -40 to 70 °C, RH: 0 % to 10 % RH, Accuracy: Temp: ± 1 °C, RH: ± 2 %). The HOBO U10 Data Logger, placed near the cave entry, was used for measurement of external air temperature and relative humidity. For specification of the measurement methods, the Methodic of monitoring of microclimatic conditions in cave systems (Hebelka et al. 2011) was used.
Data processing was performed by softwares: Microsoft Excel, HOBOware lite and STATISTICA.

Results
Temperature measurements has proven great influence of seasonality. Air temperature ranged between -11.7 and 1 °C. The temperature was bellow zero from January 22, 2013 to March 22, 2014. The temperature was a little above zero in the rest of the measuring season.

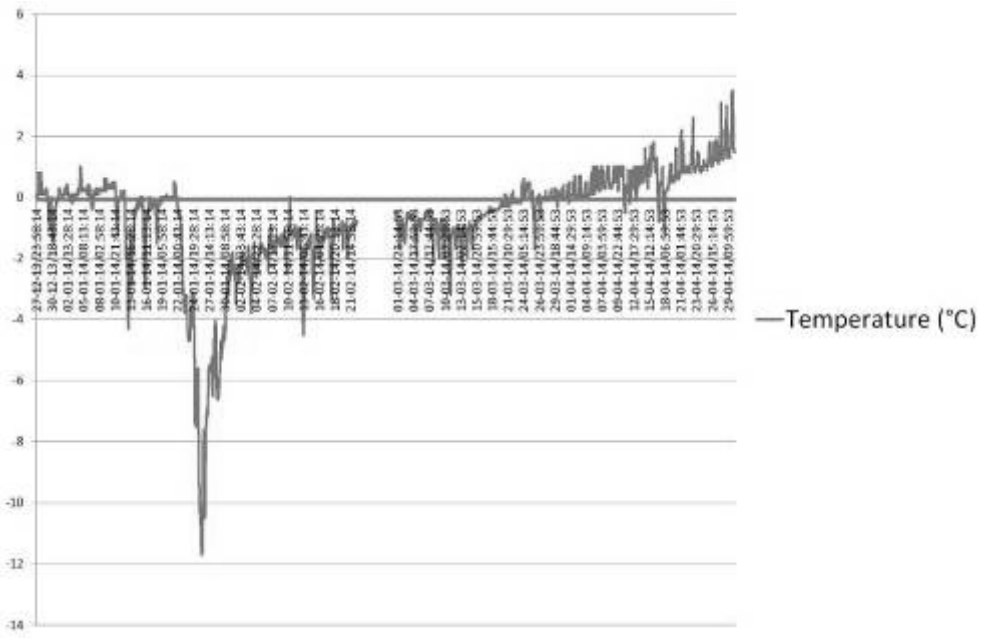

Fig. 1: Temperature in the valley

Discussion
The Stará Rasovna valley is relatively frequently visited. It lies on the red tourist trail. There are snow and ice decoration from December to April. These conditions create suitable environment for specific plants and animals. Snow and ice decoration are at the same time very attractive for tourists. The tourists play with snow, destroy snow decoration, disturb mosses and other plants. This activities can disturb fragile and rare environment.

Conclusion
Deep valleys at Moravský kras are inverse locality with snow and frost for a long time. The tourists endanger these localities and disturb this environment.

References
Badino G, (2004): Cave temperatures and global climatic change. Int. J. Speleol., 33 (1/4), 2004: 103-114.
Hebelka J eds., (2011):. Methodic of monitoring of microclimatic conditions in cave systems. Správa jeskyní České republiky, manuscript, CHMI Praha.
Přibyl J, Ložek V eds., (1992): Základy karsologie a speleologie. Academia, Praha.
Štogr J, Kučera J eds., (1997): Piková dáma a Spirálka. Monografie jeskyně. J.Štogr a J.Kučera.
Vít J eds., (1998): Jeskynní systém Piková dáma - Spirálová. Česká speleologická společnost ZO 6-19 Plánivy, Brno.

Acknowledgement
The author thanks the members of the Plánivy Caving Club 6-19 of the Czech Speleological Society for their help.

Souhrn
Výzkum krasových oblastí je v dnešní době do amatérskou záležitostí. Lidé je zkoumají ve volném čase jako rekreační aktivitu. Moravský Kras je největší krasovou oblastí v České republice a důležitým místem pro rekreační aktivity. V Moravském krasu je registrováno více než 1100 jeskyní. Většina z těchto jeskyní je veřejnosti nepřístupná. Kromě jeskyní jsou v Moravském krasu turisticky zajímavé i další krasové formy. Jednou z nich jsou hluboká krasová údolí s inverzním charakterem. V těchto údolích je specifické mikroklima důležitým prvkem jejich vzniku a existence a ovlivňuje řadu procesů.

Teplota vzduchu byla měřena v koncové části poloslepého údolí Stará rasovna, která leží v severovýchodní části Moravského krasu poblíž obce Holštejn v tzv. Hradském (Holštejnském), žlebu. Konec poloslepého Holštejnského údolí je tvořen bludištěm malých chodeb a sborem balvanů ústících do Ledové chodby jeskyně Piková dáma a patří k nejchladnějším místům Moravského krasu. Teplota vzduchu zde byla měřena vzhledem k charakteru údolí v zimním období od 27.prosince 2013 do 29. dubna 2014, interval měření byl zvolen 15 minut. V Ledové chodbě byl umístěn Data Logger CEM DT-171 Data Logger (Shenzhen Everbest Machinery Industry Co., Ltd.). Zároveň byl použit i Data Logger HOBO U10 pro měření venkovní teploty a vlhkosti vzduchu, který byl umístěn v blízkosti údolí. Pro stanovení metodiky měření byla použita Metodika monitoringu mikroklimatických poměrů v jeskynních systémech (Hebelka a kol., 2011). Teplotní měření prokázalo sezónní změny. Teplota vzduchu se pohybovala mezi -11,7 a 1 °C. Teploty pod nulou se držela od 22. ledna do 22.března 2014. V ostatním období byla teplota mírně nad nulou. Tyto teplotní podmínky vytváří prostředí vhodné pro určité druhy rostlin a živočichů. Zároveň jsou dlouho ležící sníh a ledová výzdoba atraktivní pro turisty, kteří návštěvami a hrami v této citlivé lokalitě narušují křehké a vzácné prostředí.

Contact:
Ing. Václav Ždímal, Ph.D.
Phone: +420 545 132 463, e-mail: zdimal@mendelu.cz

PRECISION OF TRAVEL COST MEASURES IN ESTIMATION THE RECREATION DEMAND: THE CASE OF ŠUMAVA NATIONAL PARK

Kateřina Kaprová
Charles University Environment Center, José Martího 407/2, 162 00 Praha 6, Czech Republic

Abstract
Recreation demand models represent the core methodology for investigation of nature-based recreation patterns and recreation utility. The application depends on travel cost measure, which serves as a shadow price of visiting natural areas. However, the determination, inclusion and specification of travel cost components vary widely among studies and there is still no consensus on the geographical and economic grounds. Rarely is travel cost data obtained directly from respondents; instead, most studies have used simplifications of journey length and time cost. Mainly for larger recreation areas, this may strongly impact the results of the demand estimation and utility analysis.
Based on a recent on-site survey in Šumava national park, this study presents a sensitivity analysis of the recreation demand results to the definition and level of accuracy of travel cost measure; we compare perceived and objectively defined travel cost measures at several simplification levels commonly used in travel cost studies, accounting also for the perception of time during the travel. We discuss also the reliability of respondents´ own assessments of journey distances and length. The study concludes with a number of practical implications for a more accurate and realistic basis for valuation in recreation demand studies and other travel-based techniques.

Key words: recreation demand, on-site

Introduction

Nature-based recreation represents an integral part of leisure-time activities in the Czech Republic the share of which has been rising since 1990s. Simultaneously, recreation is an important factor of exploiting ecosystem services. With growing pressure on the use of natural areas for recreation, where particularly protected areas - national parks of the Czech Republic - are yearly visited by hundreds thousand to millions recreationists, the urge for research of recreation behaviour of visitors and its motives arises.
Recreation demand results are, mainly in the US and western Europe, commonly used for decisionmaking about management of the site concerning future evolution of the site in terms of the width of the area accessible to the visitors, enhancing the environmental qualities of the site and equipping the site with paths or benches, or optimalisation of the visitation and setting entrance fees. The TCM estimates are also often used as a basis for cost-benefit analyses (CBA, e.g. Becker et al., 2010). In the Central Europe and the Czech Republic, the application of the results into the practice has also become important, and the focus on the precision of the estimates is therefore essential.
All of the recreation demand model specifications, nonetheless, rely fundamentally on the „price“ (travel cost) definition, which enables to link the recreation use of the site to utility derived from the visit in terms of money. There is no consensus on the components of total travel cost (Birol et al., 2008), which vary among researchers, as well as their definition. This may, nonetheless, have very important effect on the estimated recreation value, which is the main output for decisionmaking (Moons et al., 2001).
Our aim is to assess whether there is significant difference among particular subjectively perceived and objectively determined components of the total travel costs. As the behaviour and individual decisions of individuals about whether to visit the recreation site at all, which site to choose for recreation and how many trips to make to each of the sites, depend rather on subjective perception of the distance and cost, the recreation demand theory supports using subjective measures of travel cost. However, more frequent in the past research is the use of objective (GIS-based) measures. It is then very important to know which (if any) means of GIS definition leads to travel distance and time estimates that are similar to subjectively perceived; and on the other hand, whether the subjectively stated measures are reliable.

Data description

The analysis is based on an on-site survey in the central part of Šumava National Park, which took part from May to October 2014 (covering both summer recreation peak and off-season periods). The data collection techniques included face-to-face interviews at the site and not assisted data collection at several information points.

To model the recreation demand for Šumava National Park, socio-demographic information on the recreationists and characteristics of their trip to the site have been collected. Table 1 describes the variables used within the recreation demand analysis.

Tab. 1: Definition of variables

Variable	Definition	Unit
Visits	No. of visits made by the respondent in previous 12 months, excluding winter recreation visits	visits
Hiking	Main activity of the respondent is hiking (0=no, 1=yes)	binary
Nights	No. of nights spent at the site	nights
Group_no	No. of people travelling with the respondent	persons
Hotel	Accomodation in hotel or guest houst (0=no, 1=yes)	binary
Relatives	Accomodation at relatives´/friends´ house (0=no, 1=yes)	binary
Room	Accomodation in rented room/appartment/lodge (0=no, 1=yes)	binary
Camp	Accomodation in a camp/tent (0=no, 1=yes)	binary
Sex	Male=0, female=1	binary
Income	Net monthly income of the respondent	thousands CZK
Age	Age of the respondent	years
Outdoor	Not-assisted data collection=0,outdoor face-to-face data collection=1	binary

Table 2 defines various travel cost specifications that have been commonly used to model recreation demand so far: subjectively stated costs, and four specifications of computed travel costs (based on centroid of the region; precise location of the start and end of the journey; shortest path; and euclidean distance – straight line).
GIS data for modelling the travel cost has been collected from Czech Office for Surveying, Mapping and Cadastre, Nature Conservation Agency of the Czech Republic, Road and Motorway Directorate of the Czech Republic and Šumava National Park. In the analysis, we combined the GIS data with the use of route planner www.mapy.cz.
All travel cost specification are defined per person, as a sum of direct and time costs to get to and from the site. Accordingly to latest research (Czaikowski et al., 2012; Mitrica et al., 2013), the opportunity cost of time is set in all cases as 33% of the recreationist´s hourly wage rate.

Tab. 2: Travel cost specifications

<table>
<tr><th rowspan="2">Cost variable</th><th colspan="2">Direct cost of transport</th><th colspan="2">Opportunity cost of travelling time</th></tr>
<tr><th>Length</th><th>Per km rate</th><th>Travel time</th><th>Opportunity cost</th></tr>
<tr><td>Cost_perceived</td><td>Stated</td><td>Calculated using stated total direct cost</td><td>Stated</td><td rowspan="5">33% wage rate</td></tr>
<tr><td>Cost_obj1</td><td>Mapy.cz fastest route, using center of the part of municipality</td><td rowspan="4">2.51 (survey mean)</td><td rowspan="2">Mapy.cz, fastest route</td></tr>
<tr><td>Cost_obj2</td><td>Mapy.cz fastest route, using municipality center</td></tr>
<tr><td>Cost_obj3</td><td>GIS - euclidean distance using municipality center</td><td rowspan="2">Calculated using mean survey speed from mapy.cz (74 km/h)</td></tr>
<tr><td>Cost_obj4</td><td>GIS - euclidean distance using Šumava NP polygon</td></tr>
</table>

Out of the total 505 questionnaires collected in Šumava National Park, only 240 observations exhibit no missing values in some of the explanatory variables used within the estimation and are employed in the analysis. The descriptive statistics of the sample are depicted in Table 3.

Respondents make on average 2 visits to Šumava National Park per 12 months, ranging from 1 (present) visit to 20 visits.

Tab. 3: Descriptive statistics of the sample (N=240)

Variable	Mean	Std. dev.	Min	Max
Visits	2.01	2.50	1	20
Cost_perceived	654.4	344.7	86	1 865.7
Cost_obj1	643	331.4	78.1	1 891.1
Cost_obj2	640.5	331.5	74.2	1 891.1
Cost_obj3	480.9	254.1	0	1 455.5
Cost_obj4	444.4	247.9	0	1 399.1
Hiking	0.67	0.47	0	1
Nights	5.39	2.97	0	15
Group_no	3.84	3.56	1	31
Hotel	0.55	0.5	0	1
Relatives	0.07	0.26	0	1
Room	0.17	0.38	0	1
Camp	0.11	0.31	0	1
Sex	0.45	0.5	0	1
Income	18.99	6.95	6.46	30.55
Age	41.64	12.92	15	74
Outdoor	0.57	0.50	0	1

The distribution of the variables measuring travel costs as perceived and using fastest route (Cost_obj1 and Cost_obj2) is very similar; however, the use of simplified euclidean distance (straight line; Cost_obj3 and Cost_obj4) yields apparently lower travel costs than those stated by the respondents. On the other hand, there still exist a significant strong positive correlation among each two pairs of cost measures (Pearson correlation coefficients ranging from 0.78 to 0.99 are all statistically significant at α=0.01). Apparently, the closest to the magnitude of the costs which the respondents take as relevant in their recreation decisions is the Cost_obj1 specification, which is in line with the results of Zawacki and Marsinko (1999).

The difference among perceived and objective travel cost measures is, however, not caused by wrong estimation of the length or time duration of the journey by respondents, which is the main concern of demand analysts due to which perceived cost have been so rarely used in recreation demand analyses. Each of these travel cost components is highly correlated between the perceived specification and the objective specifications (Pearson correlation coefficient from 0.79 to 0.93), which means that the objections to the use of perceived costs as unreliable due to rounding errors, simplification of the real distance by the respondents etc., are not justified. As opposed to previous findings (Moons et al., 2001), in our dataset there is no evidence that the error of respondents in stating the true distance or time compared to the most precise objective measure used in *Cost_obj1*, would change with the length of the journey or familiarity with the site, and does not relate to the socio-demographic variables either (based on regression estimation).

The true cause of the differences between perceived and objective travel cost measures is thecost per km per person (correlation 0.51-0.54), which has a large variability as perceived (in fact, reflecting the real fuel consumption of the respective car, and the number of people that share the cost of fuel in each car), while the objective measures rely on a constant per km rate, and a constant average no. of people in the car, not allowing for the variations among journeys of each respondent.

Methods and estimation results

To model the recreation demand and inspect the sensitivity of the consumer surplus with respect to the specification of the travel cost variable, we employ a single-site individual travel cost model (Haab and McConnell 2002, Parsons 2003). In this demand model, the quantity demanded by the recreationist is represented by the number of trips done to the recreation site within last year, while the price of the visit is given by different definitions of travel costs. For each travel cost definition, a different recreation demand functions is estimated, using a common set of other explanatory variables describing the trip, the recreationist and type of data collection.

The estimation is based on truncated stratified negative binomial model estimated by maximum likelihood (Hilbe and Martinez-Espineira, 2005), which accounts for the specific nature of the dependent variable (nonnegative integer; on-site data collection problems such as truncation, overdispersion and endogenous stratification). The results are shown in Table 4.

Tab. 4: Recreation demand estimates

Variable /Model	Model 1 Cost_perceived		Model 2 Cost_obj1		Model 3 Cost_obj2		Model 4 Cost_obj3		Model 5 Cost_obj4	
	Parameter	*Std. Err.*	*Parameter*	*Std. Err.*	*Parameter*	*Std. Err.*	*Parameter*	*Std. Err.*	*Parameter*	*Std. Err.*
Cost	-0.002***	0.000	-0.003***	0.000	-0.003***	0.000	-0.003***	0.001	-0.003***	0.001
Hiking	-0.632***	0.228	-0.501***	0.223	-0.488***	0.223	-0.586***	0.226	-0.540**	0.226
Nights	0.060*	0.034	0.054	0.033	0.054	0.033	0.048	0.034	0.051	0.034
Group_no	-0.030	0.029	-0.030	0.029	-0.030	0.029	-0.029	0.029	-0.025	0.029
Hotel	-1.922***	0.302	-2.169***	0.299	-2.149***	0.297	-2.003***	0.299	-2.043***	0.301
Relatives	-1.155***	0.433	-1.197***	0.423	-1.198***	0.422	-1.117***	0.431	-1.021**	0.434
Room	-2.265***	0.383	-2.568***	0.383	-2.563***	0.381	-2.424***	0.384	-2.467***	0.386
Camp	-1.069***	0.374	-1.280***	0.369	-1.249***	0.366	-1.197***	0.373	-1.222***	0.375
Sex	-0.461**	0.226	-0.434*	0.223	-0.436**	0.222	-0.469**	0.225	-0.473**	0.226
Income	-0.001	0.017	0.011	0.017	0.011	0.017	0.003	0.017	0.000	0.017
Age	-0.002	0.009	0.001	0.008	0.002	0.008	0.001	0.009	0.001	0.009
Outdoor	-0.231	0.241	-0.298	0.238	-0.306	0.237	-0.302	0.241	-0.291	0.241
Constant	1.507	1.993	2.100*	1.124	2.125*	1.093	1.846	1.444	1.756	1.475
Alpha	7.21***		1.20***		3.14***		4.86***		5.08***	
N	250		250		250		250		250	
Log-likelihood	-264.55		-259.51		-259.39		-262.08		-261.37	
Wald chi2	105***		114.71***		115.47***		110.41***		111.16***	
Pseudo R2	0.210		0.225		0.225		0.217		0.219	
AIC	2.31		2.27		2.27		2.29		2.29	
BIC	-1244.11		-1244.11		-1244.11		-1244.11		-1244.11	

*Statistical significance of parameters: *** α=0.01; ** α=0.05; * α=0.1*

In all models, the cost variable is statistically significant at α=0.01 and works in the expected direction, irrespective of its precise definition. All models exhibit almost identical fit statistics and the likelihood ratio test (not shown in Table 4) shows no significant difference in performance of the models. Also, the use of any of travel cost specification does not alter the effects of any other explanatory variable on the predicted number of trips to Šumava National Park. We may observe that hikers make fewer trips to the site than cyclists and other recreationists; the same holds for people stay in hotels and guesthouses, at their friends or relatives houses, rent a room or stay in a camp. Women visit Šumava national park less often per year than men; nonetheless, the rest of socio-demographic variables is not statistically significant even at α=0.1, which means that visit frequency does not depend on income nor age. The demand for visits also does not change for the two subsamples of data based on different data collection techniques.

Table 5 lists the estimates of welfare associated with 1 visit to Šumava National Park based on different cost specifications. The point estimates of consumer surplus vary by more than 100 CZK per visit, exhibiting a downward bias related to the level of simplification of the travel cost variable. However, all 95% confidence intervals of the objective estimates of costs contain the point estimate of CS/visit using perceived costs model.

Tab. 5: Consumer surplus estimates (in CZK 2014)

Welfare measure/ Cost specification		Model 1 Cost_perceived	Model 2 Cost_obj1	Model 3 Cost_obj2	Model 4 Cost_obj3	Model 5 Cost_obj4
CS/visit		439.5	386.2	384.8	314.8	303.7
95% Conf. Int.	Lower bound	322.6	293	292	234.7	227.6
	Upper bound	689.4	566.4	564.3	477.9	456.2

The results show that when applying simplified travel cost measures instead of theoretically relevant perceived cost, care must be taken to report not only the point estimate (which is or may be biased downwards), but also the distribution of the estimate. Further, when implementing the welfare measures based on simplified travel cost estimation into cost-benefit analysis, it is essential to do a sensitivity analysis of the CBA results to recreation welfare estimates (for example using the 95% confidence intervals).

Conclusion

The Šumava National Park is a large-sized recreational area (compared to other areas in the Czech Republic), to which many visitors come from a long distance (205 km on average) from large municipalities (51% from regional capitals, 28% from Prague). Despite of these facts, the perceptions of recreationists concerning the travel distance and time are very close to the reality and thus may be considered reliable. That enables to rely on perceived travel costs, which are supported by the recreation demand theory, also in practical analyses of recreation demand in the Czech Republic.

The recreation welfare associated with 1 visit to Šumava National Park is estimated at 439.5 CZK using perceived travel cost, and at 386.2 CZK using the most precise measure of objective travel cost.

The use of simplified travel cost based on euclidean distance underestimates the true distance to the site. However, the definition of travel cost variable does not affect the fit of the recreation demand model or the stability of the effect of the other recreation demand determinants. In case a simplified travel cost measure based on euclidean distance is used, the point estimate of the recreation welfare is lower by more than 100 CZK per visit. Nonetheless, the divergence is not so dramatical as in previous studies (e. g. Moons et al., 2001). The recommendation for further analyses in the Czech Republic is that when using euclidean distance, not only the point estimate of recreation utility should be reported and further employed in cost-benefit analysis, but also the distribudion of the estimate. This enables to do a sensitivity analysis of the CBA results to recreation welfare estimates – our study shows that the confidence intervals already contain the point estimate of the model estimated using theoretically sound perceived travel costs.

References

Hilbe, J. and R. Martinez-Espineira (2005): *NBSTRAT: Stata module to estimate Negative Binomial with Endogenous Stratification*. Statistical Software Components S456414, Boston College Department of Economics.

Haab, T. and McConnell, K. E. (2002): *Valuing Environmental and Natural Resources: the econometrics of non-market valuation*, Cheltenham: Edward Elgar. ISBN 9781843765431.

Parsons, G. R. (2003): The Travel Cost Method. In: Champ, P. A., Boyle, K. J., Brown, T. C. (eds.), *A Primer on Nonmarket Valuation*, London: Kluwer Academic Publishers. ISBN 0-7923-6498-8.

Czaikowski, M., M. Giergiczny, J. Kronenberg, P. Tryjanowski (2012): The economic value of a white stork nesting colony: a case of stork village in Poland. University of Warsaw, *Faculty of Economic Sciences Working Paper* no. 11/2012 (77).

Mitrica, E., B. Mitrica, A. Stanculescu (2013): Economic analysis of nature preservation investments: the zonal travel cost approach applied for Harghita County of Romania. *Journal of Environmental and Ecological Statistics* 21(1), p. 83-93.

Becker, N., M. Inbar, O. Bahat, O.Y. Choresh (2010): Cost benefit analysis of conservation efforts to preserve an endangered species: The Griffon Vulture (Gyps fulvus) in Israel. *Journal of Bioeconomics* 12, p. 55–70.

Birol, E., P. Koundouri, Y. Kountouris (2008): Using economic valuation techniques to inform water resources management: A survey and critical appraisal of available techniques and an application. *Environment & Policy* 48, p. 135-155.

Moons, E., J. Loomis, S. Proost, K. Eggermont, a M. Hermy (2001): Travel cost and time measurement in travel cost models. *Katholieke Universiteit Leuven, Energy, Transport and the Environment Working Papers Series* No. 2001-22.
Zawacki, W., and A. Marsinko (1999): Using geographic information systems with travel cost models: A case study. *Proceedings of the 2000 Northeastern Recreation Research Symposium* (p. 287-292). Bolton Landing, NY: USDA Forest Service General Technical Report NE-269.

Acknowledgement
The work on this paper was supported by the grant GAUK No. 1544314 from the Grant Agency of the Charles University in Prague, and by the project No. TD020049 financed by the Czech Technological Agency.

Souhrn
Článek představuje výsledky analýzy rekreační poptávky v národním parku Šumava, včetně citlivostní analýzy vzhledem ke způsobu definování cestovních nákladů (stínové ceny rekreace v národním parku). Z porovnání vnímaných a několika druhů objektivně stanovených cestovních nákladů vyplývá, že zjednodušení výpočtu objektivních cestovních nákladů vede k nižším bodovým odhadům rekreačního užitku spojeného s návštěvou národního parku Šumava. Pokud je však při dalším využití takto vypočteného rekreačního užitku v analýze nákladů a užitku zahrnut intervalový odhad, nemusí mít toto zjednodušení nijak dramatický dopad na závěry, které z analýzy nákladů a užitku vyplývají.

Contact:
Ing. Kateřina Kaprová
Phone: +420 220 199 466, e-mail: katerina.kaprova@czp.cuni.cz

PROPOSAL OF „METHODOLOGY FOR IDENTIFICATION AND ASSESSMENT OF THREAT HAZARD TO NATURAL COMMUNITIES OF CULTURAL MONUMENTS “

Petr Kupec, Jan Deutscher, Monika Veličková
Department of Landscape Management, Faculty of Forestry and Wood Technology,
Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic

Abstract
The paper introduces a methodology focused on the assessment of threat hazard to the vegetation of cultural monuments, parks and gardens. It has been designed as a part of the results obtained during the elaboration of a research task named „The identification and assessment of threat hazard on natural communities of cultural monuments“ guaranteed by the Ministry of Culture CR. The methodology assesses the state and possible hazards to trees and shrubs in the natural communities of cultural monuments. It works with a simplified parameterization of potential development of assessed biotopes. A part of it is also a recommended areal differentiation for the purposes of the use of the methodology.

Key words: risk assessment, natural communities of cultural monuments, potential development of natural communities

Introduction

Presented paper concludes a part of the results obtained during the elaboration of a research task named „The identification and assessment of threat hazard to natural communities of cultural monuments“ focused on the formulation of a methodology for risk assessment of vegetation of cultural monuments, parks and gardens. The task has been elaborated within the project of Ministry of Culture of the Czech Republic (MC CR) under the category Applied research and development of national and cultural identity (NAKI) named “Identification of important areas with cultural and historical values threatened by natural and anthropogenic influences”. The basic parameters when designing the methodology were: simplicity, easy application, relative generality and the combination of standardized approaches to woody vegetation assessment.

Materials and methods

The proposed methodology is focused on the risk assessment to the vegetation of cultural monuments. More precisely, it deals with the evaluation of shrubs and trees and the threat hazard to the fulfillment of their expected function, as important aesthetic and landscape features. The evaluated parameters and their combination was chosen and drafted in a way to best mirror and maintain the velocity and dynamics of the environment rather than simple conservation of the current state. In other words, special importance is given to the perspective of the future development and its long-term sustenance in accord with the leading idea of the cultural elements’ composition, rather than to the evaluation of the current state of the vegetation as it is.

The evaluation was proposed in following parameters:

A) Age structure of trees

1 – Individuals with expected lifespan of 30 years and more are predominant
2 – Individuals with expected lifespan of 10 - 30 years are predominant
3 - Individuals with expected lifespan under 10 years are predominant
90% of individuals on the locality are considered predominant.

This parameter delimitates the expected lifespan of individual trees in the evaluated segment according solely to their physical vitality. No attention is paid to their health status as that is addressed in the next parameter. This parameter indicates the relationship of trees between their age and potential lifetime, resp. physical vitality (the ability to regularly grow and fruit). The parameter scale matches the resulting classification of threat hazard to vegetation stated in the Results.

B) The health status of trees

1 – Healthy or individuals with first symptoms of damage are predominant
2 – Individuals with little to medium symptoms of damage are predominant
3 – Dying or individuals with severe symptoms of damage are predominant

This parameter indicates the health status of trees in the evaluated segment. It is diagnosed mainly as the ocular damage such as defoliation, the incidence of disease fungi and pests, irreversible damage by game. It is based on current methods of forest health assessment by ICP Forest (Strnady, 2007 –

modified for the purposes of this methodology). The evaluation is carried out according to the number damaged trees in the segment, which indicates the total damage of the segment according to Table 1.

Tab. 1: The tree health status evaluation - simplified

Tree damage		**Total segment damage**				
Damage (defoliation)		**Health status**	**Max. % damaged trees**			
%	**Characteristics**		**0-10**	**11-30**	**31-50**	**50+**
do - 30	healthy to little damaged	**1**	100	20		
31 - 50	little to medium damaged	**2**			32	5
51 - 100	severe damaged to dying	**3**			84+	30+

Zdroj: Vyskot,I.: Kvantifikace a hodnocení funkcí lesů České republiky. [S.n.]: Nakladatelství 131 Margaret, 2003. 168 s. ISBN 80-900242-1-1, modified.

The parameter scale matches the resulting classification of threat hazard to vegetation stated in the Results.

C) The amount of tree individuals (species) on the border of their ecological optimum

1 – up to 10%
2 – between 11 - 30%
3 – more than 30%

This parameter indicates the relationship between current vegetation and the natural conditions of the site. It is a relative parameter which main purpose is to evaluate the potential resilience of trees to the stress factors of the environment based on the premise, that the closer the individual (species) is to its ecological optimum, the more resilient it is. The ecological optimum should be understood as such natural conditions where the assessed species prospers due to its natural adaptive mechanisms. For the evaluation of ecological optimum in the conditions of CR it is possible to use for example Buček and Lacina (1999). When evaluating the ecological optimum of introduced and exotic species, it is needed to proceed individually, or consult expert authorities. For simplification, if the introduced species is located in conditions similar to its original geographic area, for the purposes of this methodology, those can be considered its ecological optimum. The parameter scale matches the resulting classification of threat hazard to vegetation stated in the Results.

D) Age structure of shrubs

1 – Individuals with expected lifespan of 30 years and more are predominant
2 – Individuals with expected lifespan of 10 - 30 years are predominant
3 - Individuals with expected lifespan under 10 years are predominant
90% of individuals on the locality are considered predominant.

Similarly to the age structure of trees, this parameter delimitates the expected lifespan of shrubs in the evaluated segment according solely to their physical vitality with the difference, that it does not evaluate individuals, rather whole communities (with the exception of solitaire shrubs). No attention is paid to their health status as that is addressed in the next parameter. This parameter indicates the relationship between the current age of evaluated shrubs and their potential lifetime, resp. physical vitality (the ability to regularly grow and fruit). The parameter scale matches the resulting classification of threat hazard to vegetation stated in the Results.

E) Health status of shrubs

1 – Healthy or individuals with first symptoms of damage are predominant
2 – Individuals with little to medium symptoms of damage are predominant
3 – Dying or individuals with severe symptoms of damage are predominant

This parameter indicates the health status of shrubs in the evaluated segment. Similarly to the previous parameter, it is mostly evaluated for the whole shrub communities. It is diagnosed mainly as the ocular damage such as defoliation, the incidence of disease fungi and pests. Own parameterization was developed for this purpose from the modified tree health status parameterization as shown in table 2.

Tab. 2: Shrub health status evaluation - simplified

Individual damage		Total segment damage			
		Health status	Max. % damaged shrubs		
%	Characteristics		0-30	31-50	51-100
do - 30	Healthy or little damaged	**1**	100		
31 - 50	Little to medium damaged	**2**		90	10
51 - 100	Severe damaged to dying	**3**			90+

The parameter scale matches the resulting classification of threat hazard to vegetation stated in the Results.

F) The amount of shrubs (species) on the border of their ecological optimum

1 – up to 10%
2 – between 11 - 30%
3 - more than 30%

This parameter works the same as in the case of trees, it indicates the relationship between current vegetation and the natural conditions of the site. It is again a relative parameter which main purpose is to evaluate the potential resilience of shrubs to the stress factors of the environment. Even for the shrubs species, for the evaluation of ecological optimum in the conditions of CR it is possible to use for example Buček and Lacina (1999). The parameter scale matches the resulting classification of threat hazard to vegetation stated in the Results.

The resulting classification of threat hazard to vegetation:

1 – low – low degree of threat hazard of given locality. The current state of vegetation matches the natural conditions is stabilized, with no need for treatment of improvement. In 30 years the need for treatment should be expected.
2 – medium - medium degree of threat hazard of given locality. Critical phenomena occur on the locality leading to serious threat hazard with the potential for a rapid disturbance of the current state. In 10 years the need for treatment should be expected.
2 – high – critical state, the danger of irreversible damage, degradation and devaluation. Treatment needed as soon as possible, maximum within 2 years.

Results

Since the above chapter introduces the methodology for identification and assessment of threat hazard to the natural communities of cultural monuments in its basic form, the following chapter deals with its application in the field. The first task that has to be dealt with during the evaluation is to choose proper sampling size of the vegetation. The defining criterion in this case is the total area of the locality and its homogeneity. The total area is considered the whole planar acreage. The homogeneity is considered the variations in age structure, species composition and spatial distribution of vegetation. For the purposes of this methodology, segments of trees within 20 years of age difference and shrubs of 5 years of age difference can be considered as age homogeneous. The occurrence of similar species or ecologically corresponding vegetation formations of up to 5 different species in one segment can be considered as homogenous. Stands with similar height of the main canopy level, or similar structure and height in different canopy levels can be considered as spatially homogenous. Following these criteria, it is possible to carry out locality-wide evaluation on well selected transects (linear representative areas 20m wide) or on well selected sampling sites (sites or individuals reaching at least 10% of a homogeneous segment). The evaluation can be carried out either locality-wide or on well selected segments. The segmentation can be realized again by the criteria of acreage and homogeneity in a way that following installation of sampling sites within a segment is optimized. It can be stated, that there is no universal recommendation for the use of either locality-wide, transect or sampling site evaluation. However, based on the experience gained during field applications of this methodology, following scheme can be used (Table 3). A simplified approach to the evaluation is shown in Table 4.

Tab. 3: A simple scheme for the differentiation of assessed localities

Acreage / Homogeneity	up to 1 ha	1 ha – 5 ha	more than 5 ha
Age, species, spatial	Sampling site	Transect	Set of transects
In two parameters one of which is age	Transect	Set of transects	Set of sampling sites
Other cases	Locality-wide	Set of sampling sites	Set of sampling sites

Tab. 4: A simplified approach to the assessment and identification of threat hazard to natural communities of cultural monuments

Tree vegetation			
Degree	***A) Age structure of trees***	***B) Health status of trees***	***C) The amount of tree individuals (species) on the border of their ecological optimum***
1	Individuals with expected lifespan of 30 years and more are predominant	Healthy or individuals with first symptoms of damage are predominant	up to10%
2	Individuals with expected lifespan of 10 - 30 years are predominant	Individuals with little to medium symptoms of damage are predominant	11 - 30%
3	Individuals with expected lifespan under 10 years are predominant	Dying or individuals with severe symptoms of damage are predominant	30% and more
Shrub vegetation			
Degree	***D) Age structure of shrubs***	***E) Health status of shrubs***	***F) The amount of shrubs (species) on the border of their ecological optimum***
1	Individuals with expected lifespan of 30 years and more are predominant	Healthy or individuals with first symptoms of damage are predominant	up to 10%
2	Individuals with expected lifespan of 10 - 30 years are predominant	Individuals with little to medium symptoms of damage are predominant	11 - 30%
3	Individuals with expected lifespan under 10 years are predominant	Dying or individuals with severe symptoms of damage are predominant	30% and more
Degree	***Resulting classification of threat hazard to vegetation:***		
1	Low (In 30 years the need for treatment should be expected)		
2	Medium (In 10 years the need for treatment should be expected)		
3	High (Treatment needed as soon as possible, maximum within 2 years)		

Conclusion

Presented paper concludes a part of the results obtained during the elaboration of a research task named „The identification and assessment of threat hazard to natural communities of cultural monuments“ focused on the formulation of a methodology for risk assessment of vegetation of cultural monuments, parks and gardens. The task has been elaborated within the project of Ministry of Culture of the Czech Republic (MC CR) under the category Applied research and development of national and cultural identity (NAKI) named “Identification of important areas with cultural and historical values threatened by natural and anthropogenic influences”. The basic parameters when designing the

methodology were: simplicity, easy application, relative generality and the combination of standardized approaches to woody vegetation assessment. The methodology is divided into the assessment of the current state and of threat hazard to trees and shrubs in natural communities of cultural monuments. Its integral part is a recommended differentiation of types of assessment according the total acreage and the homogeneity of the locality. Up to 2014, its verification was carried out on 7 cultural monuments in total. The results of this verification are not the subject of this paper, rather they are presented in a different paper on this very conference due to the writing space limitations.

References

Buček, A., Lacina, J. (1999): Geobiocenologie II. Mendelova zemědělská a lesnická univerzita Brno, 249 s

Kolektiv: Monitoring zdravotního stavu lesa v České republice. Ročenka programu ICP Forests/Forest Focus 2006 a 2007). Výzkumný ústav lesního hospodářství a myslivosti, Strnady, 2007

Vyskot,I.: Kvantifikace a hodnocení funkcí lesů České republiky. [S.n.]: Nakladatelství 131 Margaret, 2003. 168 s. ISBN 80-900242-1-1

Acknowledgement

This contribution was supported by the project DF12P01OVV035 „Identification of significant areas with cultural and historical values threatened by natural and anthropogenic stresses “, 2012–2015, for Ministry of Culture of the Czech Republic.

Souhrn

Předkládaný článek shrnuje část výsledků řešení dílčího výzkumného úkolu s názvem " Hodnocení stavu a identifikace rizik přírodních společenstev kulturních památek" zaměřenou na formulaci metodiky na hodnocení ohrožení vegetace památek, parků a zahrad. Úkol byl řešen v rámci projektu Ministerstva kultury kategorie NAKI s názvem "Identifikace významných území s kulturně historickými hodnotami ohrožených přírodními a antropogenními vlivy. Při koncipování metodiky byly základními požadavky: jednoduchost, snadná aplikovatelnost, relativní obecnost a kombinace pokud možno standardizovaných postupů hodnocení dřevinné vegetace. Metodika je rozdělena na šetření stavu a rizik stromové a keřové části společenstev kulturních památek. Její součástí je rovněž doporučená diferenciace typů hodnocení území dle jeho rozlohy a homogenity. Do roku konce roku 2014 byla provedena její verifikace na sedmi kulturních památkách. Výsledky verifikace nejsou předmětem tohoto článku, nicméně jsou z důvodu omezení rozsahu příspěvku prezentovány v jiném příspěvku na této konferenci.

Contact:
Assoc. Prof. Ing. Petr Kupec, Ph.D.
Phone: +420 545 134 097, e-mail: petr.kupec@mendelu.cz

PROTECTION OF RECREATIONAL AREA OSADA WITH USING ACTIVE ANTIABRASIVE STABILIZATION OF BANKS

Lenka Gernešová, Jana Marková
Department of Landscape Management, Faculty of Forestry and Wood Technology,
Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic

Abstract
The paper deals with problems of abrasive cabins of Brno dam reservoir in Osada area, in relation of recreology. Brno dam reservoir is attractive area for a wide range, not only for residents of Brno. People are visiting this area throughout the whole year with varying intensity. Most tourists will come here mainly during the summer, but in spring and fall too. Osada area is lined by a number of cottages along the coast. The cottages are the most vulnerable to shoreline erosion. There arise several meters high cabins that must be stabilized to prevent further erosion of soil into the reservoir and thus reduce the risk to the cottages built close to the shore. One possible solution is to use an active anti-abrasive protection.

Key words: bank erosion, cabins, protection, cottage, recreology.

Introduction

Abrasion or shore erosion is a natural phenomenon occurring on a number of water reservoirs. This state is very good observable especially on the coast of seas and oceans.
Abrasion is a process that can be described as surface abrasion of bottom and banks by the movement of the water level (waving) associated with transporting and storing loose material. Due to this process may cause abrasion cabins; loose material is transported into the reservoir. This situation is undesirable (Šlezingr, 2011).
Development of bank erosion is conditioned by several factors: the movement of the water level and the material forming the reservoir shore. The movement of water levels may be caused by the movement of vessels or by wind (wawe growth is closely related to the fetch length - Pelikán, 2013). The problem of wind-driven waves was investigated by many scientists worldwide, e.g.: Phillips and Miles (1957), and Lukáč and Abaffy (1972, 1980). The Czech scientists due to wave in their works dealt with e.g.: Kratochvil (1987), Šlezingr (2004, 2007, 2011) and Pelikán (2013).
In case of Brno dam reservoir the process of bank erosion is most noticeable in the area Osada. The others parts of reservoir do not show such damage to the banks (the influence of geological conditions and the impact of bank stabilization carried out in the past). The suburban area is popular with a wide range of tourists, various visitors due to nearby cities and good accessibility (infrastructure).

Materials and methods

Whole area of Brno dam reservoir is a quite attractive place for inhabitants of the Brno city and other nearby settlements. There is a very good access to public transport, car, bike or walk. Visit rate of entice reservoir area is all year.
Osada area – investigate area is situated along the left bank of Brno dam reservoir. This area is the most affected by abrasion. The high of abrasive cabin reaches 6 m. This area is frequently visited by tourists. There are a many places for stay (private cottages, restaurants), places for sport and recreation activities. Many of them are located in close to the shoreline affected by abrasion. The further gradual development of abrasion may endanger these objects. Another danger can be humans life-threatening.
In the summer months is possible to see the visitors walking at the edge of the shore. There is risk of breaking the shore and it's slide down into the reservoir. In the winter months the water level in reservoir is lowered; shore zone is shifted into the reservoir. There arise beaches, which are used for walking (see Fig 1 and Fig 2). Even in this case exist the danger of a landslide the walls of abrasive cabin.
For Osada area is proclaimed ban on construction because of kingfisher protection which nest in cavities perpendicular shore walls. We decided to apply there the active anti-abrasive protection of shore in our research. It's should reduce the erosive effect of the waves. Within the research project "Active anti-abrasion structures" there were proposed and implemented types of active protection of banks.

Fig. 1: Walking visitors in Brno dam reservoir

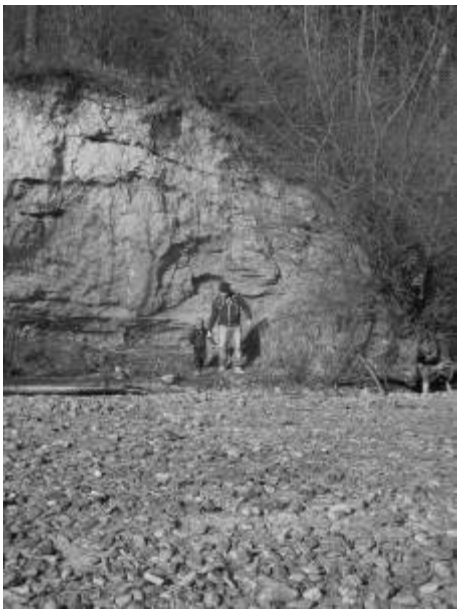

Fig. 2: Man with his child under abrasion cabin

Results

The bank of reservoir in area Osada is composed by well washed out soils prone to erosion. Furthemore, the ban on construction there doesn't build any measures that would result in intervention to shore. It would be disturbed habitat for kingfisher nesting.

In the past there have been implemented features that should protect the shore – breakwater of willow stand, double wattle fence (see Fig. 3). Within the research project there were created next protective features: gabions, single row wattle fence and palisade of stakes.

The willow stand there was planted nearly 10 years ago. The stand has in term of protecting of banks, function of the breakwater. From the observation and analysis of samples is obvious that the fine eroded material is settled there.

Double wattle fence – It's wattle fence made of willow stakes with interlocking willow branches and fill up by gravel (local material). Because this fence didn't reach the water level, was modified in year 2013 – has been extended and increased. Today the fence has form of geminate double wattle fence.

Gabions, single row wattle fence and palisade – all these features are newly constructed. All features achieves water level due to reduction energy of water level waving (See Fig. 4 and Fig. 5).

This year (2015) will be done measurement on all these (new and old) anti-abrasive features. The measurement will be done with using wavemeters that should capture if these protective features really dampen wave energy.

Fig. 3: Willow stand and geminate double wattle fence

Fig. 4: Gabion

Fig. 5: Palisade

Discussion

Abrasion in the framework of Brno dam reservoir is manifested especially from spring to fall, In time when the water level is maintained at a certain level. Before the onset of winter, the water level is reduced. At this time the abrasion process is interrupted because the water level is below the level of the eroded bank.

The current active anti-abrasive features of bank protection should dampen energy of waving water level. All measures were proposed at the height of the water level in reservoir (in summer months) and built parallel to the shoreline. The planned research should confirm the reduction of wave energy. For better efficiency the measures could be increased beyond the water level.

Implemented anti-abrasive measures don't stop bank erosion, but rather slows. We assume a gradual clogging of the area behind the anti-abrasive feature by material from bank. This can prevent to clogging of eroded material directly into the reservoir.

Conclusion

Brno dam reservoir is attractive area for tourists throughout all year. One of the well-attended area is Osada area that is situated along the left bank of reservoir. This area is notable for development of bank erosion. It's seen there in form of up to 6 m high cabins which are not stabilized. The ongoing process of abrasion threatens buildings near the damaged shoreline – cottages, restaurants, roads and even the health and lives of visitors.

Because of ban on construction (such as habitat protection of kingfisher) there is not possible to interfered into bank or changed it. In the research are proposed and built different types of active anti-abrasive protection (breakwater from willow stand, wattle fences, gabions and palisade) which should slows the process of bank erosion. The effectiveness of individual elements is under investigation.

References

Kratochvíl, S., (1970): Stanovení parametrů větrových vln gravitačních vln v hlubokých přehradních nádržích a jezerech. Vodohospodársky časopis, ročník XVIII, č. 3.

Lukáč M., (1972): Vlnenie na nádrži a jeho účinky na brehy nádrže. Bratislava, MS Katedra Geotechniky SVŠT.

Lukáč M., Abaffy, D., (1980): Vlnenie na nádržiach, jeho účinky a protiabrázne opatrenia. Ministerstvo lesného a vodného hospodárstva SSR, Bratislava.

Miles, J. W. (1957): On the Generation of Surface Waves by Shear Flows. Journal of Fluid Mechanics, Vol. 3. pp 185-204.

Pelikán, P., (2013): Přetváření břehů vodních nádrží vlivem břehové abraze. Dizertační práce, Mendelova univerzita v Brně, 147 s.

Phillips, O. M., (1957): On the Generation of Waves by a Turbulent Wind. Journal of Fluid Mechanics, pp 417–445.

Šlezingr, M., (2004): Břehová abraze. CERM, Brno, pp 160. ISBN 80-7204-342-0.

Šlezingr, M., (2007): Stabilisation of Reservoir Banks Using an "Armoured Earth Structure". Journal of Hydrology and Hydromechanics, Volume. 55, Issue. 1, pp 64-69. ISSN 0042-790X.

Šlezingr, M., (2011): Břehová abraze – Možnosti stabilizace břehů. Folia Brno, pp 172, ISBN 978-80-7375-566-9.

Acknowledgement
The article contains partial results of research project “Active anti-abrasion structures”, reg. no. LDF_VT_2015011, funded by IGA FFWT MENDELU Brno.

Souhrn
Vodní dílo Brno je turisticky atraktivní oblastí a to po celý rok. Jednou z hojně navštěvovaných oblastí je i oblast Osada nacházející se na levém břehu nádrže. Tato oblast je význačná rozvojem břehové abraze. Ta se zde projevuje v podobě až 6 m vysokých srubů, které nejsou nijak stabilizovány. Pokračující proces abraze ohrožuje stavby v blízkosti poškozeného břehu – chaty, restaurace, komunikace a dokonce i zdraví či životy návštěvníků.
Kvůli stavební uzávěře (jako ochrana biotopu ledňáčka říčního), zde není možné do břehu nijak zasahovat a měnit ho. V rámci výzkumu jsou v této oblasti navrženy a vybudovány různé typy aktivní protiabrazní ochrany (vlnolam v podobě porostu vrb, zápletové plůtky, gabionové koše, palisáda z kůlů), která by měla proces břehové eroze zpomalit. Účinnost jednotlivých prvků je předmětem zkoumání.

Contact:
Ing. Lenka Gernešová
Phone: +420 545 134 082, e-mail: xgerneso@mendelu.cz

Ing. Jana Marková, Ph.D.
Phone: +420 545 134 009, e-mail: jana.markova@mendelu.cz

RAINWATER MANAGEMENT AND RECREATION IN MAINLY AGRICULTURAL LANDSCAPE

Václav Tlapák[1] , Jan Šálek[2] , Miloslav Šlezingr[1], Petr Pelikán[1], Lenka Gernešová[1]
[1] Department of Landscape Management, Faculty of Forestry and Wood Technology, Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic
[2] Vránova 92, Brno, Czech Republic

Abstract
The goals of article are economical and ecological ways management with rainwater in mainly agricultural landscape and their relationship with recreation and outdoor activities. Recreation associated with outdoor activities of this type requires revival landscape by water feature (small water stream, small water reservoir, wetland) which create small oases calm in landscape and they are situated in islands of green stands equipped by benches, tables or open shelter – gazebos, racks for bikes, crossbars for tethering horses – everything should be located on grasses places that are surrounded by higher trees providing shade. The next very important feature is planting of trees along the streams, on banks of small water reservoirs and agricultural roads. It's necessary restoration of small water streams draining rainwater, and their integration into the landscape. All this measures accumulate rainwater, part of rain is infiltrated, enriching resources and manages groundwater level and subsidize water all the above devices in dry season. Very important elements are wetlands, reservoirs and others which are important for revival of landscape like refugium necessary for survive and succession of fauna and flora.

Key words: rainwater, oasis of calm, water regime

Introduction

The current state of rainwater management in mainly agricultural landscape is unsatisfactory. Existing state of management is rather simple rainwater management consisting mostly of uncontrolled infiltration of rainwater into the soil, evaporation into the air and runoff remaining rainwater by surface, hypodermical and subsurface into drainage system, water streams and small water reservoirs. The coordination of rainwater management in urban, agricultural and forest landscape is missing. It's necessary to use rainwater in mainly agricultural landscape for recovery landscape and create conditions for formation of bio-centrums, bio-corridors and recreation too. The recreation in mainly agricultural landscape has own specifics consisting in the use environment of the agricultural landscape, a different character from the typical recreational areas. Own solution is largely influenced by terrain topography, elevation, plant composition, ways of using landscape, network paved rural roads, layout and size urban areas and so on. The ways of rainwater management in agricultural landscape can be divided into the following groups:

- Rainwater management on the land (plots) used agricultural crops typical of the region;
- Captation of rainwater surface runoff and using of this water for irrigation consumptive water-intensive plants, windbreaks, alleys and so on;
- Recovery landscape with new features which are derivative canals, small water streams, small water reservoirs and wetlands;
- Creating of calm oases in conjunction with small water reservoir, green islands with equipment for short stays and recreation;
- Proposal of protective anti-erosion measures, measures against high waters and protection of banks against flowing water and waves;
- Restoration of artificial drainage and irrigation canals, small water reservoirs, small water streams and wetlands including adjustments to their surroundings;
- Build and integration rural roads and trails in landscape environment including the settlement of the issue reinforcement and drainage of rainwater from the road surface and their use;
- Creating rainwater supplied protective refuges aquatic animals, aquatic and wetlands plants and managed wetlands;

It's necessary to solve rainwater management in relation urban, agricultural and forest environment, mainly higher runoff from urban, agricultural areas respectively lower runoff from forests areas. Own design must be preceded by detailed meteorological, climatic, hydrological, hydro-pedological survey; determine ownership; economic, social and history-cultural exploration and so on.

Materials and methods

The keeping and using main part of rainfall in landscape is the most important task of rainwater management in agricultural landscape. Surface runoff of rainwater closely related to intensity of rainfall and intensity of their infiltration into the soil which depends on the soil particle size, structure and texture of soil, hummus content, soil hydraulic conductivity, timing of infiltration, capacity pores in soil, high of groundwater level, water capacity in agricultural areas, vegetation cover and others. Permeability of soils is desirable to increase the appropriate agro-techniques. It's necessary to improving soil structure, increasing the humus content and increase water capacity of soils. The shaping of agricultural lands and choice of suitable crop is very effective. The technological discipline in agro works is very important – it's necessary to restriction passes through the fields by heavy mechanics, increasing rainwater infiltration, thereby increasing recoverable reserves of groundwater. Rainwater surface runoff is collected in small streams and reservoirs used for irrigation of alley along the roads, drains and watercourses. The small water reservoirs are proposed with storage and retention area which is slowly emptying by bank infiltration and sampling measure for irrigation – see fig. 1.

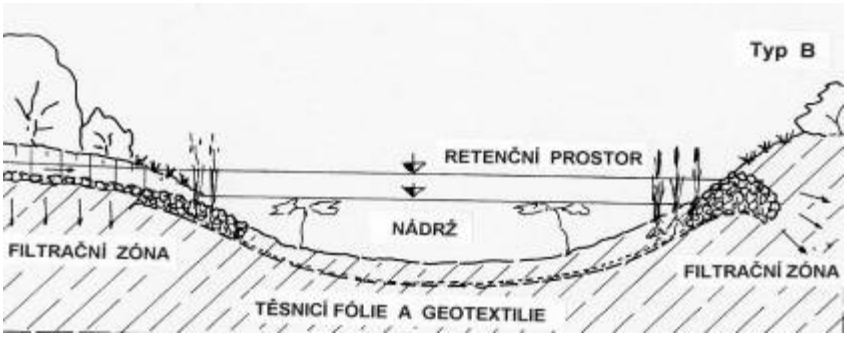

Fig. 1: Small water reservoir with bank infiltration of rainfall water (Scheme - prof. Ing. J. Šálek, CSc)

The surrounding of reservoir is grassing and planting by various trees and shrubs which provide shade and create the necessary environment for recreational wellbeing. There can be small calm oases equipped with benches, tables with open shelters, bike racks, place for tethering horses and so on. For larger reservoir are proposed islets which are used for recreation or using as bathing beach. An example arrangement is shown on Fig. 2. In a flat area are applied small water reservoir of lake type, fed by rainwater – there is possible allowing fish for recreational purposes like fishing – Fig. 3. Small water reservoir positively affect s the surrounding vegetation by continuous supply of water, creates a comfortable microclimate and stays in this modified location is very enjoyable.

The banks is necessary to stabilize against influence of flowing water (rainwater running down the banks, water that returning after leveling etc. – causes erosion) and against damages caused by water level waving (wind driven waves, moves of boats – causes abrasion). The stabilization may suggest like biological or technical, or combination of these both types.

Fig. 2: Small water reservoir with island used to recreation - Budkov
(Project prof. Ing. V. Tlapák, CSc)

Fig. 3: Small water reservoir using for recreational fishing (Revitalized derivative canal of river Jihlava in Malešovice. (Project prof. Ing. V. Tlapák, CSc.)

Small water reservoir stocked mostly by rainwater has also function biological reservoirs that perennial cleansing effect of increasing the quality of surface waters.
Revitalization of drainage and irrigation canals is proposed for year-round flow channel or channels where is possible to ensure the survival of aquatic organisms. Revitalizing measures are proposed in accordance with CSN 75 2101: 2009. The most important restoration measures on the canals consist mainly in restoring their basic function – the ability to lead the water, it's segmentation and layout ensuring continuous flow of water in the channel, increasing rainwater retention in the landscape, improve water quality in canal, improved landscaping and aesthetic functions drainage channel. Along the channels is revitalized vegetation, especially herbal level, but also alleys and there is proposed the road – paved, rural road or cycle path (Fig. 4).

Fig. 4: Rural road run along revitalized derivative canal in Malešovice.
(Project prof. Ing. Václav Tlapák, CSc.)

Rural roads run along derivative, drainage or irrigational canals are usually multi-purpose. They are usually situated on one bank, give access to various part of the channel, small reservoir, allow connection municipalities outside the main road, creating rest areas that can benefit the citizens of neighboring municipalities for walks and tourists for recreation. For this reason, it is advisable to design rural paved roads to be possible use them during all year and in cases less favorable weather conditions (Fig. 5).

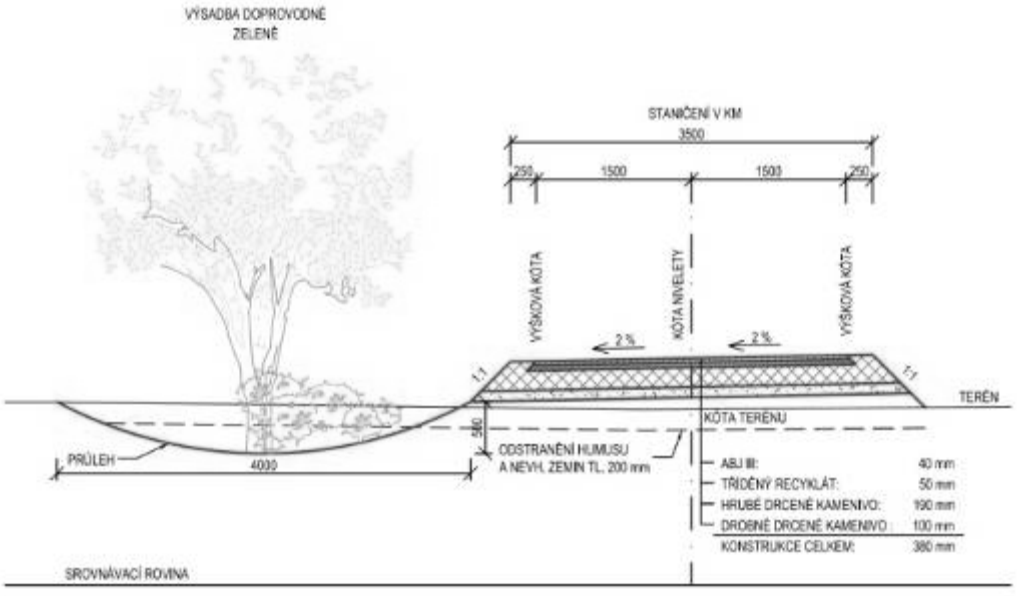

Fig. 5: Typical cross section by rural road, revitalized drainage canal with vegetation. (Ing. P. Pelikán)

Results and Discussion

Issues rainwater management and recreation in agricultural landscape can be solved by mutual agreement. Building a multi-purpose reservoir including design and planting of suitable riparian vegetation and attractive recreational features do not impair the primary function of reservoir. Similarly can be designed restoration of water streams – for example: integrate cycle path into own proposal and if it is possible, connection of exists paths/roads to new designed.

However it's necessary to respect protection of nature and landscape, but also protection of agricultural production and (in season too) try to combine the needs and requirements of different groups of all our society.

Conclusion

This article is presented in the spirit of the proposal for possible adjustments in landscape which should support the natural attractiveness of landscape and if it's possible lead to her minimal disruption. In a strongly anthropogenically influenced region of central Europe, we must learn to compromise within a multi-use landscapes. Unable to prefer ways long-term land use that lead to the collapse of landscape.

References

Geiger, W., Dreiselt, H., (1995): Neue wege für das Regenwasser. Gelsenkirchen, pp. 291.

Hanák, K., Kupčák, V., Skoupil, J., Šálek, J., Tlapák, V., Zuna, J., (2008): Stavby pro plnění funkcí lesa. Praha: ČKAIT, pp. 304.

Holý, M., (1994): Eroze a životní prostředí. Praha: Vydavatelství ČVUT, pp. 383.

Šálek, J., Kriška, M., Pírek, O., Plotěný, K., Rozkošný, M., Žáková, Z., (2012): Voda v domě a na chatě. Praha: Nakladatelství Grada, pp. 144.

Šálek, J., Malá, E. (ed.), (2001): Stabilizační a dešťové nádrže. Sborník referátů z konference. Brno: FAST VUT, pp. 67.

Šálek, J., Mika, Z., Tresová, A., (1989): Rybníky a účelové nádrže. Praha: SNTL, pp. 267.

Šálek, J., Kujal, B., Doležal, P., (1989): Rybníky a účelové nádrže. Brno: ES VUT, pp. 144.

Šáalek J., Tlapák, V., (2006): Přírodní způsoby čištění znečištěných povrchových a odpadních vod. Praha: ČKAIT, pp. 283.

Korytárová J., Šlezingr M., Uhmannová H., (2007): Determination of potential damage to representatives of real estate property in areas affliced by flooding. Journal of hydrology and hydromechanics, 55: 282-285.

Šlezingr,M., (2007): Stabilisation of reservoir banks using an "armoured earth structure", Journal of hydrology and hydromechanics, no.1/2007,

Tlapák, V., Šálek, J., Legát,V., (1992): Voda v zemědělské krajině. Praha: ZN Brázda, pp. 318.

Tlapák, V., Šálek, J., Tlapáková, P., (2013): Small recreational reservoirs. In: Public recreation and landscape protection - with man hand in hand. Brno: Mendelova univerzita vBrně, pp.159 - 165.
Tlapák, V., Prokop, J., (2007): Revitalizace Allahových rybníků. In: Allahy - revitalizovaná rybniční soustava. Brno: Dolní Morava - biosférická rezervace, pp. 71-75.
Tlapák, V., Prokop, J. The Allahy Fishponds restoration. In: The Allahy Fishponds. Brno: Dolní Morava - biosférická rezervace, pp. 246 - 152.

Acknowledgement
The article contains partial results of research project “Active anti-abrasion structures”, reg. no. LDF_VT_2015011, funded by IGA FFWT MENDELU Brno.

Souhrn
Referát pojednává o využití srážkových vod soustředěných ve vodotečích a malých vodních nádržích k rekreačním účelům v zemědělské krajině. Poukazuje na zvláštnosti, které je třeba splnit, aby se tento záměr mohl plně uskutečnit. V první řadě jde o vytvoření těchto vodních prvků v krajině, jejich zpřístupnění, ochrana před erozí, korozí, zanášením a velkými vodami, ale také jejich začlenění do krajiny prostřednictvím zeleně.

Contact
Prof. Ing. Václav Tlapák, CSc.
Phone: + 420 731 486 930; e-mail: tlapak.vaclav@seznam.cz

RECONSTRUCTION OF THE UNIQUE WATER TROUGH AT HARMANEC AS THE EXAMPLE OF THE ATTRACTIVENESS

Jiří Junek, Jitka Fialová, Hana Kubíčková
[1] Silva Bohemica, Lesník, Les, independent journalist
[2] Department of Landscape Management, Faculty of Forestry and Wood Technology, Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic

Abstract
Our ancestors knew how to help themselves while working in the forest without current results of science and technology. The power of water was used for skidding from the forest stands with difficult access mainly in the spring time of sufficient amount of water, as well as for the river floating.
Traffic transport for dry skidding of logs and water flumes for timber skidding were made from the trees. The last preserved and still functional water flume for timber floating is hidden in the beautiful Rakytovo valley near Dolný Harmanec in the National Park Veľká Fatra. The flume is 2.450 meters long and was probably built in the 19th century. It was used for floating logs generally in the spring - in the rich water period. The flume is made entirely of spruce or fir logs. Construction of the flume consists of a transversal logs, which were used such a foundation bed of the flume and longitudinally cut logs and side logs were attached to log sideboard. The water flume is trough shaped in the cross section. Logs were skid to the flume manually or by horses in previous years before the spring floating and they had to be cut to meter long pieces or chipped. In the period of log floating, there were patrols along the flume to secure a fluent movement of timber in the flume. Patrols have to move back logs, which were wedged. Depending on the length of the flume and amount of floating logs, there were needed 40 to 80 people during the floating period. Daily output was about 150 stacked cubic meters of floated logs. The flume ended in Harmanec creek, where the logs were caught and taken out by „hooks“ eventually logs continued floating trough Bystrica creek to Banská Bystrica to the former municipal timber yard „Zábava“.
In 2000 the flume Rakytovo was declared such a National Cultural Monument. After more than 100 years after the period when was built the construction of the flume, the city Banská Bystrica decided to make a reconstruction, which was in 2006. The costs of 1.5 millions Slovak crowns were covered by the project “The development of tourism infrastructure of city Banská Bystrica“, which supported the European Union, the Slovak Republic and the city of Banská Bystrica.
Acknowledgement also belongs to great effort and skilful hands of staff from Municipal Forests of Banská Bystrica.
This unique masterpiece of water was presented in its full beauty with logs floating demonstration during the Forestry Day events held on the 27th of April 2007, and the 25th of April 2008.

Key words: skiding, floating, sapina (rod with metal hook)

Detvan express train on the track between Banská Bystrica and Turčianské Teplice weaves a romantic landscape of forests and rocks on the border between two mountain ranges - Nízké Tatry and Velká Fatra. Detvan express train passes through two dozen tunnels.
Zvolen´s diesel locomotives - front red "brejlovec", from back typical orange "orange" - leads without difficult problems to the highest point of the track - to Čemošnianský tunnel. In some places, the tunnels are so close together that neither man really is not enough to perceive the beauty of the steep canyons that separate them. This is the case of Dolný Harmanec station and a short walk outside before the station Harmanec - Jaskyňa. The express train ride takes between the two tunnels just a few seconds. The train goes over the bridge, which stands high above sheer canyons. Only few people notice in this place interesting forestry technical construction at its bottom. Construction which belongs to the first in line in the hierarchy of means of log transport.
This is last Slovak water flume for logs - rizňa - which runs in Rakytovo valley since the nineteenth century. Father of woodman Ján Vajs from Dolní Harmanec remembered functional water flume, one of the last of experts for building a water flume.
In Rakytovo valley, there is still no way to pulling logs. Only a narrow sidewalk wind parallel with water flume in lush vegetation. The nature is really intact here. Harmanec´s foresters from Banská Bystrica forests are really proud on their water flume.
Let´s introduce a few technical data of water flume. Technical data provided Emeritus Directorate of General of Forests of the Slovak Republic, sp, Banská Bystrica Ing. Michal Štefančík, CSc. A man who is largely credited with the preservation of this forest rarity. The total length of the preserved

section is 2.450 m, originally it was 7.000 m. It starts at the end of the valley, at an altitude of 790 m. Water overcomes slope 280 m to the mouth of the Čierný creek in water flume.
On the construction of the water flume is was used spruce and fir wood, assembled into four to five meters long portions which were being formed into a trough. The individual parts are put on wooden bases long 120-140 cm, with a diameter of 20-25 cm. The bottom of the water flume is created by two or three hand-chipped trunks. Individual parts are attaching by wooden studs to the base. Wooden studs are made of hard parts of spruce branches. Once, they have even used yew wood. The advantage of wooden studs was the possibility of rapid removal of damaged parts of the flume. They have used an ax for repairing of the flume. The main advantage of wooden studs was that evenly abrasion was together with other parts of the flume. Ablation logs were not trapped, as they would when were using metal studs.

Fig. 1: Harmanec´s water flume - information board (photo by Jiří Junek)


Fig. 2: Harmanec´s water flume - it´s inauguration after reconstruction with support from EU (photo by Jiří Junek)


Fig. 3: Harmanec´s water flume ends at the hydroelectric power (photo by Jiří Junek)

Fig. 4: Harmanec´s water flume in the valley of Rakytovo, there are also information boards and spring (photo by Jiří Junek)

Fig. 5: Harmanec´s water flume. Historical hydroelectric power by Harmanec´s paper-mill at the estuary of the water flume (photo by Jiří Junek)

Fig. 6: Harmanec´s water flume. There were used rods with metal hooks (sapina) for removing one metre logs from the water flume (photo by Jiří Junek)

Resurgent forestry tradition is used every spring

Foresters piled up heaps piece of logs along the wooden flume. See flume, if is not broken somewhere. They prepare rods with metal hooks - sapina. One April morning, foresters meet at the forest district in Dolný Harmanec and then come to Rakytovo, point of annual floating. It is not part of their daily work duties, but foresters have an interest in this unique Slovak forestry technical monument. In the past, there were several flumes in the valley of Slovak forests. Now there is survived only this one.

At the estuary of Rakytovo - narrow steep valley on the edge of the Veľká Fatra - are ready "lumber-jack breakfast" for foresters, which is hearty breakfast to strengthen and boost in the morning. After it, foresters prepared logs for floating. Logs are floating in the water flume, if some log has jammed and barred the way to others, foresters release it. It is accompanied by an impressive geyser of water. Several foresters remain with the rods with metal hooks at the lower part of water flume and they pull

out floating meter logs from the water. This requires strength and dexterity. The guys take turn. After a while they go to fortify and chat with friends who are meeting there on the occasion of floating in the water flume. Not only local foresters - workers of the Municipal Forests Banská Bystrica with Director Ing. Blažej Možucha - care about water flume and organize this event. On this event also come colleagues from state forests, state administration, conservation, from surrounding urban forests and former colleagues. Opportunity to come between foresters did not even omit the former mayor of the city Banská Bystrica Mgr. Peter Gogol immediate superior of the Banská Bystrica foresters, have came from the headquarters of the Forest of Slovak Republic, sp. He came not only for goulash. He took sapina rod and went to the valley to help other foresters.
A feast for Harmanec´s foresters are sometimes those parts of spring and autumn, when there is lots of water and it´s possible floating in water flume. It is the best water level which is reaching in two-thirds of the height of the flume. Before logs floating, foresters must thoroughly inspect and remove any flaws or damage. Most often it is released sidewall. Just before the logs floating in the water flume, it is going to dam up the point of estuary to the Čierný creek. The water level rises and there is a small lake. One metre floating logs float to the surface, where they are pulling out by using rod with metal hook - sapina. Logs are throwing smoothly to the water flume because of avoiding of the jamming. There are confronts patrols - varty in the point where will be a stop and displace logs from water flume. From the lower end of water flume, there are logs shipped off to customers. Originally, around 1933, logs continued without interruption by Čierný brook into Harmanec´s paper-mill or hereafter by river Bystrica to Banská Bystrica.
If you visit Harmanec´s cave, go for a walk from a nearby building Forestry Administration in Harmanec. Then go in the way of upstream Čierný brook to the small historic hydroelectric power. In the vicinity of hydroelectric power starts Rakytovo valley with the water flume at the information board. Every spring, there is Harmanec´s floating which is carry on in the second half of April. Rakytovo valley with the water flume already visited several excursions of the Czech foresters.
When you are listening to the pleasant hum of bound water, may be you remember the story from your childhood on a courageous journey of princess Krasomila and king Miroslav, when they escaped from their pursuers on a log in the water flume.

References

Junek, J. (2002): *Modrá – zelená*. Ústav pre výchovu pracovníkov lesného a vodného hospodárstva SR, Zvolen.
Významné lesnícke miesta na Slovensku I., kol. (2009): Lesy Slovenskej republiky, š. p., Banská Bystrica.

Souhrn

Již naši předkové věděli, jak pomoci sami při práci v lese, aniž by dosavadní výsledky vědy a techniky. Síla vody byla použita pro přibližování z lesních porostů s obtížným přístupem především v jarním období, kdy bylo dostatečné množství vody. Zařízení pro suché přibližování klád a vodní skluzavky pro přibližování klád byly vyrobeny ze stromů. Poslední zachovalý a stále funkční vodní žlab pro plavení dřeva se skrývá v krásném údolí nedaleko Rakitovo Dolný Harmanec v Národním parku Velká Fatra. Náhon je 2,450 m dlouhý a byl pravděpodobně postaven v 19. století. Byl použit obecně na jaře - v období bohatém na vodu. Žlab je vyroben výhradně z smrkových nebo jedlových kmenů. Konstrukce žlabu se skládá z průřezových kulatin. Podle záznamů byl smyk na náhonu ruční nebo pomocí koní. Dříví museli zkrátit na metrové kusy nebo naštípat. V závislosti na délce žlabu a množství plovoucích kulatiny, bylo během období plavení potřeba 40-80 lidí. Denní výkon byl 150 metrů krychlových kulatiny. V dnešní době je to velmi atraktivní turistický cíl.

Contact:

Jiří Junek
Phone: +420 723 259 010, e-mail: junek@bohemica.cz

Bc. Ing. Hana Kubíčková
Phone: +420 545 134 082, e-mail: hanicta@centrum.cz

Ing. Jitka Fialová, MSc, Ph.D.
Phone: +420 545 134 096, e-mail: jitka.fialova@mendelu.cz

RECREATIONAL POTENTIAL INCREASE OF THE AREA WITH THE HELP OF SPECIFIED ELEMENTS OF ATTRACTIVENESS

Hana Kubíčková, Jitka Fialová
Department of Landscape Management, Faculty of Forestry and Wood Technology, Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic

Abstract
Land consolidation, respectively plan of common facilities does not accept the planning possibility of parallel recreational use of specific cadastral territory. For this reason, we propose the dividing of cadastral territory into zones of recreational attractiveness, in which will occur an existing and newly designed elements of attractiveness. These defined elements of attractiveness followed and are carried out in accordance with the comprehensive land consolidation, respectively plan of common facilities. The purpose of design of these elements is especially outline new possibilities of landscape planning in the field of recreation and recreational use of the area carried out in the context of land consolidation.

Key words: recreation, land consolidation, landscape planning, cadastral territory

Introduction

Current state of the solution of land consolidation does not reflect adequately the needs of local residents and tourists for recreational use. According Vaňous (2013) land consolidation serves as a tool for the practical implementation of agricultural policies. According to him is meant a deliberate intervention in the organization of the landscape in order to more sustainable agricultural use. Pursuant to Act 139/2002 Coll., on land consolidation and land offices, as amended, with land consolidation in the public interest spatially and functionally structure the land, consolidate or split them and ensures accessibility and utilization of land and settlement of their boundaries so that to create the conditions for rational management of landowners. In this context, the original plots are vanishing while new plots are creating to which is organize the ownership rights and related easements. At the same time land consolidation provide the conditions for improving the quality of life in rural areas and improve the environment. Results of the land consolidation serve to renewal of cadastral, but are also the basis for spatial planning. In terms of recreation and recreational planning must not forget mainly recreational tolerable capacity, which characterizes the possible of recreational potential of a specific area. Combining of these ideas should lead to the creation of new ways to interconnect the plan of common facilities and recreational land use.

Materials and methods

The source of inspiration for the implementation of comprehensive land consolidation is in the following of the recreational use of area may be the implementation of Local biocentre LBC 9b Močidla in cadastral territory Mořice. The area belongs to the Land Office Prostějov. Local biocentre area is 3.0017 ha. It is a wetland with small and large bank, where the palisades were plant and zone were modeled. The overall scope of measures was based on the current draft of common facilities in comprehensive land consolidation (CLC) in the cadastral territory Mořice. This newly designed element as biocentre is representing biota floodplain areas with meadows, forest and wetland. They also perform the function of publicly accessible green space as an educational area and refugium of original and people deliberately disseminated biota. The proposed planting will be increased ecological stability of the territory and improved conditions for the protection of agricultural land against water and wind erosion. There is given the option of shared use biocentre and people through the nature trails around biocentre.

A prerequisite for the proposal scale, which is based on dividing the cadastral territory into zones attractiveness is the primary determination of elements of attractiveness. We divide elements of attractiveness into two types. Existing elements of attractiveness in the territory or newly defined, designed elements of attractiveness. On the elements of attractiveness, both existing and newly designed is viewed from three perspectives - from the natural, cultural and historical perspective. Based on these aspects we divided elements of attractiveness in the natural elements of attractiveness, cultural elements of attractiveness and historical elements attractiveness. Each element is assigned a point value. Specific elements of attractiveness can be incorporated into more than one category, because we are aware of possible of multi-functional character of the individual elements.

Within the natural elements of attractiveness, we focus on vegetation and plant communities which we evaluate from the perspective of native and alien species composition (forest, solitary, avenue). Secondly, we look at the cadastral territory or it´s specific part from the view of protected plant species whose occurrence area is not part of the specially protected area or whether in the territory are found planted valuable trees and shrubs (also cultural and historical focus).
From the perspective of animal communities we follow representation of protected species and migratory routes of higher mammals. In terms of rock communities, we monitor quantity and accessibility of rock formations, such as rocks, rock communities and accompanying rock flora and fauna, we also monitor the occurrence of caves, vegetation and accompanying fauna and the amount of sinkholes in the area and the accompanying fauna and flora. We do not forget on the presence of mines and associated flora and fauna, where is also taken the cultural and historical focus.
From the perspective of aquatic communities we propose to monitor the occurrence and quality of water features in the landscape (streams, rivers, lakes, reservoirs, wells), whether they are natural, revitalized, non-revitalized or are unoriginal flow patterns.
Within the natural elements of attractiveness we also monitor the occurrence of significant natural areas that meet at the same time also the cultural aspect such as national parks, protected landscape areas, national nature reserves, nature reserves, national nature monuments, natural sites, the Natura 2000 sites (sites of European importance and bird´s sites), areas protected by the Ramsar Convention, important landscape elements and territorial system of ecological stability found in the given cadastral territory in the context of measures to protect and improve the environment.
Within the cultural elements of attractiveness, we are observing whether the castles, forts, ruins, forts and settlement occurrence in the specific cadastral territory. Technical buildings (water and windmills, ponds, raceways). We also do not ignore the small sacral inventory, such as crosses, calvary, chapel, where it is evident significant historical attractiveness of the element as well. We also explore verge of positive / negative events (eg. the battlefield) within the cultural elements of attractiveness.
From the perspective of sports enjoyment, we explore a number of sports grounds and sports complexes, respectively natural areas for sports, outdoor swimming pool (lakes, quarries) in the territory. We look about the access for cycling, bridle path, cross-country skiing trails and sidewalks in the context of arrangements for access to properties in the land consolidation and also their mutual connection or collision. We also intend on the disclosure territory for seniors, families with strollers and disabeled people. In this context we focus mainly on the quality of the road surface and special routes and their difference of heights in the study area, the availability of higher class communication and the amount of available rest areas. These elements are recorded in the designed tables for exist and newly designed elements of attractiveness. The background must also be educational function of the area. We refer to the technical and cultural buildings in the territory of the museum, natural areas and nature trails, mining areas and newly established units (heap dumps, quarries, etc.), tree-lined avenue, cemeteries.
Elements of attractiveness have multifunctional character in our opinion. So the historical elements of attractiveness are freely reflected into accordance with cultural elements. We mean castles, forts, ruins, fortresses, settlement and also archaeological findings. Furthermore, small sacral inventory, such as crosses, calvary, chapels. Technical buildings (water and windmills, ponds, raceways). Verge of positive/negative events (eg. the battlefield legend, a miracle, saying murtuary, conciliation stones, genius loci). Also mining areas, historical formations (heap dumps, quarries, etc.), tree-lined avenue and cemeteries.

Results

We present a proposal on the table to fill existing or newly designed feature below. It is useful especially during field reconnaissance surveys within the boundaries of land consolidation, where we can define the existing elements or to make a preliminary draft of the new elements that could be later incorporated into the design of a new land consolidation. Existing elements or redefined proposed elements of attractiveness would be related to a particular parcel.

Tab 1: Existing element or the newly designed element of attractiveness (adjusted by Muchová, Hrnčiarová and Petrovič, 2013)

Existing element of attractiveness/ newly designed element of attractiveness			
Official Name			
Local Name			
Cadastral Territory		Parcel Number	
Projection to another cadastral territory		Type of holding	
Method of use			
Characteristics of element of attractiveness			
The current state of the element of attractiveness			
Incorporating of element of attractiveness in nature conservation (yes-no), the degree of protection		Incorporating of element of attractiveness to the natural characteristics of the cadastral territory	
Incorporating of element of attractiveness to the cultural characteristics of the cadastral territory		Incorporating of element of attractiveness to the historical characteristics of the cadastral territory	
Their combinations			
Negative phenomena influencing element of attractiveness			
Design Measures			
landscape-ecological			
management			
landcape			
engineering			
Proposals for legal protection and degree of protection			

Discussion

We consider principal means of increasing the recreational potential of the cadastral territory by defining of existing and newly proposed determination of elements. On the basis of well-defined elements we can also plan a socio-economic use of a specific territory and raise awareness of the population about the natural, cultural and historic features appearing in the cadastral territory of the municipality. For this purpose it will well served locating table for existing and newly designed elements of attractiveness, which is connected with a specific plot that can be used within a terrain reconnaissance carried out in complex land consolidation. We will continue with review and revised where necessary on above-described elements of attractiveness in specific cadastral territories in order to eliminate systematic errors and to further integration with land consolidation, respectively tie in measures resulting from the plan of common facilities.

Tab 2: Proposal scoring for natural elements of attractiveness (only part)

NATURAL ELEMENTS OF ATTRACTIVENESS		
Vegetation, plant communities		
Species composition	The original species composition (3 p.)	Alien species composition (1 p.)
forest		
solitaire		
tree-lined avenue		
Interesting vegetation	yes	no
Points	3 p.	0 p.
representation of protected species, but in a lower number		
Points	1 p.	0 p.
planted valuable trees, shrubs (cultural-historical perspective)		

Tab 3: Proposal scoring for the historical elements of attractiveness

HISTORICAL ELEMENTS OF ATTRACTIVENESS		
Points	7p.	0p.
Castles, forts, ruins, fortresses, settlement		
Archaeological findings		
Points	5p.	0p.
Technical buildings: water and windmills, raceways, ponds		
Points	3p.	0p.
Small sacral inventory, such as crosses, calvary, chapels		
Verge of positive/negative events (e.g. the battlefield legend, a miracle, saying murtuary, conciliation stones, genius loci)		
Cemeteries		
Mining areas and newly established units (heap dumps, quarries, etc.)		
Tree-lined avenue		

Conclusion

Linking land consolidation and recreation is still in our conditions unsolved and neglected topic. We are aware that the current situation of the solutions of land consolidation does not allow concurrently solving of recreational function of the specified area because of the legal and methodological arguments. Therefore, we seek above all a new perspective on this issue, which could help to open discussion on changes in solution of land consolidation and recreation. Our biggest concern in the recreation is directed to local residents, respectively residents of a specific cadastral territory. For this reason, we receive more convenient to relate the recreation and land consolidation, respectively recreational potential of the cadastral territory in the form of existing and newly designed elements of attractiveness and their accessibility for residents of a specific cadastral territory, which is solved in comprehensive land consolidation.

Nowadays more than ever has a cultural landscape multifunctional character when the designer must locate array of diverse interests on a particular cadastral territory according Kubíčková and Fialová (2014). According them, it is important take a think about the man and his option for recreational rest in the cultural landscape (especially in the agriculturally used).

References
Kubíčková, H., Fialová, J. (2014): *Rekreační využívání krajiny a jeho vazba na pozemkové úpravy.* In: Fialová, Jitka (eds.). *Konference krajinné inženýrství 2014.* 1. vyd. Brno: Česká společnost krajinných inženýrů, s. 216. ISBN 978-80-87384-06-0.
Muchová, Z., Hrnčiarová, T., Petrovič, F. (2013): *Miestny územný systém ekologickej stability na účely pozemkových úprav.* 1. vyd. Nitra: Slovenská poľnohospodárska univerzita v Nitre, s. 138. ISBN 978-80-552-1127-5.
Soutěž *„O nejlepší realizované společné zařízení v pozemkových úpravách v roce 2008“*. Pozemkové úpravy: Časopis pro tvorbu a ochranu krajiny: teorie a praxe. 2009, roč. 17, č. 69, s. 17.
Vaňous, M. (2013): *Pozemkové úpravy v naší historii.* Pozemkové úpravy: Časopis pro tvorbu a ochranu krajiny: teorie a praxe. roč. 21, č. 1, s. 10-11.
Act 139/2002 Coll., „*o pozemkových úpravách a pozemkových úřadech,* ve znění pozdějších předpisů“

Acknowledgement
The paper was written with the support of the Internal Grant Agency No. 2015026/2015.

Souhrn
Jsme si vědomy toho, že současný stav řešení pozemkových úprav neumožňuje souběžně řešit z důvodu legislativních a metodických rekreační potenciál území. Proto se snažíme především o nový pohled na tuto problematiku, který by měl přispět k otevření podmětné diskuze na změnu v řešení. Náš největší zájem v oblasti rekreace směřuje na lokální obyvatele, resp. obyvatele konkrétního katastrálního území obce. Z tohoto důvodu vztahujeme rekreaci na pozemkové úpravy, resp. stanovujeme rekreační potenciál katastrálního území za pomoci existujících a nově navržených prvků atraktivity a jejich následné dostupnosti pro obyvatele konkrétní obce řešené v komplexních pozemkových úpravách. Z tohoto důvodu považujeme vymezení existujících a stanovení nově navržených prvků za stěžejní prostředek zvýšení rekreačního potenciálu katastrálního území, na základě něhož je pak možné plánovat socio-ekonomické využití konkrétního území obce.

Contact:
Bc. Ing. Hana Kubíčková
Phone: +420 545 134 082, e-mail: hanicta@centrum.cz

Ing. Jitka Fialová, MSc, Ph.D.
Phone: +420 545 134 096, e-mail: jitka.fialova@mendelu.cz

REQUIREMENTS AND MATERIALS FOR STAIRS AND STAIRWAYS IN NATURE

Pavla Kotásková
Department of Landscape Management, Faculty of Forestry and Wood Technology,
Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic

Abstract
Staircase in nature belongs to structures, where prevails purpose. Aesthetic importance cannot be ignored. In the natural environment, it is suitable to use natural materials: wood and stone. Stairs should copy the terrain to act as naturally as possible. When we design the stairs, it is necessary to comply with certain requirements in order walking the stairs was comfortable and safe. For this reason, in some cases it is suitable to design staircase made of steel or reinforced concrete. It should be incorporated at the location where the best fit into the natural environment. Construction elements in nature should not be disruptive.

Key words: wooden structures, stair treads, railings

Introduction

Stairs and staircases are used for the communication connection between the two different height levels. Staircase should be designed, where the slope of the tour was higher than 10 °. It is the overcoming of height higher than 1 m at 6 m in length. The different height levels may be overcome by one or two steps or stairs. Three more steps are considered as a staircase. Staircase must be comfortable and safe during ascent and descent. Pedestrian perceived very negatively any deficiency in the design of stairs. During the design, it is necessary to respect the fundamental provisions of the applicable standards ČSN 73 4130 Schodiště a šikmé rampy - základní ustanovení a ČSN 74 3305 Ochranná zábradlí.

Materials and methods

The individual steps set up in series creates a stair flight. Passage width of the stair flight, which is measured as the horizontal distance between the outer edges of the flight should match to the width of the path, which is adjacent to the stairs. For the passage of adult humans it is recommended 600 mm (can be reduced to 550 mm). For passing two persons is required minimum width 900 mm. It is recommended to design multiple of width, which is necessary for the passage of an adult, and which can be reduced to 550 mm (fig.1). We distinguish between direct stair flights, which is made up from straight steps. Ground plan shape of the stairs is a rectangle. If you need to change the straight direction (we need to turn), we design a mixed or circular stairs. These are composed of oblique steps. Ground plan shape of the stairs is a trapezoid.
Pitch line - an imaginary line of the staircase output, that connects the front edges of the steps is situated on the ground plan in the axis of the flight. For mixed or circular stairs is situated on a ground plan at a distance of 1/3 the width of the flight, measured from the outer edge of the stair flight. When passage width is larger than 1800 mm, the pitch line is placed in the axis of the stair flight.
On the pitch line of the stair flight, the step must have designed dimensions (tread and rise of the step). Tread of the steps with a curved pitch line is measured as bowstring of the arc at the intersection of the pitch line with the edges of subsequent steps. (ČSN EN 15567-1)
In the stair flight, all steps should have the same rise. The rise of a step is measured as the vertical distance between the scales (the upper surfaces of steps) of two consecutive steps in the flight. The width of the flight is measured as the horizontal distance between the front edges of two consecutive steps in the flight. (Klimešová 2007)
The ratio between the rise and tread of the steps is given by:
$2 x h + b = 630 mm$
Wherein:
h – rise [mm],
b – tread [mm].

Slope of stair flight is the basis for the total rise of terrain stairs. Slope (gradient) means the angle between connectors of the front edges of the steps and the horizontal plane. Minimum recommended rise is 80mm. For slope between 10° to 20°, the rise of the steps is until 130mm. When the slope of the slight staircase 20° to 25°, the rise is from 130 to 150mm. The optimum rise is 150mm. Greater tendency is not recommended for use in the field. The slope less than 10 ° overcomes by using oblique surfaces - ramps. Sometimes we need to overcome the larger height difference on a relatively

small area. It's mostly on trails that are difficult to access eg. in the rocks. Here it is necessary to use a much larger slope. There is a possibility to use a stairs with treads between or steep stairs. Steps then have a rise of 180-240 mm. These stairs have a slope from 35 ° to 60 °. Above this inclination, we design ladders.
Number of steps is based on height, which we need to overcome by staircase.
If we want to design more than 10 degrees and the situation on the ground it allows, it is appropriate to divide the staircase on more flights and separate by intermediate landing.
Outgoing walker in this case see a flat surface of the landing, which keeps wellbeing in his mind.
It is recommended that the height level of the landing does not exceed the height of the eyes average man i.e. 1650 mm (fig. 2).
Depth of landing on which we don't change the direction must be at least equal to the sum of 630 mm and a tread of the step to move on well.
Finally, in general:
l = n x 630 + b
Where l is the length of the landing,
n is the number of steps,
b is the tread of the step.

Landings which serve to rest, or even stop, may be implemented as a ramp with an inclination up to 10 °. If the staircase is within five steps and follow the terrain, it is not necessary to design the railing. For staircases above 5 steps, it is recommended, to ensure the safety of persons moving on the stairs, to design railings placed at least on one side. The minimum allowable height of the railing is 1000 mm. When the depth space is not more than 3.0 m, the height may be reduced to 900 mm.
If the depth space is at most 12.0 m, the height of the railing should be 1100 mm. If the depth space is at most 30.0 m, the height of the railing must be 1200 mm. (Hykš, Gieciová, 2008)

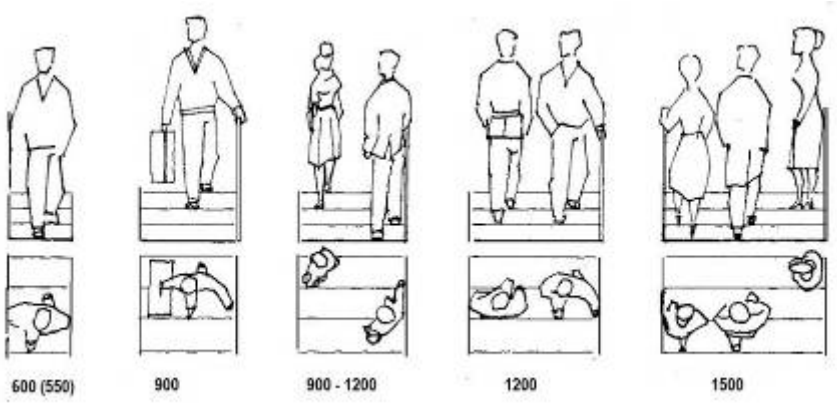

Fig. 1: Passage width of the stair flight

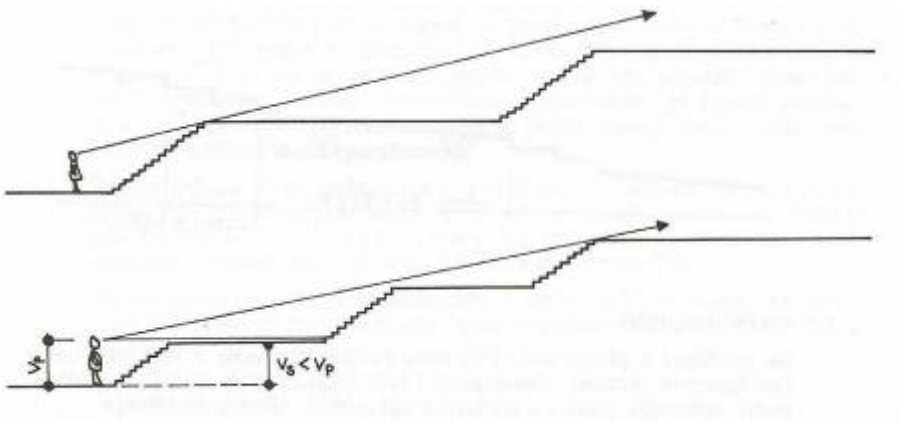

Fig. 2: The elevation of the landings: 1- unsuitable 2 - suitable

Results

When building stairs outdoors on hiking trips we have to reckon with the fact that the stairs will be exposed to all weather conditions that can be extremely different during the year.

In summer, in the sunshine temperatures can reach up to 40 ° C in winter even - 20 ° C. Is it necessary to substantial influence - rain, ice and snow. Terrain staircase must be, as each staircase, stable, solid, non-oscillate and wear resistant. For this reason it is necessary to give special attention to the choice of materials and way of founding. Each scale and landings should have a slight inclination about 1% towards the riser to allow water to drain without a problem.

On the stone steps and stair we use quarry stone, which should be placing in unmade ground, not into the bank. We select stones, which have one plane surface. They are massive and heavy to ensure sufficient stability. The individual steps are built on dry, without mortar, joints shall be supplemented by smaller stones and fill in by soil, like dike. If there is requirement for stable staircase, you can build from quarry stones and connect with cement mortar.

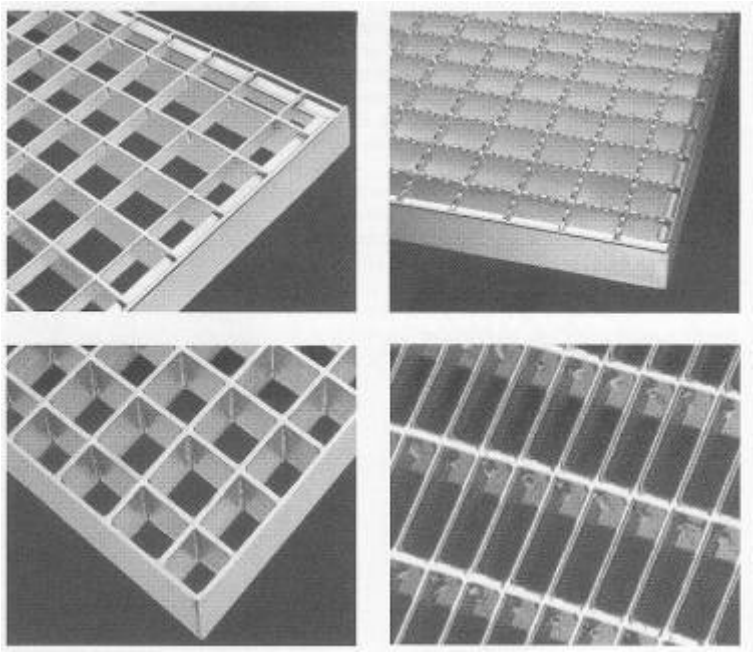

Fig. 3: Molded gratings PR

Discussion

Wood and stone are the most natural materials for staircase used in the landscape. Yet, sometimes we have to use a different material. For hard accessible places and where degradation of wood elements required very expensive maintenance or frequent replacement it is preferable to use metal structures. Currently used steel structures which are used on steps are molded gratings PR (fig. 3). Their advantage is easy to maintain even in the winter months, when snow usually falls through the gratings. We should be aware that this element does not fit into the natural environment. That is why we place it only in exceptional situations.

Conclusion

Often it exists naturally beautiful places eg. the gorge, that ordinary tourist does not have the opportunity to visit. Suitable construction of bridges, staircases and ladders allow that this place becomes the destination for trips also for less experienced hikers (fig. 4). In addition to the suitable materials natural - wood and stone, we use in exceptional cases, concrete or steel structures (fig. 5). In a humid environment, wooden stairs can be slippery. It is appropriate to design the railing in these places. For higher security, it is recommended to provide railings on both sides.

Fig. 4: Staircases and footbridges in the gorge

Fig. 5: Steel structure of staircases

References

ČSN 73 4130: *Schodiště a šikmé rampy - základní ustanovení.* Český normalizační institut, Praha 2010.

Klimešová, J. (2007): *Nauka o pozemních stavbách: modul M01.* Vyd. 1. Brno: Akademické nakladatelství CERM, 57 s. ISBN 978-80-7204-530-3.

Hykš, P, Gieciová, M. (2008): *Schodiště, rampy, žebříky.* 1. vyd. Praha: Grada, 160 s. ISBN 978-80-247-2688-5.

Souhrn

Schodiště v přírodě patří mezi stavební konstrukce, u nichž převažuje účel. Nelze však přehlížet i estetický význam. V přírodním prostředí bude vhodné použít přírodní materiály: dřevo a kámen. Schody by měly kopírovat terén, aby působily co nejpřirozeněji. Při návrhu je třeba dodržet určité požadavky, aby chůze po schodišti byla pohodlná a bezpečná. Základem pro návrh výšky terénního

schodiště je stanovení sklonu schodišťového ramene. Při stavbě schodišť v přírodě na turistických cestách musíme počítat s tím, že schody budou vystaveny všem přírodním klimatickým vlivům a podmínkám, které se v průběhu roku extrémně liší. Je nutné počítat s podstatnými vlivy dešti, námrazy či sněhu. Terénní schodiště musí být, jako každé schodiště, stabilní, pevné, nesmí se kývat a odolné proti opotřebení. Z uvedeného důvodu je nutné věnovat mimořádnou pozornost výběru materiálu a způsobu založení. Stupně mají mít mírný sklon přibližně 1% směrem k podstupnici, aby z nich voda mohla bez problému odtékat a nezůstávala na stupnici.
Na kamenné schody a schodiště používáme lomový kámen, který by měl být ukládán do rostlého terénu, nikoliv do násypu. Vybírají se takové kameny, které mají jednu plochu rovnou. Jsou masivní, těžké, aby zajistily dostatečnou stabilitu. Jednotlivé stupně se staví na sucho, bez malty, spáry se doplní drobnějšími kameny a zasypávají zeminou, podobně jako suché zídky. Jestliže je požadavek na stabilnější schodiště, je možné schodiště z lomového kamene spojovat cementovou maltou.
Dřevo a kámen je nepřirozenější materiál pro schodiště použité v krajině. Přesto se někdy neubráníme použití i jiných materiálů. V případě špatně přístupných míst, kde by degradace dřevěných prvků vyžadovala velmi nákladnou údržbu nebo častou výměnu je výhodnější využít kovových konstrukcí. V současné době se využívají ocelové konstrukce, které mají na stupně použity lisované rošty PR. Jejich výhodou je jednouchá údržba i v zimních měsících, kdy sníh většinou roštem propadá. Měli bychom si být vědomi, že do přírodního prostředí tento prvek nezapadá, proto je umísťujeme jen opravdu ve výjimečných situacích.
Ve vlhkém prostředí mohou být nejen dřevěná schodiště kluzká. Je vhodné v takových místech navrhovat zábradlí. Pro vyšší bezpečnost se doporučuje opatřit zábradlím po obou stranách.
Mnohdy jsou přírodně krásná místa např. soutěsky, kam se nemá možnost běžný turista dostat. Vhodnou konstrukcí lávek, schodišť a žebříků se tato místa mohou stát cílem výletů i pro méně zdatné turisty. Kromě vhodných materiálů přírodních - dřevo a kámen, použijeme ve výjimečných případech i železobetonové nebo ocelové konstrukce.

Contact:
Ing. Pavla Kotásková, Ph.D.
Phone: +420 545 134 010, e-mail: pavlakot@mendelu.cz

REROUTING FINLAND´S AGROFORESTRY SCHEME

Henri Vanhanen, Rainer Peltola
Natural Resources Institute Finland – Luke, Joensuu, Yliopistonkatu 6, FI-80101 Joensuu, Finland

Abstract
Agroforestry has long traditions in Finland in form of wood pastures and reindeer herding. However latter is nowadays the only form of agroforestry which is widely practiced in northern parts of Finland as area coverage of wood pastures has declined steeply form the beginning of 1950´s. Finland has vast resources of forest, the total forest coverage being 71,6 % of Finland's total land area. This number is one of the highest in the world. However, new innovative and active agroforestry measures distinctive to the environment and culture has not been developed in the past though forests hold several, readily available Non-wood Forest Products (NWFP`s). Forests have mainly been seen as a source of timber and pulp and the awareness of multiple uses of forest has not been come to prominence until 1990´s.
Berries and mushrooms are Finland's most important NWFPs. They are collected from the wild for incomes and recreation. The yearly value of forest berry- and mushroom harvests varies from 4 to 25 million € and from 300 000 to 4 million €, respectively. Berry- and mushroom harvests vary greatly between years, depending on weather conditions affecting the flowering, pollination and fruiting body formation. As wild berries and mushrooms are the most important NWFP´s in Finland, MTT Agrifood Finland (as from 1.1.2015 Natural Resources Institute Finland – Luke) started to develop innovative, active agroforestry methods for high-yielding and constant berry and mushroom production. Two projects were launched; LUSTI in 2010 and RahaRääseikkö in 2012. Both of them were funded by the EU Rural Development Programme for Mainland Finland 2007-2013.
Project LUSTI – Securing the Availability of Nature Derived Berries with Cultivation Practices, aimed to test the feasibility of several agroforestry - based cultivation practices to ensure higher and more stable wild berry harvests. Project RahaRääseikkö aimed to develop mushroom production methods in low productive forests. Both of these projects aim to shape new cultural identity for Finnish agroforestry. These projects are presented briefly in this article.

Key words: agroforestry, berries, lingonberry, bilberry, mushrooms, Inonotus obliquus

Introduction

Agroforestry is a traditional land use practice in which livestock is herded or crops are cultivated in forested areas. It is a relatively new name for a very old practice which was once widely practiced throughout Europe. Agroforestry practices are commonly associated with the farming systems in tropics, but in Europe it is the oldest form crop and livestock production (Mosquera-Losada *et al*. 2009). Due to intensification of both agriculture and forestry, agroforestry practices gradually disappeared during the 20th century, when these two land - use practices were considered to be more effective when separated (McAdam *et al*. 2009). In many cases practicing agriculture – especially forest pastures - in forest was considered to be harmful for effective forestry.
Although agroforestry has been in decline in Europe during the 20th century, there is nowadays growing interest towards it. More overly it is seen and should be seen as a sustainable way of land management and not as conflicting between agriculture and forestry. Agroforestry systems have been developing especially in southern and central Europe, where forest farming, silvoarable, silvopasture, riparian buffer strips, improved fallow, multipurpose trees, woodland orchards and many other agroforestry practices are adopted (Mosquera-Losada *et al*. 2009).
In Finland agroforestry exists as wood pastures and reindeer husbandry. Beside these, also small scale beekeeping is practiced to produce specialty honey from flowers of forest berries such as bilberry, lingonberry and cloudberry. The areal coverage of wood pastures has declined steeply form the beginning of 1950´s reflecting the trend in Europe and the growing importance of forestry in Finnish society (Vainio *et al*. 2001). Reindeer herding which is widely practiced in northern parts of Finland has grown as reindeer meat is seen as highly valued and priced foodstuff. The lack of development of new agroforestry systems distinct to Finland or Northern Europe has not been developed though for example in Finland the total forest coverage is 71,6 % of total land area. This number is one of the highest in the world. Although this resource would offer interesting business opportunities in addition to tree production, new agroforestry systems and related business models are lagging behind as compared to other Europe. As several pulp- and paper mills have been closed due to severe structural changes in Finnish forest sector, there has been demand for new operation models, new forest derived products and services (see Hetemäki *et al*. 2011). Also the change in national forest legislation in year 2014 gives more freedom for the forest owners

when deciding forest management practices. It has been stated that joint production of timber and bilberries may have a surprisingly strong effect on both the profitability of forestry and optimal stand management (Miina et al 2010).
Berries and mushrooms are Finland's most important NWFPs. They are collected from the wild mainly for household use and recreation purposes, but also by professional pickers. As mushroom and berry crops in forests are not actively managed, the crops vary greatly between years. The yearly value of forest berries and mushrooms varies from 4 to 25 million € and from 300 000 to 4 million €, respectively (MMM 2009). The huge difference between years creates challenges for the berry- and mushroom refining industry which is dependent on availability of the raw material. Uncertainty between years decreases the investments in refining and huge amount of the yearly crop is sold directly as a raw material, without refining and increment value from refining.
There are several active agroforestry measures developed for both forest berries and mushrooms, but none of them have been trialed or applied in Finland. Mushrooms have been cultivated as an agroforesty practice in China as early as 600 C.E. (Chang 1993) and there are well developed cultivation methods for lowbush blueberry (*Vaccinium angustifolium*) in North America (Yarborough 2012, Drummond *et al*. 2012). In the following chapters we will present two projects which aim to develop innovative agroforestry measures distinctive to the environment and culture. Two projects that were launched were LUSTI – Securing the Availability of Nature Derived Berries with Cultivation Practices and RahaRääseikkö – cultivation of Pakuri (*Inonotus obliquus*).

LUSTI – Securing the Availability of Nature Derived Berries with Cultivation Practices
LUSTI-project started in 2010, it aimed to test the feasibility and economy of several cultivation practices to ensure higher and more stable wild berry harvests from agricultural and forested land in Kainuu and Lapland regions.
Bilberries (*Vaccinium myrtillus*) and lingonberries (*Vaccinium vitis-idaea*) are derived from forests for both domestic and wholesale markets. Currently berries are collected from the wild and Everyman´s right, which is applied in Finland and in other Nordic countries, allows collecting them no matter who owns the land. Most of the yearly crop is collected from Northern Finland, North-Karelia, Kainuu, North Ostrobothnia and Lapland but the crop varies significantly from year to year (Picture 1). Currently most of the harvest (80%) is collected by foreign workers, mainly from Thailand, since locals pick berries mostly for household use. These pickers do not have a formal employment relationship. Instead, they act as "freelancers", selling the berries they have picked and covering the expenses through part of their berry-incomes. Foreign berry-pickers have roused a debate in Finland, in which accusations of human trafficking, labour deprivation and misuse of everyman´s right have been presented. (Rantanen & Valkonen 2011, Peltola 2013).
Yearly variations of crop and uncertainty of availability of foreign work labour creates unsustainable situation for wholesale markets and refinement industry. Though Finland boasts one of the biggest wholesale companies in the world of wild berries, significant refinement industry is lagging. One of the reasons for this is the unstable influx of raw material.

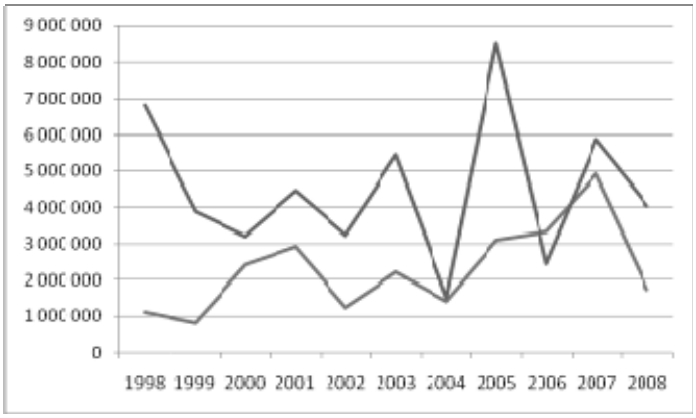

Fig. 1: Yearly amounts (kg) of berries for wholesale markets. Lingonberry – upperline, billberry. MMM 2009 - Marsi 2008

All of the R&D targets in LUSTI - project (cultivation of lingonberry on agricultural land, developing pollination services/ enhanced pollination (bumblebees, solitary bees) and production of specialty honey for lingonberry and bilberry) aim to increase berry yields in select areas in order to concentrate harvest management and logistics. Preliminary results of the project are promising. In cultivation trails lingonberry yields have been up to 2-5 metric tons per hectare on farmland and with solitary- or honey

bee - enhanced pollination on forested land the increase of bilberry harvest has been two- to threefold (Peltola *et al*. 2014, Vanhanen & Peltola 2015, Lasala *et al.* 2015).
In future the project will be continued by adopting more practices from *V. angustifolium* cultivation from North America in order to develop methods especially for forested environment using existing *Vaccinium* vegetation.

RahaRääseikkö – cultivation of Pakuri (*Inonotus obliquus*)
RahaRääseikkö (direct translation MoneyThicket) -project started in 2010 in co-operation with the University of Eastern Finland's Forest Department. Project aimed to develop production methods for specialty mushrooms. The project´s target species was pakuri (*I. obliquus*) which grows as pathogen in living birch trees (Betula sp.) eventually killing its host. pakuri forms sterile conks on the side of the tree (Picture 2.). The conks are collected and used in, for example, beverages and nutraceuticals. It is highly valued in Asia due to its medicinal properties (Glamočlija *et al*. 2015). Although being an effective pathogen in forests managed for tree production, its value can exceed almost tenfold the value of the tree in which it grows. The stumpage price (€) for birch varies from 16 to 20 €/m^3 (MetInfo 2015). The price of dried pakuri is 30 - 60 €/kg, single birch trunk can host several conks. This makes active collection and production of pakuri an intriguing option for forest owners as the profit from it goes directly to the forest owner as collecting pakuri is not considered to be a part of every man´s right like berry picking.


Fig. 2: Pakuri, a sterile conk of *Inonotus obliquus*. Photographer: Kai Pulkkinen.

In Finland, consumption of pakuri in beverages and nutraceuticals has increased.. Traditionally, pakuri was used in Tikka-tea ("Woodpecker-tea"), which was also commercially available. In Asia and Russia the market demand for pakuri is mostly supplied by raw material originating from Far East Russia (Pilz 2004).
In current situation, pakuri refinement industry in Finland obtains the raw material from contract collectors and pakuri is collected from selected areas to ensure high quality of the raw material. RahaRääseikkö project started to test the feasibility of cultivation practices to ensure higher and more stable crop from forested land by using living birch trees as a growing media. Wild pakuri strains were collected from several parts of Finland and the fastest growing strains were selected for field trials. These field trials were started in 2013 and final results are expected in coming years. However, preliminary results were gained in fall 2014 as small scale conk formation was already observed on birches inoculated with *I. obliquus* hyphae.
Cultivation of pakuri is possible in areas in which the tree production is marginal in terms of forestry – i.e. the average tree growth is 0.1 – 1.0 m^3/ha/yr. In such a case the production of pakuri does not compete with tree production. In some cases cultivation could also be incorporated to current forest management practices such as thinning. Constant supply of raw material by cultivation would ensure the availability of pakuri for refining industry and improve its competitiveness also in international markets.

Discussion
In Finland time is prominent for R&D of NWFP sector due the changes in the operational environment as new income sources and value chains are sought by both the forest owners and the forest industry.
Finnish forest sector is often seen as conservative and slow regenerating as compared to other, more "modern" sectors like mobile- and game industry or even agricultural sector in which new ideas, innovations and crop plants are swiftly adopted and measures put to practice. This is quite understandable as the cycle time of tree production (time between final felling) is long, 60 – 120 years

in Finland. However, wild berry- and mushroom harvests recur yearly and even pakuri should be collectible after 10 – 15 years. With current R&D, yields of NWFPs could be increased with novel agroforestry practices. Some of the processes may evolve bottom-up, without governmental incentives, but as many of the companies in NWFP sector are small and middle sized enterprises their influence is limited when nationwide forestry practices with long traditions should be adjusted. Therefore ruling bodies and authorities in question should be active when seeking ways to adjust regulations which are restrictive and limit the development NWFP entrepreneurship.
New innovations in primary production for NWFP´s have and are been developed and also forest management practices are sought to increase the berry and mushroom yields. The profitableness of joint timber production and NWFPs may well exceed the profitableness of a model in which forests are harnessed for sole timber or NWFP production (Miina *et al*. 2009 and 2010, Turtiainen *et al*. 2013, Kurttila *et al*. 2013). Such a paradigm changes are always challenging, especially in the case of agroforestry, as the agroforestry practices are often considered to be obsolete. However, history teaches us about consequences when well-established practices are valued too much. Back in the 19th century, tar was the most important exported product of Finnish forests. When iron replaced wood in ship construction, demand of tar collapsed and many respected tar companies went to bankrupt. Those companies which were enlightened enough to change their business approaches flourished later in, for example, sawmill business.

References

Chang S. (1993): Mushroom biology: The impact on mushroom production and mushroom products. In: Chang S., Buswell J. & Chiu S. (Eds.). Proceedings of the First International Conference on Mushroom Biology and Mushroom Products. Chinese University of Hong Kong. 392 p.

Drummond, F., S. Annis, J. M. Smagula and D.E. Yarborough. (2009): Organic Production of Wild Blueberries. I. Insects and Disease. Acta Hort. 810. p. 275-286.

Glamočlija J. Ćirić A., Nikolić M., Fernandes Â., Barros L., Calhelha R., Ferreira I., Soković M., van Griensven L. (2015): Chemical characterization and biological activity of Chaga (*Inonotus obliquus*), a medicinal "mushroom", Journal of Ethnopharmacology, 162. p.323-332.

Hetemäki L., Niinistö S., Seppälä R. & Uusvuori J. (Eds.) (2011): After the structural change – The future of forest use in Finland (In Finnish). Metsäkustannus Oy. 140p.

Kurttila M., Miina J. & Salo K. (2013): Forest management and commercial mushroom yields in spruce stands in Eastern Finland. Non-Wood Forest Products, Health and Well-Being, Korpilampi, Espoo, Finland; 11/2013.

Lasala I., Leinonen R., Manninen O., Pohjola P. Pohjoismäki J. Peltola R. & Vanhanen H. (2015): Pollinator Fauna of Boreal Lingonberry and Bilberry Redefined. manuscript.

MMM 2009. MARSI 2008 – Amounts forest berries and mushrooms for wholesale in 2008. Ministry of Agriculture and Forestry.

McAdam J., Burgess, P., Graves A., Rigueiro-Rodríguez A. & Mosquera-Losada M. (2009): Classifications and Functions of Agroforestry Systems in Europe. In: Rigueiro-Rodríguez A., McAdam J., Mosquera-Losada M., (Eds.) Agroforestry in Europe - Current Status and Future Prospects. Advances in Agroforestry 6. Springer Netherlands. 450p.

MetInfo (2015): Birch timber and pulpwood stumpage prices €/m³ during 9/2014–2/2015. Natural Resources Institute Finland - LUKE, MetInfo (http://www.metla.fi/metinfo) retrieved 11.4.2015.

Miina J., Hotanen J., Salo K. (2009): Modelling the abundance and temporal variation in the production of bilberry (*Vaccinium myrtillus* L.) in Finnish mineral soil forests. Silva Fennica 43: 577–593.

Miina J., Pukkala T., Hotanen J. & Salo K. (2010): Optimizing the joint production of timber and bilberries. Forest Ecology and Management 259(10): 2065-2071.

Mosquera-Losada M., McAdam J., Romero-Franco R., Santiago-Freijanes J. & Rigueiro-Rodríguez A. (2009): Definitions and Components of Agroforestry Practices in Europe. In: Rigueiro-Rodríguez A., McAdam J., Mosquera-Losada M., (Eds.) Agroforestry in Europe - Current Status and Future Prospects. Advances in Agroforestry 6. Springer Netherlands. 450p.

Peltola R. 2013. Berry phone of Lapland. MTT Raportti 93. MTT Jokioinen. 26p.

Peltola R., Manninen O., Leinonen R. & Vanhanen H. (2014): Boosting pollination services in northern boreal forest. In: Tolvanen A. & Hekkala A. 2014. The 9th European Conference on Ecological Restoration – Abstracts. 231 p.

Pilz D. (2004): Chaga and other fungal resources: assessment of sustainable commercial harvesting in Khabarovsk and Primorsky Krais, Russia Winrock International, Arkansas. 54 p.

Rantanen P. & Valkonen J. (2011): Foreign forest berry pickers in Finland. (In Finnish). Reports – Ministry for Foreign Affairs of Finland. The European Union's external relations fund. 84p.

Turtiainen M., Miina J., Salo K., Hotanen J. (2013): Empirical prediction models for the coverage and yields of cowberry in Finland. Silva Fennica 47(3). 22p.
Vanhanen H. & Peltola R. (2015): Annual Report – LUSTI Securing the Availability of Nature Derived Berries with Cultivation Practices –project (In Finnish).19p.
Vainio M., Kekäläinen H., Alanen A. & Pykälä J. (2001): Traditional rural biotopes in Finland. Final report of the nationwide inventory (In Finnish). The Finnish Environment 527. 163 pp.
Yarborough D. (2012): Establishment and Management of the Cultivated Lowbush Blueberry. International Journal of Fruit Science 12(1-3):14-22.

Acknowledgement
LUSTI-project was funded by Lappi and Kainuu ELY-centers from the Rural Development Programme for Mainland Finland, Raha Rääseikkö – project was funded by several Leader LAGs (Local Action Group): Joensuu Area, Vaara-Karjala, Veej´jakaja, Elävä Kainuu, Oulujärvi, Myötäle, Nouseva Rannikkoseutu, Outokaira tuottamhan and Pohjoisimman Lapin from the Rural Development Programme for Mainland Finland as well as Finnish Cultural Foundation's Lapland Regional Fund and Marjatta and Eino Kolli foundation. We are grateful for their financial support for both of these projects.

Souhrn
Agrolesnictví má ve Finsku dlouholetou tradici ve formě lesních pastvin a chovu sobů. V současné době je tento způsob praktikován zejména v severní části Finska, kde i v této části země rozloha lesních pastvin prudce klesla a to zejména v padesátých letech minulého století. Samotné území Finska má velkou rozlohu lesů s celkovým pokrytím 71,6 %. Toto pokrytí je jedním z největších v porovnání se všemi zeměmi světa. Nové inovativní a aktivní přístupy rozlišují dva rámce a to les jako životní prostředí a les jako kulturu. Dřívější přístupy nebraly v úvahu mimo-dřevní funkce lesa. Lesy byly spíše vnímány jako zdroje dřevní hmoty a celulózy, s mimo-produkčními funkcemi se začalo uvažovat až v devadesátých letech.
Různé bobulovité ovoce a houby jsou ve Finsku jedním z nejdůležitějších artiklů mimo-produkčních funkcí lesa. Tyto komodity jsou získávány za účelem rekreace a prodeje. Roční tržní hodnota těchto plodin se pohybuje mezi 4 – 25 miliony eur (u ovoce) a 300 000 – 4 miliony eur pro houby. Samozřejmě hodnota je závislá na množství sklizně mezi jednotlivými roky v závislosti na počasí mající přímý vliv na kvetení, opylování a tvorbu plodnic u hub. Lesní plody, jako jsou houby a bobulovité ovoce, jsou nejdůležitější složkou mimoprodukčních funkcí lesa, tyto plody jsou využívány zejména v MTT zemědělsko-potravinářském odvětví Finska (od 1. 1. 2015 Institut přírodních zdrojů Finska - Luke). Tento institut vznikl v rámci inovativních a aktivních metod lesnictví pro stále výnosnější produkci hub a bobulovitého ovoce. Byly vytvořeny dva projekty: LUSTI v roce 2010 a RahaRääseikkö v roce 2012. Oba tyto projekty byly financovány z Operačního programu Rozvoje venkova EU pro pevninské Finsko 2007 – 2013.
Projekt LUSTI slouží k zajištění dostupnosti a udržitelnosti pěstování bobulového ovoce v lesích Finska. Projekt Raha Rääseikkö je zaměřen na vývoj produkce hub v nízkých hospodářských lesích. Oba tyto projekty mají za úkol formovat nové lesní identity finského agrolesnictví, které jsou blíže rozepsány v samotném příspěvku.

Contact:
Henri Vanhanen
Phone: +358 29 532 6609, e-mail: henri.vanhanen@luke.fi

RESTORATION OF ABANDONED MEANDERS – THE VIEW OF PUBLIC RECREATION AND LANDSCAPE PROTECTION

Pavla Pilařová[1], Kristýna Bláhová[2]
[1] *Department of Landscape Management, Faculty of Forestry and Wood Technology, Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic*
[2] *SPOLEČNĚ o.p.s., Mendlovo námstí 1a, Brno, Czech Republic*

Abstract
Presented paper deals with possible solutions for restoration of selected abandoned meanders of the river Morava within the order of kilometer 215,500 – 225,500 with the viewpoint of recreation and nature protection. Within the pertained section of the river Morava were selected 10 plots bearing remnants of former meanders of the river (oxbow lakes or cutoff stream branches or areas with certain characteristics), for which were designed restoration plans. Detailed analysis of each restoration plan showed, that the position of plots against the centre of the village, therefore accessibility of plots for local inhabitants, played important role in fulfillment of the requirements of nature protection and public recreation. The assumption, that during restoration of former meanders of the river Morava laying within urban areas or nearby them, the nature protection regulations subside to the recreation potential of the area, was confirmed. On the contrary, remote areas (unaccessible without the use of bicycle, long walk or restricted use of vehicles) brings the opportunity to fulfill nature protection requirements (maximum support of the object of protection) in the restoration plans.

Key words: oxbow lakes, water courses, revitalisation, urban areas, accessibility, leisure activities, funding

Introduction

The river Morava plays important role in the historical development of our country, as the first settlement and trade routes were emerging on its banks. First documented notice of the name Morava is dated from the year 1203. (Hosák & Šrámek, 1980).
The development of settlement caused changes in the primary structure of the landscape and evolvement of secondary structure of the landscape with the characterictic mosaic, which was typical in the area until the end of the 18th century. Radical intensification of agriculture in the Fifties of the 20th century was characterised by large scale farming, the last remnants of meadows and marshes were drained through the means of melioration canals and later in the Eighties with drainage system.
The river itself was extremely modified by technical water management. The route of the water course was straightened with inserted arcs of great diameter and rugged cross section profile was modified into the shape of trapezium, with the toe of the slopes fortified by riprap or rockfill. Transection of the riverbed was lowered due to construction of two weirs „Tážalský and Bolelocký“, which resulted in the change of the hydraulic regime of the river and also creation of migration barriers within the water course.
Some of the oxbow lakes of the river Morava are preserved in different stages of succession. It is also possible to identify areas of former meanders of the river, which have vanished in time, by the presence of characteristic wood vegetation and information from historic maps.
The paper presents information about the condition of the oxbow lakes and cutoff stream branches in the area of interest and evaluates factors, which influence the restoration plans in order to fulfill the requirements of nature protection and recreation potential for local inhabitants.

Materials and methods

Materials

The ten kilometer long stretch of river Morava (Fig. 1) is located South below the town of Olomouc. The southern end is demarcated by a bridge (km 215,50) on a 3rd grade road between villages of Věrovany and Citov. The northern end is demarcated by „Tážalský weir“ (km 225,50).
The analysis of historical maps and field research in the locality led to determination of ten plots, which bear signs of former meanders of the river Morava (Fig. 2). The current stage of sustainment and the means of communication with the river were factors, that diversified the plots into four types:

- Oxbow lake – active communication with the river through upper or lower connection to the water course,
- Cut off stream branch with water surface – water surface communicates with the river through underground water (4 plots in total),

- Cut off stream branch without water surface – water from the river flows through during floods (1 plot),
- Others – plot determined on the base of historical maps, characteristic terrain configuration and wood vegetation (1 plot).

Ecological value was also evaluated for each of the plots:

- low – area hugely anthropogenically affected (5 plots in total),
- medium – area in the stage of developed succession with low anthropogenic influence, absence of protected plants or animals.(4 plots in total),
- high – area with presence of protected plants or animals (1 plot).

Restoration of determined areas, including the designs is still in the process of development.
Overall information about the determined plots is summarized in table 1. Every plot is defined with specific code, where letters represent the name of the cadastral area, where the plot is situated (BLA – Blatec, DUB – Dub nad Moravou, CHAR – Charváty, VER – Věrovany) and numbers signify order of the plot within the cadastral area.

Methods

Each restoration plan of the former meanders of the river was evaluated with number of factors:

- ownership – lands affected by the designs are owned by:
    - private persons (PP),
    - towns,
    - Czech republic (government body with right to maintain the land),
- investor of restoration:
    - owner of the land,
    - other,
- source of funding:
    - funding from grants from EU or CZ,
    - funds of the investor or the owner of the land,
- requirements of nature protection,
- requirements of the owners of the lands,
- distance from the centre of the urban area.

The aim of the analysis of the restoration plans was to figure out, which factors affected the final technical solution, which defines the future function of the plot – natural, natural with recreational aspects, recreational with natural aspects.
Hypothesis stated, that the declining distance of the restored areas of the former meanders from the centre of the urban area, will result in emphasis being placed on the recreational function of the plots.

Results

Defined factors were evaluated for each plot. Results are organized in table 2.
Comparison of tables 1 and 2 clearly shows, that no matter the present ecological value of the plots (low, medium or high), the aim of the nature protection is sustainment, strenghtening or restoration of the ecological value of the former menaders of the river. This demand can be expected due to present state of the river and its flooding area, where any remnant of area with nature-like character surrounded by landscape with intensive agriculture, should be supported. The nature-like character of the designs is also supported by the law num. 114/1992 Sb., about nature and landscape protection, which defines the plots as „significant landscape component“ and these plots also represent part of territorial system of ecological stability.
The requirement to enforce a plan, which would apart from nature protection, enable recreational usage of the area evolved from the owners of the lands. Table 2 and map in Fig 3 clearly demonstrates, that for plots nearby (up to 500 m) the urban centres, is the recreational function emphasized more likely, than for those situated further.
Results confirmed the hypothesis, that when dealing with designing plans for restoration of former menaders of the river Morava situated in urban areas or near them, the emphasis is placed on the recreational function of the area at the expense of nature protection requirements. On the contrary, designs planned for areas reachable with difficulty, can implement the nature protection purpose as the primary aim of the restoration (maximum support of the object of protection).

Tab 1: Summarized information about determined plots of former meanders in the selected stretch of the river Morava

Code of the plot	Category	Means of communication with the river Morava	Ecological value	Status of the design and restoration
BLA1	cutoff stream branch with water surface	Underground water	Medium	Restoration plan completed
DUB1	oxbow lake	Upper connection through pipe	Low	Restoration completed
DUB2	cutoff stream branch with water surface	through DUB1 – nearly disfunctional	Low	Restoration completed
DUB3	cutoff stream branch with water surface	Underground water	Medium	Restoration plan completed
DUB4	others	--	Low	Restoration plan completed
CHAR1	oxbow lake	Lower connection through pipe	High	Restoration currently in progress
CHAR2	oxbow lake	Lower connection through pipe	Low	Restoration plan completed
VER1	cutoff stream branch with water surface	Underground water	Medium	Restoration plan completed
VER2	oxbow lake	Upper connection through pipe	Medium	Restoration completed
VER3	cutoff stream branch without water surface	Only during flooding	Low	Restoration plan completed

.

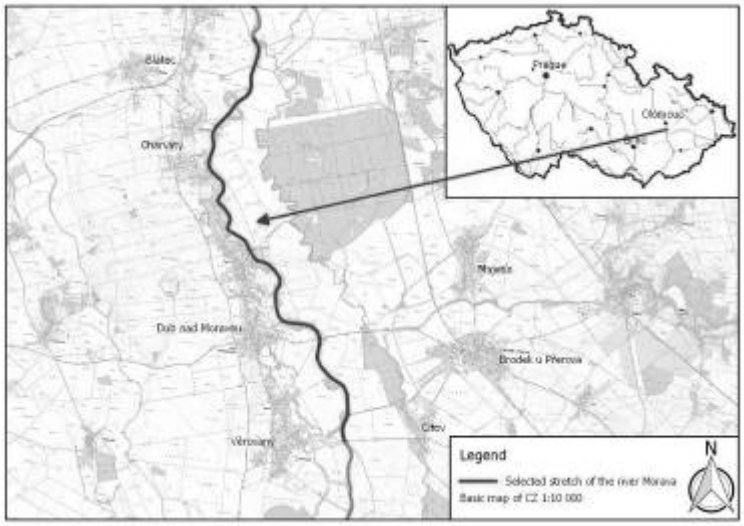

Fig. 1: Selected stretch of the river Morava

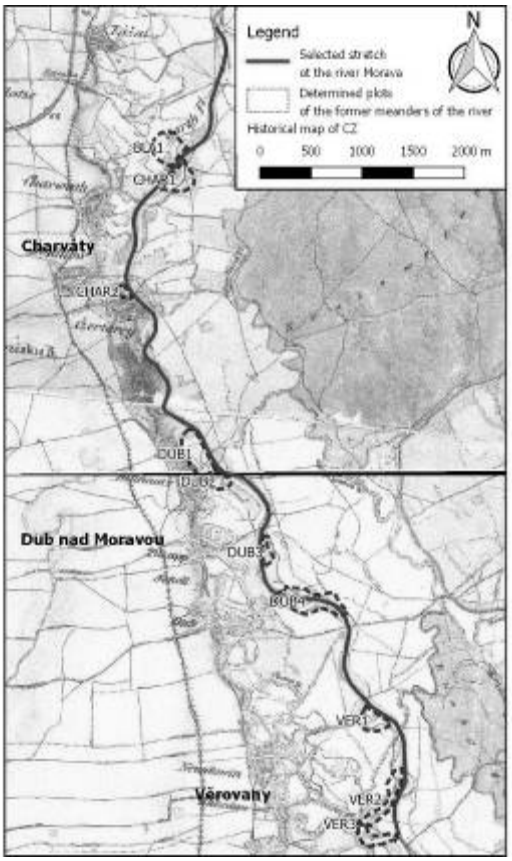

Fig. 2: Historical map of the meandering of the river Morava

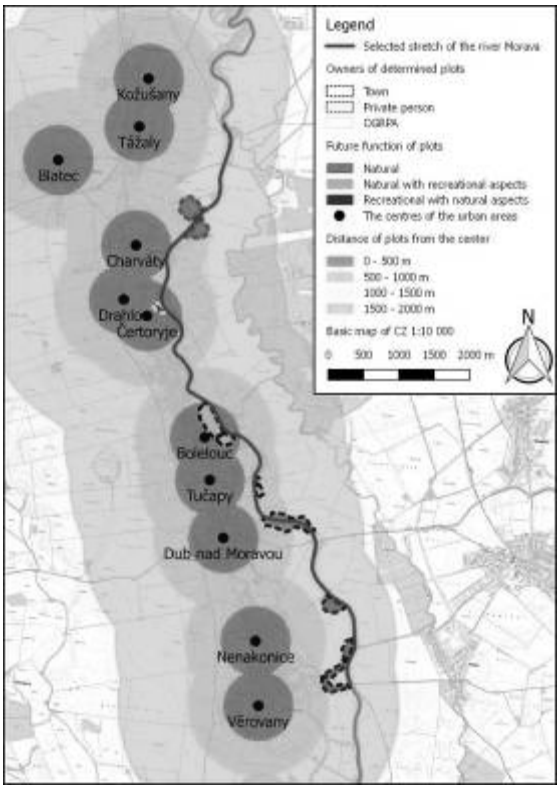

Fig. 3: Map of intersection of factors considered in the restoration plans

Tab 2: Summarized information about determined plots of former meanders in the selected stretch of the river Morava

Code of the plot	Ownership	Investor	Source of financing	Nature protection requirements	Owner requirements	Distance [m]	Future function of the plots
BLA1	Private person	owner of the land	EU grants	Sustainment and strenghtening	No recreation	to 1000	natural
DUB1	Town Dub nad Moravou	owner of the land	EU grants	Restoration	Possible recreation	250 - 500	natural with recreational aspects
DUB2	Town Dub nad Moravou	owner of the land	EU grants	Restoration	Possible recreation	250 - 500	natural with recreational aspects
DUB3	Town Dub nad Moravou	owner of the land	EU grants	Sustainment and strenghtening	Recreation	to 750	natural with recreational aspects
DUB4	Town Dub nad Moravou	owner of the land	EU grants	Restoration	No recreation	1000 - 1500	natural
CHAR1	Private person	owner of the land	EU grants	Sustainment and strenghtening	No recreation	to 1000	natural
CHAR2	CZ – OGRPA *	Town Charváty	EU grants	Restoration	Recreation	250 - 500	recreational with natural aspects
VER1	Town Věrovany	owner of the land	EU grants	Restoration	No recreation	to 1500	natural
VER2	Town Věrovany	owner of the land	EU grants	restoration	Possible recreation	1000 - 1500	natural
VER3	Town Věrovany	owner of the land	EU grants	restoration	No recreation	1000 - 1500	natural

* The Office for Government Representation in Property Affairs (OGRPA)

Conclusion

The result of long-term anthropogenical influence in the section of the river Morava and its flooding area, is loss of mosaic of forests, meadows, arable land, marhses, ponds and naturally curved water courses, which led to the decline in ecological value of the area of interest. Restoration of the former meanders of the river Morava is therefore essential.

The results of the analysis of the designs for restoration of former meanders of the river signify, that due to the technical limitations (present constructions, engineering mains, technological facilities) and also due to socio-political and economical factors, not all the areas of former meanders can be restored to its original natural state.

The influence of nature protection on the restoration of former stream branches of the river Morava

The aim of the representatives of the Department of Nature Protection is maximum protection of former meanders and therefore the restoration designs should, according to it, aim at sustainment, strenghtening or restoration of their ecological value. Fulfillment of these requirements is supported by the fact, that most of the funding for such projects is gained from EU grants. These grants have very strict criteria for restoration designs and the success at fulfilling these criterias defines the level of financial support from EU and therefore the level of necessary funding coming from the investor of the project.

The influence of the owners of the land in restoration designs of former stream branches of the river Morava
An important role is also played by the owners of the land, where the restoration takes place. The representatives of the local towns tend to enforce such designs, which create areas with recreational, nature-like function, especially those areas near the centre of the urban area, which are easily accessible by the local inhabitants.
It was learned, that the reason for the requirements of the recreational function of the restored areas, is the necessity to defend the project, which affects the budget of the towns, against the citizens of the towns. On the other hand restoration design, which brings more attractive options for leisure activities for the citizens is likely to be accepted by the general public. Therefore the representatives of local towns procure especially restoration plans of the former meanders of the river within 500 m from the centre of the urban area with emphasis on recreational function of the restored area (accessibility of water, easy movement through the restored area, character of wood vegetation and grass cover), which at the same time fulfill the criterias for grant funding.

Designs, which fulfill the requirements of nature protection as well as recreational function of the restored area
In order to fulfill the requirements of all interested parties, it is advisable to divide the restored area into two sections according to their future function. One section strictly nature-like with specific management (often extensive character or completely left to its own development) and another section designed for recreational use with intensive management (regular cutting, forming of wood vegetation and eradication of unwanted self seeding of wood vegetation). It is beneficial to place a „buffer zone“ between these sections.

References
ATELIER FONTES, s.r.o. (2015): Studie proveditelnosti revitalizace řeky Moravy a její nivy v ř. km 215,500 – 225,500.
Hosák, L., Šrámka, R. (1980): Místní jména na Moravě a ve Slezsku II., Academia, Praha, 962 str.

Acknowledgement
The paper was prepared mainly thanks to support of the company ATELIER FONTES, s.r.o., which also produced part of the materials.

Souhrn
Obnova ploch bývalých meandrů v předmětném úseku řeky Moravy má vzhledem k nízké ekologické hodnotyě zájmového území své opodstatnění.
Avšak, jak výsledky analýzy návrhů obnovy bývalých meandrů řeky Moravy naznačují, nejen díky technickým limitům (současné stavby, vedení inženýrských sítí a technologických zařízení), ale také díky socio-politickým a ekonomickým vlivům nelze veškeré plochy bývalých meandrů řeky Moravy navrátit do původního přirozeného stavu.

Vliv ochrany přírody na obnovu bývalých ramen řeky Moravy
Snahou orgánů ochrany přírody je maximální ochrana současných ploch bývalých meandrů. Naplňování podmínek a požadavků orgánů ochrany přírody podporuje fakt, že finanční zdroje potřebné pro realizaci návrhů jsou čerpány především z dotačních titulů Evropské unie. Příslušné dotační tituly mají velice přísná hodnotící kriteria projekčních návrhů a od naplnění jednotlivých kritérií se odvíjí výše finanční podpory a s tím spojená výše potřebného dofinancování z vlastních zrdojů investorem akce.

Vliv vlastníků návrhy dotčených pozemků na obnovu bývalých ramen Moravy
Z výsledků analýzy návrhů obnovy bývalých meandrů řeky Moravy vyplynula snaha vlastníků, jimiž jsou v zájmovém území převážně obce, prosadit takové návrhy, které budou vytvářet plochy s přírodě-rekreačním či rekreačně-přírodním charakterem, a to u ploch, které se nacházejí v blízkosti center obcí a jsou pro místní obyvatele snadno dostupné.
Z šetření na místních samosprávách obcí bylo zjištěno, že důvodem požadavků obcí na možnost rekreačního využití obnovovaných ploch, je potřeba obhájení realizace stavby, která zasáhne do obecního rozpočtu, před samotnými obyvateli obce. V případě návrhu obnovy, který zatraktivní obec a její bezprostřední okolí, je zásah do obecního rozpočtu před obyvateli obce snázeji obhajitelný. Z tohoto důvodu prosazují zastupci místních samospráv především obnovu ploch bývalých meandrů

řeky Moravy do vzdálenosti 500 m od center obcí s důrazem na takové technické řešení návrhu, které naplní požadavky na rekreaci a zároveň naplní hodnotící kritéria pro přijetí žádosti o dotaci.

Řesení návrhu splňující požadavky ochrany přírody i rekreačního využití

Při snaze zkloubit podmínky orgánů ochrany přírody a požadavky samotných vlastníků návrhy dotčených pozemků na tvorbu nových atraktivních prostor pro volnočasové aktivity místních obyvatel se nejvíce osvědčilo rozdělení plochy na dílčí plochy dle budoucího funkčního charakteru. Tedy v rámci obnovované plochy vymezit prostor „čistě pro přírodu“ s příslušným budoucím managementem (extenzivní charakter či úplné ponechání plochy samovolnému vývoji) a prostor pro rekreaci s intenzivním managementem (pravidelné sečení ploch, formování výsadeb a odstraňování náletů dřevinné vegetace). Mezi tyto dvě rozdílné funkční ploch je vhodné situovat tzv. přechodovou plochu.

Contact:
Ing. Pavla Pilařová, Ph.D.
E-mail: pilarova.pavla@gmail.com

Ing. Kristýna Bláhová
E-mail: kristynablahova1@gmail.com

SOIL EROSION RISK IN THE CATCHMENT AREA OF THE WATER RESERVOIRS

Martina Zeleňáková, Vlasta Ondrejka Harbuľáková, Zuzana Kárászová
Technical University, Faculty of Civil Engineering, Institute of Environmental Engineering, Vysokoskolská 4, 042 00 Kosice, Slovak Republic

Abstract
Soil erosion is one of the major soil degradation processes, which greatly contribute to reducing of its quality. It leads to loss of the most fertile surface layer of agricultural land and it causes also to the loss of nutrients, humus (soil organic matter) and reduction of microbial activity. Long-term, intense impact on soil erosion processes can lead to a complete erosion of fine particles, which ultimately means the demise of the land itself. Therefore, it is necessary to solve the risk of soil erosion mainly for purposes of the spatial planning. The aim of the paper is evaluation of the erosion processes in the area of small water basins Hrcel, Nizny Zipov a Velke Ozorovce. In consequence the proposal of erosion measures in the basin's water bodies are described. Paper presents determination of erosion – soil loss calculation using suitable methods for this assessment. The results are supplemented by using different methods of soil loss calculation.

Key words: assessment of soil erosion, erosion degree, soil loss

Introduction

As the human population has expanded, more and more land has been cleared for agriculture and other pursuits that degrade the soil and make erosion more likely to occur. The effects of soil erosion go beyond the loss of fertile land. It has led to increased pollution and sedimentation in streams and rivers, clogging these waterways and causing declines in fish and other species. And degraded lands are also often less able to hold onto water, which can worsen flooding. Sustainable land use can help to reduce the impacts of agriculture and livestock, preventing soil degradation and erosion (https://www.worldwildlife.org/threats/soil-erosion-and-degradation). Soil erodibility is an estimate of the ability of soils to resist erosion, based on the physical characteristics of each soil. Texture is the principal characteristic affecting erodibility, but structure, organic matter and permeability also contribute. Generally, soil with faster infiltration rates, higher levels of organic matter and improved soil structure have a greater resistance to erosion. Sand, sandy loam and loam-textured soils tend to be less erodible than silt, very fine sand and certain clay-textured soils (http://www.omafra.gov.on.ca/english/engineer/facts/12-053.htm).
Soil erosion has a special position between land degradation processes. Although the compaction of soil and chemical pollution of soils can be very dangerous, it can be said that soil erosion is the most serious degradation processes, often leading to the complete loss of fine soil and to extinction of the soil. No other environmental process work for so long and so wide. (Ilavská, 2005)
This paper aims to monitoring erosion and transport processes in small water basins catchments Hrcel, Nizny Žipov and Velke Ozorovce in the eastern Slovakia using appropriate methods for the evaluation of these phenomena. As an appropriate method for determining the long-term average soil loss is universal soil loss equation (Universal Soil Loss Equation - USLE). Under this method, there are many possibilities of erosion classification e.g. by Act no. 220/2004 Coll., by Kozbel et al. (2005), by Vasku (1991), by Zachar or according to Research Institute of Soil Science and Conservation (RISSC).
In the paper classification according to Act no. 220/2004 Coll., according to Vasku (1991) and RISSC are shown and discussed. Subsequently, the proposed anti-erosion measures in selected small water basins catchments are presented.

Material and methods

Erosion vulnerability of the area, respectively its potential of erosion is erosion denuding of soil (soil layer thickness expressed in mm/year), which would happen at the selected area, when there is forest or permanent grassland removed. (Fialová, 2010)
Also this state came to pass when there should lacked of soil protective vegetative cover or any technical, hydro-agro, biogenic erosion control measures. (Šlezingr, 2012, Galas, 2013)
The maximum value of soil loss caused by water (which allows stable and economically maintain soil fertility) is known as the admissible soil loss. Its value varies according to the depth of the soil. Limit values of soil loss in accordance with Law no. 220/2004 Coll. are shown in Table 1.

Tab. 1: Limited values of soil loss [3]

Shallow soils (up to 0.3 m)	4 $t.ha^{-1}.year^{-1}$
Middle deep soils (0.3-0.6m)	10 $t.ha^{-1}.year^{-1}$
Deep soils (0.6-0.9m)	30 $t.ha^{-1}.year^{-1}$
Very deep soils (more than 0.9m)	40 $t.ha^{-1}.year^{-1}$

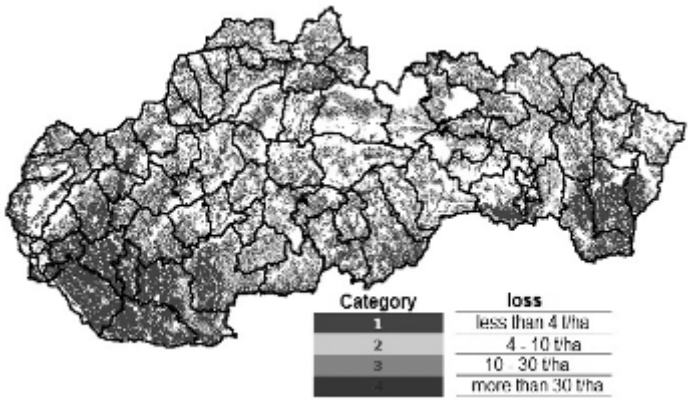

Fig. 1: Graphical position of limited values of soil loss in condition of Slovakia [8]

From the older sources of erosion intensity measurements next assessment of soil erosion are known: Indicative values for the assessment of "normal" (natural, geological), "mild" (weak) and "moderately accelerated" (which is exceptional) and "strongly accelerated". Erosions values of soil loss as a part of the agricultural system are listed in Table 2.

Tab. 2: Description of soil erosion intensity in relation to soil loss degree [9]

Soil loss [$t.ha^{-1}.year^{-1}$]	Soil loss [$mm.year^{-1}$]	Description of soil erosion intensity
less than 0.8	less than 0.05	normal (natural, geological)
0.8–4.0	0.05–0.3	weak (mild)
4.0–10.0	0.3–0.7	moderately accelerated (conditionally tolerate)
10.0–20.0	0.7–1.4	strongly accelerated
20.0–30.0	1.4–2.15	exceptionally accelerated
more than 30	more than 2.15	Disastrous

Depending on the intensity, the erosion can be divided to harmless - normal, or harmful - accelerated. Harmless, normal erosion occurs with low intensity, the creation of soil profile is in balance with its disruption. The thickness of the soil profile does not decrease; changes are only in the texture of soil horizon, which becomes coarser. In case of harmful, accelerated erosion the loss of soil is faster than the formation of the soil profile, which leads to decrease of profile or to total perishing.

Study areas

The aim of the paper is the evaluation of soil erosion in the catchment area of small water basins. Also proposals of appropriate erosion control measures are described.

- Small water basin Hrcel

Village Hrcel is located in the Eastern Slovakia lowland, near Zemplinske Mountains. The village is situated about 15 km from the district city Trebisov and 30 km from Velke Kapusany. Elevation of the village is 120 m asl. Water basin is built in Hrcel stream and is located eastward of the built-up area of the village (Fig. 3).

Parameters of the Hrcel small water basin are:

Total volume of the small water basin is $50.5E10^3$ m^3, when storage volume is $37.4E10^3$ m^3 and retention is $13.1E10^3$ m^3. Maximum elevation H_{max} is 117.3 m asl., flooded area is 3.98 hectares and average depth is 1.5 m.

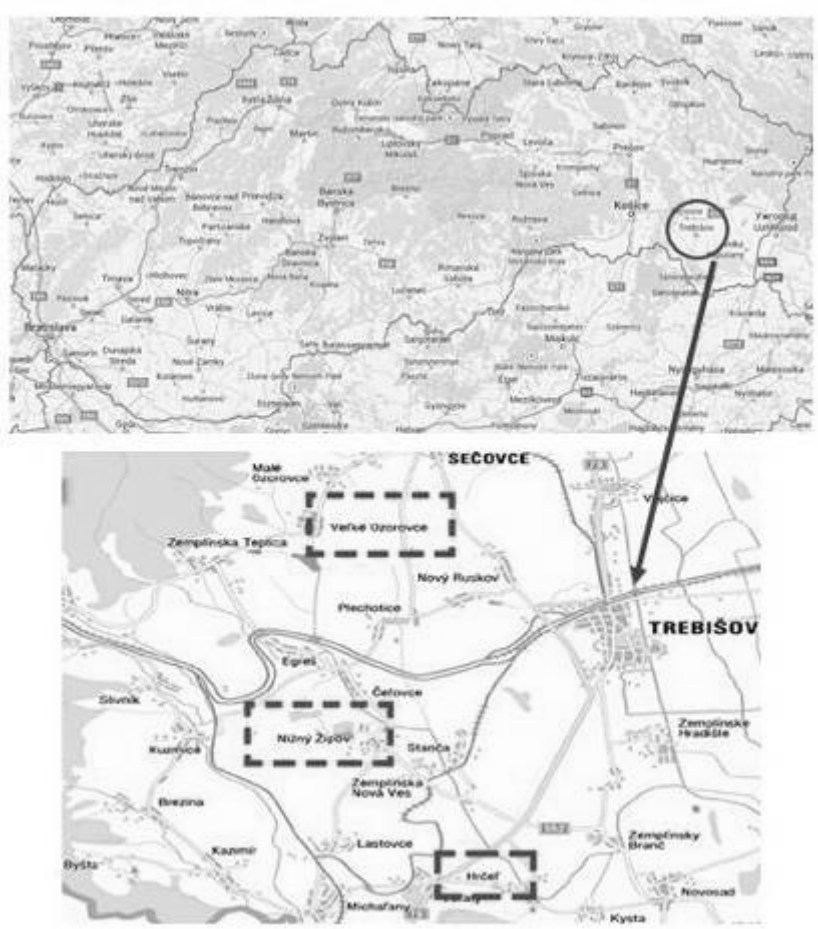

Fig. 2: Map of selected water reservoirs

Fig. 3: Small water basin Hrcel

- Small water basin Nizny Zipov

Village Nizny Zipov is located in the south-western part of the Eastern Slovakia lowland, bordered by Podslanska highlands on the west. The village covers an area of 1716 km^2 and lies at an altitude of 132 m asl. The purpose of the small water basin (Fig. 4) was the accumulation of the water for irrigation purposes. A secondary objective was formation a suitable environment for fish and ducks farming. Currently the reservoir does not have an irrigation function anymore. The small water basin is located to west from the village at Zipovsky stream at 0.8 river kilometre. The small water basin is formed by the front embankment; the other two sides are bounded in naturally raised terrain.

Parameters of the small water basin Nizny Zipov:

Total volume of the small water basin is 178E10^3 m^3, storage volume is 120E10^3 m^3, retention is 30E10^3 m^3 and permanent volume is 28E10^3 m^3. Maximum elevation level H_{max} is 139 m asl., flooded area is 5.9 hectares and average depth level is 2.5 m.

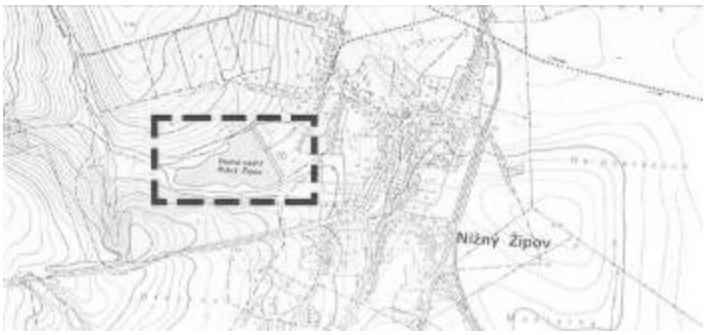

Fig. 4: Small water basin Nizny Zipov

- small water basin Velke Ozorovce

Velke Ozorovce is located in the Trebisov city district, in region of South Zemplin. The municipality has an area of 1377 hectares. The reservoir is situated in the cadastral territory of Velke Ozorovce in the south, about 1500 m from the village at Ciza stream. The small water basin is formed of the front embankment; the other two sides are bounded in naturally raised terrain. Its main objective is to provide water for the irrigation of land. Another purpose of this small water basin is fish farming.
Parameters of the small water basin Velke Ozorovce:
Total volume of the reservoir is $1.158E10^3$ m^3, when storage volume is $0.538E10^3$ m^3, retention is $184.6E10^3$ m^3 and permanent volume is $19.7E10^3$ m^3. Maximum elevation H_{max} is 162.3 m asl., flooded area is 8.05 hectares.

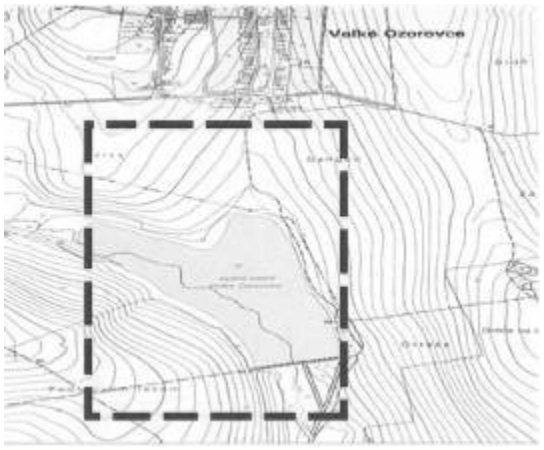

Fig. 5: Small water basin Velke Ozorovce

Results and discussion

In Table 3 results of evaluation of erosion intensity in studied small water basins catchments according to different methods of assessment is presented.
As it is presented in Table 3, the soil loss is According to Law No. 220/2004 Coll. almost in the all studied small water basins threaten by soil erosion (except Velke Ozorovce – 3rd plot). Results gain from evaluation by Vasku (1991) shows strongly accelerated erosion in small water basin Hrcel, and in case of 3rd plot of Velke Ozorovce. In this small water basin very dangerous – extremely accelerated erosion was calculated in the rest plots. According to this method, Nizny Zipov suffers for moderately accelerated erosion. Different conclusions were found out according to Research Institute of Soil Science and Conservation (RISSC) where the disrupted 3rd plot of Velke Ozorovce is threaten by moderate erosion and the rest plots are under strong erosion.
Small water basins Hrcel and Nizny Zipov are threaten by strongly and moderate erosion, respectively in compliance with each selected methods of erosion assessment.

Tab. 3: Assessment of soil erosion according to difference sources

Reservoir	Plot	According to Law No 220/2004 Coll.		According to rate of soil loss (Vasku, 1991)		According to (RISSC)
Hrcel	1401/1	13.94 t/ha/yr	Yes, threaten by soil erosion	0.98 mm/yr	strongly accelerated erosion	strong erosion
	1301/1	12.58 t/ha/yr	Yes, threaten by soil erosion	0.88 mm/yr	strongly accelerated erosion	strong erosion
Nizny Zipov	6603/1	6.297 t/ha/yr	Yes, threaten by soil erosion	0.44 mm/yr	moderately accelerated erosion	moderate erosion
	6602/1	5.79 t/ha/yr	Yes, threaten by soil erosion	0.40 mm/yr	moderately accelerated erosion	moderate erosion
Velke Ozorovce	8801/1	23.87 t/ha/yr	Yes, threaten by soil erosion	1.67 mm/yr	extremely accelerated erosion	strong erosion
	6802/2	16.62 t/ha/yr	Yes, threaten by soil erosion	1.16 mm/yr	extremely accelerated erosion	strong erosion
	7705/1	8.6 t/ha/yr	No threaten by soil erosion	0.60 mm/yr	strongly accelerated erosion	moderate erosion

Conclusion

There is no doubt that soil erosion is a critical environmental problem throughout the world´s terrestrial ecosystems. The most serious form of soil degradation is from accelerated erosion. In paper the evaluation of the erosion processes in the area of three small water basins Hrcel, Nizny Zipov a Velke Ozorovce are presented using three methods of assessment. In case of small water basin Hrcel and Nizny Zipov the result were similar for each method of assessment. Disproportions were found out for small water basin Velke Ozorovce, where different intensity of erosion was calculated for each selected method of erosion evaluation. These results correspond with slopes inclination. The smallest erosion vulnerability is for small water basin Nizny Zipov, located (very low inclination of slopes) and the greatest erosion vulnerability was calculated for Velke Ozorovce (steep slopes). I also explain calculated differences for each method of erosion assessment.

References

Act No. 220/2004 Coll. on protection and use of agricultural land
Available at: http://www.omafra.gov.on.ca/english/engineer/facts/12-053.htm
Available at: https://www.worldwildlife.org/threats/soil-erosion-and-degradation
Fialova, J., Vyskot, I. (2010): The changes in the values of ecological-stabilization functional potentials of forests in the model area Český les. Folia Oecologica. 2010. sv. 37, č. 1, s. 16--22.
Galas, S., Galas, A., Fialova, J., Kubickova, H., Slezingr, M. et al. (2013): Environmental impact assessment process in the field of recreation in the V4 countries. Journal of Landscape Management. sv. 4, č. 1, s. 12-18.
Ilavská, B., Jambor, P.,Lazúr, R. (2005): Identifikácia ohrozenia kvality pôdy vodnou a veternou eróziou a návrhy opatrení, Výskumný ústav pôdoznalectva a ochrany pôdy Bratislava
Šlezingr, M., Fialova, J. (2012): An examination of proposals for bank stabilization: the case of the Brno water reservoir (Czech Republic). Moravian Geographical Reports. sv. 20, č. 2, s. 47--57.

Vašků Z. (1991): Sylaby přednášek z protierozní ochrany pro krajinné inženýry. Prague: Katedra biotechnických úprav krajiny, LF VŠZ.
Zastúpenie kategórií pôd ohrozených vodnou eróziou. Available at: http://www.podnemapy.sk/portal/reg_pod_infoservis/vod/vod.aspx

Acknowledgement
This paper was written thanks to support from project VEGA 1/0609/14.

Shrnutí
Při sledování eroze vybraných vodních nádrží bylo zjištěno, že největší erozní ohroženosti je v oblasti vodní nádrže Veľké Ozorovce, kde je největší sklon svahů. Nejmenší erozní ohroženosti je v oblasti vodní nádrže Nižný Žipov, která se nachází v rovinaté oblasti.

Contact:
Assoc. Prof. Ing. Martina Zeleňáková, PhD.,
Phone: +421 556 024 270, e-mail: martina.zelenakova@tuke.sk

SOUNDSCAPE: IMPORTANT ATTRIBUTE OF PLA MORAVIAN KARST LANDSCAPE CHARACTER

Eva Kostková
Department of Landscape Management, Faculty of Forestry and Wood Technology, Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic

Abstract
The sound is an important part of landscape characteristic, but it is often neglected. It could have a big influence on the whole landscape, but the major part of this study is focused on recreational potential. The noise pollution could debase the landscape character and change the whole value of the landscape. This study deals with evaluation of acoustic conditions (soundscape) in PLA Moravian Karst. Eleven soundtracks were recorded there in different places in spring 2012. The locations for recording were chosen to best represent the territory and contain all types of landscape in PLA Moravian Karst. Also various types of forest are compared. Soundtracks were analysed and sounds were filed in to categories which Raymond Murray Schaffer has defined. Output of this study is overall evaluation of sound characteristic in Moravian Karst.

Key words: landscape, sound, acoustic ecology, audiodiversity

Introduction

Landscape, as the primary space for the life of plants, animals and humans, offers a number of ways for it to view and assess. Although the initial assessment will be visual, at least for the human population, other landscape constituents may be equally important. Even landscapes of high value may become damaged through sound pollution to such extent that they directly affect the viewer's perception and final feeling. The latter then may be completely negative even if that involves a landscape assessed positively from all the other aspects.
On the other side of the imaginary spectrum, there are landscapes that are influenced positively by sound, so their value and recreational potential becomes amplified in the eyes of the observer, although they may not involve sites of extreme importance in terms of visual assessment. The study of sounds of landscapes, acoustic ecology, or soundscape, thus provides another dimension of environmental assessment. Primarily, it is assessment by humans, since it is humans who carry out all the measurements, recordings and subsequent evaluation of sounds in the landscape. Determining how noise pollution affects animals in the landscape is very difficult but potential for observing certain regularities in their ethology exists here as well. Analysing soundscape forms an important part of the overall landscape character assessment. It gives the viewer a better possibility to assimilate with a certain territory and realise the dimension of sound in the landscape. Acoustic ecology therefore does not aim to evaluate only the landscape character; it also seeks to grasp the importance of sound as a landscape constituent and, as a result, understand the landscape as such.

Materials and methods

The Moravian Karst has largely a levelled surface which is however dissected with very sharp, 100-200 m deep-cut valleys that in the northern portion can be described as arid karstic canyons. There are relatively highly allochthonous watercourses flowing into the karst from the surrounding non-karstic regions, particularly from the highlands of Drahanská vrchovina; these sink at the edge of the karstic area, flowing through it underground into karstic springs found on the western limit of the bioregion. (Culek, 1996) The Moravian Karst is the largest and most karstified territory of the Czech Highlands. In terms of typology, it is a holokarst, i.e. full karst with a significant expansion of the surface and underground karstic phenomena. (Němec, Pojer, 2007) Cambisols are the dominant group of soils throughout the district. According to Quitt, E. (1971, 1984), the district is nearly fully located in a moderately warm climatic region, the sub-units of which are distributed from the warmest and driest to the coldest and wettest areas in the valley of the River Svitava symmetrically towards the eastern and western borders of the district. The vegetation of the territory is mainly influenced by the geological substrate. For the Moravian Karst, potential natural vegetation involves flower-rich sedge beech woods, *Melica* beech woods or woodrush acidophilous beech forests (very rarely). The backbone of the existing local vegetation consists of flower-rich beech woods, particularly the subalpine Dentario enneaphylli-Fagetum association.
Sites that were selected for the recording always represented a certain type of landscape that is spatially reproducing in the Moravian Karst (Fig. 1.) Evaluating soundscape chiefly aims at detecting the sounds that represent the real status of the landscape at a certain place while describing

observer's feelings very well. Since this particular case involved an individual landscape, defined mainly by karstic phenomena, the method of determining the recording sites aimed at capturing this aspect in the recordings. To allow for at least general comparison of the sound tracks against each other, the recording included a "blank sample", i.e., a sound track recorded in indoors in the cave of Kateřinská jeskyně. This is not a strict silence; rather, it involves a specific, naturally formed landscape with minimal noise load. Subsequently, recordings were taken mainly based on the vegetation cover and land use, i.e. the sites involved various types of woods, agricultural areas of arable land, and a meadow. Recordings were also taken that were assumed to have the dominant representation of sounds of anthropogenic origin. In this case, it was an interior of the municipality of Křtiny and places near caves which are exposed to intense pressure from tourism.
The recording made use of Hi-MD WALKMAN MZ-RH1 (Sony©) and microphone ECM-C10, also of the SONY© brand. Edition and evaluation by Audicity programme (Fig. 2.)

Results
Items defined from each recording were always as follows:
Soundmark - sounds of anthropogenic or natural character which directly define a specific place in the landscape and are typical of the site. Examples of natural soundmarks may include a waterfall or thermal geyser, while soundmarks of anthropogenic origin may include e.g. church bells or noise from mining.
Keynotes - background sounds; perceived rather subconsciously, they are less distinct.
Sound signals - distinct sounds, perceived to a greater extent. As part of the imaginary scale of sounds in the landscape, these can be referred to as "foreground sounds".

The sites were classified based on the landscape character as natural sites (# 1, 3, 4, 5, 6, 7, 9 and 10) and anthropogenic sites (# 2, 8 and 11). The key sound signals were subsequently defined in the recordings and split as well into the natural and anthropogenic categories. This evaluation found that site 7 and site 9, defined as natural sites, featured a predominant anthropogenic sound signal. In contrast, a natural sound signal prevailed on site 8 and site 11, defined as anthropogenic sites. The habitat of deciduous wood (site 10) was also observed to feature a higher audiodiversity in comparison with mixed woodland (sites 1 and 6).

Discussion
The assessment was particularly about the description of the sound constituent of the environment and its relationship to anthropogenic activities in the landscape. Audiodiversity, i.e. the variability of sounds that are possible to record within a given territory, forms another evaluation component. The process of evaluation found a heavy tourism impact on sites 7 ("Skalní mlýn") and 9. (entrance into the cave of Sloupská jeskyně). The presence of a large number of tourists is also the reason for the prevailing sounds of anthropogenic origin that suppress those of natural origin. This reduced the overall visual attractiveness of the territory of a considerable value in terms of tourism.
In contrast, site 8 (a footbridge over the creek near the entrance into the cave of Sloupská jeskyně) and site 11 (a field near Vilémovice) are locations defined primarily by natural sounds. This is due to the presence of natural sites in a close proximity to the recording places.
Audiodiversity was observed to be higher in the habitat of deciduous woods compared with mixed woodlands. This outcome, however, should not be considered conclusive due to the small number of sites. Within a certain area, audiodiversity is also heavily tied to the immediate climate, season or time of day when the recording was taken. Therefore, assuming any relationship between the type of vegetation and sound diversity should only be theoretical. The hypothesis, however, would require a rather extensive research.
Visual assessment of the landscape presents only one of the possible efforts to understand it. Acoustic ecology provides more ways of viewing the landscape, assessing it and understanding its links and patterns. Aspects that are perhaps partly overlooked when evaluating by sighting, but perceived very intensely when analysing, include tourism. With the caves of Punkevní jeskyně with the Macocha Gorge still remaining the most visited natural monument in the Czech Republic, the anthropogenic pressure on the territory is striking in the event of the Moravian Karst. The aim of this work was thus not only characterise the Moravian Karst Protected Landscape Area in terms of sound, but also to identify potential risks to the region.

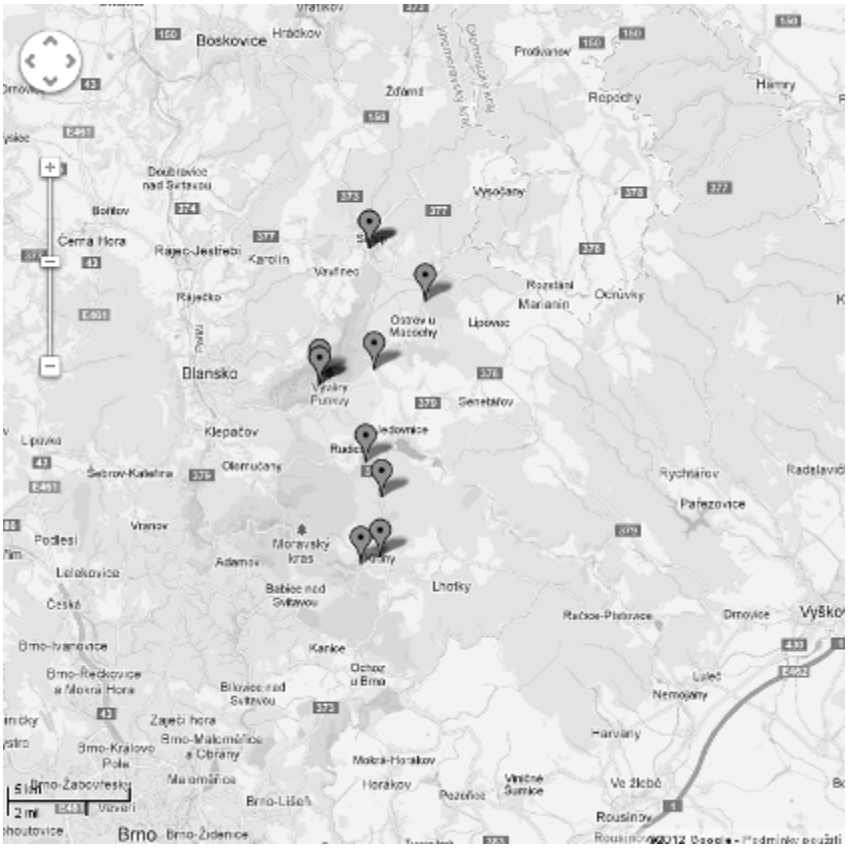

Fig. 1: Map of the sampling sites


Fig. 2: Example of the recording – site # 9 - entrance into the cave of Sloupská jeskyně

Conclusion

As part of the project to assess soundscape of the Moravian Karst, eleven soundtracks from various sites were recorded in the territory of the protected landscape area and subsequently edited using the Audicity program. Their content was evaluated using characteristics and methodology of Raymond Murray Schaffer, the founder of the field of acoustic ecology.

Three basic sound characteristics were determined for each recording: soundmarks - sounds of anthropogenic or natural character that directly define a certain point in the landscape; sound signals - distinct sounds, intensely perceived "in the foreground" and keynotes, i.e. little perceived sounds "in the background". The evaluation of the recordings shows that soundmarks of purely natural character

can be recorded only in forest ecosystems which are not close to any tourist destination of major attractiveness. In contrast, there are a number of valued natural sites, particularly nearby karst caves, where the tourism pressure on the territory can be very well observed using sound recordings. The survey yielded a finding that natural monuments that form important tourism sites are affected by recreation activities to such extent that for some visitors they may lose attractiveness. This example confirms the fact observed in many other cases that recreationally attractive natural monuments cease to be attractions for certain groups of tourists from a certain moment onwards because the place makes it not possible to find natural ecosystems and valuable landscapes as it would be the case when the site was visited by fewer tourists.
The Moravian Karst is a specific landscape, full of valued ecosystems. A number of these are preserved through effective conservation management mainly as a result of Moravian Karst PLA Administration. The conservation of local natural values in the future will simultaneously lead to maintaining the specific soundscape of local landscapes.

References

Bárta, F. (2007): *Krajina v České republice*. Editor Jan Němec, František Pojer. Praha: Pro Ministerstvo životního prostředí vydal Consult. ISBN 978-80-903482-3-3.
Culek, M. (2005): *Biogeografické členění České republiky*. 1.vyd. Praha: Agentura ochrany přírody a krajiny ČR, 2005, 589 s. ISBN 80-860-6482-4.
Chráněná území ČR. Vyd. 1. Editor Peter Mackovčin. Praha: Agentura ochrany přírody a krajiny, c2007, 932 s. ISBN 978-808-6305-028.
Wrightson, K.. An Introduction to Acoustic Ecology. , 1999.
Lercher, P a B Schulte-Fortkamp. (2003):The relevance of soundscape research to the assessment of noise annozance at the community level.
Nový, R. (2009): *Hluk a chvění*. Vyd. 3. V Praze: České vysoké učení technické, 400 s. ISBN 978-80-01-04347-9.
Trojan, J. (2011): Akustická ekologie a soundscape v kontextu multimédií. Vyd. 1. Praha: Triga pro Akademii múzických umění v Praze, 116 s. ISBN 978-80-904506-4-6.
Truax,B. (1999): SIMON FRASER UNIVERSITY. Http://www.sfu.ca/~truax/wsp.html: the world soundscape project [online]. vyd. [cit. 2012-03-31].

Acknowledgement

This study was realized as a part of „The Education and teamwork in areas of intensive land reclamation disturbed by human activities CZ.1.07/2.3.00/09.0090“ project, (Ministry of Education, Youth and Sports, European Social Fund) and by support of „Sustainable management of mixed forests in highland areas – Fluxes of elements and biogeochemical nutrient cycles LD14018“ project. (Ministry of Education, Youth and Sports)

Souhrn

Krajina jakožto primární prostor pro život rostlin, živočichů a člověka nabízí mnoho možností jak na ni pohlížet a jak ji hodnotit. I krajiny velmi hodnotné mohou být zvukovým znečištěním natolik poškozeny, že přímo ovlivňují vnímání a koncový pocit pozorovatele. Ten pak může být zcela negativní a to i v případě že se jedná krajinu po všech ostatních stránkách hodnocenou kladně. Stejně tak ale i krajina degradovaná může po stránce zvukové působit stabilně a pozitivně. Hodnocení zvukové stopy určité krajiny (soundscape) je vždy subjektivní. Tato studie si však kladla za cíl alespoň rámcově stanovit pravidla pro hodnocení zvuků, jakožto podstatnou součást hodnocení krajinného rázu.
V rámci projektu hodnocení soundscape Moravského krasu bylo nahráno 11 zvukových stop z různých lokalit na území chráněné krajinné oblasti. Následně byly tyto nahrávky upraveny za pomocí programu Audicity a jejich obsah byl vyhodnocen pomocí charakteristik a metodiky zakladatele oboru akustické ekologie, Raymonda Murraye Schaffera.
U každé nahrávky byly stanoveny tři základní zvukové charakteristiky: *Soundmarks* – zvuky antropogenního nebo přírodního charakteru, které přímo definují určité místo v krajině, *sound signals* – zvuky výrazné, intenzivně vnímané, „v popředí“ a *keynotes* – zvuky málo vnímané, „v pozadí“. Jednotlivé lokality byly také zařazeny do kategorie „přírodní“, nebo „antropogenní“. Z vyhodnocení nahrávek vyplývá, že soundmarks čistě přírodního charakteru je možné zaznamenat pouze v lesních ekosystémech, kde nejsou v blízkosti žádné významné turisticky atraktivní destinace. Oproti tomu je mnoho přírodně hodnotných míst, zejména v okolí krasových jeskyní, kde je turistický tlak na území na zvukových záznamech velmi dobře zaznamenatelný. Výsledkem pozorovaní je tedy zjištění, že místa turisticky významná jakožto přírodní památky jsou rekreací natolik poznamenána, že mohou pro některé návštěvníky ztrácet atraktivitu. Moravský kras je specifická krajina plná hodnotných

ekosystémů. Mnoho z nich je díky účinnému managementu ochrany zachováváno, zejména zásluhou správy CHKO Moravský kras. Zachování místních přírodních hodnot v budoucnu povede i k zachování specifického soundscape místní krajiny.

Contact :
Ing. Eva Kostková
Phone: +420 774 156 772, e-mail: eva.kostkova@mendelu.cz

TECHNOLOGIES FOR THE REINFORCEMENT OF FOREST TIMBER HAULING ROADS AND THEIRS RECREATIONAL SUITABILITY

Petr Hrůza
Department of Landscape Management, Faculty of Forestry and Wood Technology, Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic

Abstract
The reinforcement of forest roads is a broad issue that encompasses different solutions. They must take into account that the primary reason for the road reinforcement is the timber transport during which there are heavy pressures of the transport machinery axles on the road surfaces due to the weight of the transported timber. In some cases, timber transport is accompanied with a requirement of an all-year-round operation, i.e. timber transport under all weather conditions. However, also the economic aspect of the reinforcement is considered as forest roads are roads with a low intensity of transport. Last but not least, the reinforcement of forest roads must meet the growing demands of the forest visitors concerning its aesthetics and the utilisation of forest roads for sports purposes. All together, this puts high demands on the construction and the methods of forest road reinforcement so that all of the above listed objectives are met and forest roads fulfil the requirement for multifunctional use. This paper presents the historical development of the reinforcement of forest roads as well as different types of reinforcement used throughout the history and the present, so that forest visitors get an idea about the technologies for their construction. At the same time, it must be pointed out that each technology currently used is more or less suitable for the particular purposes of the utilisation of forest roads.

Key words: forest road, reimforcement, technologies

The Subject Matter
The first attempts of road reinforcement appeared around 4000 BC in Great Britain (Lay, 1992) with pole timber used in corduroy roads. This type of reinforcement was especially used on sites with a low bearing capacity affected by water, where putting the pole timber across the road created a wooden bar which more effectively spreads the pressure from vehicle axles over the area. The presence of water prevents contact between air and wood and thus reduces the rate of the decomposition of the pole timber. Even today, we can find remnants of this type of reinforcement from the 16th century, for example in Germany (Johnson, 2014). Another type of reinforcement, also from the past, although still used in some developing countries (Winkler, 1999), is the technology called stone pitching. This technology can be commonly seen in forest roads construction in the past that are still in use by hauling vehicles in Europe (Hrůza, 2013). It is a base layer of larger pyramid-shaped quarry stones, with a width of 10 to 15 cm, a length of 15 to 30 cm and a height of 15 to 25 cm, and a rectangular base. They are placed manually positioned close together, with the tip upwards and the longer dimension across the road so that, if possible, the adjacent rows are locked together. After a certain area is stone pitched, the projecting parts of the stones are hammered out and the fragments are used to wedge the spaces between the pitch stones. After the wedgingprocess, the surface should be continuous. The thickness of the pitching layer is usually 15 to 25 cm. If the road is inclined, stone pitching is laid in the direction against the incline so that the stones lock well together (Makovník, 1973). The disadvantage is that the stones must be laid manually, the work is strenuous and cannot be mechanised. Another drawback is that unless the wedging is perfect, the transport loading is borne by individual stones and the axle pressures are not spread over the area. Due to these drawbacks and thus the time demands of the construction, the use of stone pitching as reinforcement on forest roads has been abandoned (Makovník, 1973). These historical reinforcement technologies do not meet the current needs of timber transport and neither forest visitors, both hikers and cyclists like them as the resulting surfaces are very rough and uneven. The pitching technology was first replaced with a layer of coarse crushed stone by a Scottish builder, John Loudon McAdam (in 1816). He first crushed the stone mechanically directly at the extraction spot and transported the crushed stone by vehicles to the road subgrade as a reinforcement layer. Coarse crushed stone of a larger faction is still called macadam after this innovator. Gravel of large grain, called macadam, was spread out in 15 to 20 cm layers and rolled out with heavy static rollers. As the gravel layers can be laid using machinery, the macadam base layer gradually replaced the stone pitching reinforcement. However, the rolled layers had fairly large voids among the stones and the surface did not meet the requirement of uniform pressure on the subgrade. Therefore, the road surface got significantly deformed by the vehicles. The builders started to look for a technology to fill in the macadam voids and level and close the surface,

ideally using the material that remains after stone is crushed to macadam. This technology is called water-bound macadam and was especially used in the first half of the last century. It is basically a layer of coarse gravel with slurry. The method of water-bound macadam consisted of spreading crushed coarse gravel and its grouting by the binding slurry. The spread gravel layer is compacted (rolled), first using the dry procedure, then gently sprayed with water. The rolling is finished when the gravel stops moving and the gravel grain laid under the roller does not get pressed in but is crushed. The voids in the compacted gravel layer are filled with the slurry. It can be made directly at the location of the road or in mixers (Jurík, 1984). The amount of slurry used to fill the voids in the gravel should not be more than 20 to 25% of the volume of the compacted layer (Jurík, 1984). A major disadvantage of this type of reinforcement is the sensitivity of the loamy sand cement to humidity; it can only be used in locations not affected by water. The material characteristics of water-bound macadam report the modulus of elasticity to be 500 MPa (TP 170, 2010). This type of reinforcement does not satisfy the needs of the current hauling machinery as regards the bearing capacity; however, it is the best surface for hiking and sports purposes as it is natural, flexible, and absorbs impacts.

In the second half of the last century, the technology of penetration macadam that is a form of a technology of grouted courses began to prevail in the forest roads of the Czech Republic. It consists of a reinforcement layer composed of coarse aggregate grouted with a bituminous binder and filled with spread and compacted (stone) aggregate. Based on the type of coarse aggregate, this can be fine penetration macadam with the aggregate fraction of 16 to 32 mm and a total layer thickness of 5 cm, or coarse penetration macadam with the aggregate fraction of 32 to 63 mm and a total thickness of 10 to 20 cm. The layer of penetration macadam is carried out in several stages. The foundation is coarse aggregate, which is usually spread by a grader. After spreading and the levelling of the coarse aggregate, pre-compacting is carried out by a smooth roller without vibration. To avoid crushing the coarse aggregate, moderately heavy rollers are used. The stone layer is grouted by distributors. Immediately after the asphalt binding, an amount of crushed aggregate, enough to fill in the voids in the gravel, is dosed onto the surface using a shredder; it is then immediately rolled. More aggregate is only added to the spots that are not sufficiently filled. The spread aggregate is levelled using a frame brush during compaction so that the spaces in the gravel are well filled but the gravel mosaic remains visible. Vibrating of the fine aggregate and the concurrent compacting of the layer must begin immediately after the spreading and is carried out by a vibrating roller. The wearing course of penetration macadam has to be coated (ČSN 73 6127-2). The material characteristics of penetration macadam report the modulus of elasticity to be 800 MPa (TP 170, 2010). This technology is not very popular among forest visitors due to its frequent damage as well as its uneven and sharp surface. This technology was gradually replaced, the main reason was that the asphalt binder used in the forest to grout the coarse aggregate contained tar and its application in asphalt emulsions was rejected to protect the environment. As a result, not only was environmental protection enhanced but also the quality of the asphalt emulsion increased. However, the disadvantage was the increased economic costs of penetration macadam. Also, the rate of asphalt emulsion hardening without the tar component is considerably faster and thus it is very difficult to reach complete grouting of the coarse aggregate. Considering also the economically disadvantageous local repairs of damaged penetration macadam, the use of this technology has been gradually reduced to a minimum.

Penetration macadam has been replaced with the technology of unbound layers, especially Type 1 unbound mixture, less vibrated gravel. These technologies are used in classical road construction as a road base layer. However, they could be used as the surface layer of forest road reinforcement in the forest as the intensity of transport is low and some of the roads are only used seasonally. Type 1 unbound mixture is the most advanced type of unbound layer within road building and it also has the highest load bearing capacity. It is a layer made of unbound mixtures of crushed aggregate with texture from 0 to 32, or 45 mm with the optimum moisture, spread and compacted under conditions ensuring the maximum possible load bearing capacity. The design of the mixture must be done in compliance with the provisions of the standard (ČSN EN 13285) along with the exact procedure of construction works (ČSN 73 6126-1). Unbound layers are spread in one or more layers by finishers or graders. When the work is of a small scale and done in small areas, it is possible to use any other appropriate machinery; alternatively, it can also be done manually. In manual work, the mixture cannot be thrown by shovels but it is recommended to form small piles and spread those. The spreading of an unbound mixture has to begin immediately after its delivery in order to maintain the optimum moisture. Compaction can be performed by a vibrating tandem roller with two smooth drums. When the work is of a small scale and done in small areas, in the proximity of drainage fixtures or curbs, it is possible to use vibrating plates, rammers and manual rollers. The mixture must be produced and delivered so that its moisture when laying and compacting meets the standard (ČSN EN 13285), regarding the aggregates, the shape of the granularity curve and the determination of the optimum moisture of

aggregates to achieve the maximum volumetric mass of compaction. The modulus of elasticity of the Type 1 unbound mixture has to reach a value of 600 MPa. This technology best suits the multifunctional purposes of forest hauling roads, including the recreation purpose. The financial costs of their construction are minimized and this reinforcement is able to meet high demands. Its sole disadvantage is the limitations in all-year-round timber transport.

Another type of unbound layer used for the reinforcement of forest roads is the vibrated gravel. It is an older technology of reinforcement and actually the predecessor of Type 1 unbound mixture, which only came into use when the development of stone crushing was allowed. Crushing machines which were able to produce small crushed stone and compacting instruments able to compact not only by pressure but also vibration were necessary. Thus, it was possible to fill in the original macadam skeleton by fine aggregate and create a continuous layer with minimum voids. This layer better resists the pressures from the axles of transport machinery, it does not break and has a better resistance to water. The basis of the gravel layer of vibrated gravel is a coarse aggregate of fraction 32 to 63 mm, which is usually spread by a grader. After the layer spreading and levelling, a vibrating roller is used. It is recommended that before the roller is used the stone layer is moisturised. After the setting of the coarse aggregate, the fine aggregate with a maximum grain size of 16 mm is spread. The ideal aggregate fraction and amount needs to be established experimentally for each given condition. In practice, usually the fine aggregate fractions 0 to 16 mm, or 0 to 8 mm are, used, at an amount of 30-35% of the weight of the coarse gravel skeleton. The maximum amount of the fine aggregate is restricted by the following requirements: after vibrating the fine aggregate, the structure of the coarse aggregate must be apparent; the fine material must not be compacted, but only the voids need to be filled. Before compaction, it is recommendable to moisturise the layer; however, if a fraction at the lower limit of texture is used, it is difficult to vibrate it in. After vibrating, the stone skeleton must be filled coherently at least to a depth of 100 mm. The smallest thickness of the vibrated gravel is 2.5 times the largest grain, i.e. 150-200 mm, the optimum thickness is 250 mm. The modulus of elasticity of vibrated gravel has to reach 500 MPa (TP 170, 2010). This technology is less popular for recreation purposes, due to its roughness; it is also less suitable for cycling as the surface gets disintegrated resulting in worse riding comfort.

Currently, we can also see compacted asphalt courses of bituminous mixtures in forest roads. Compacted asphalt courses have better properties in terms of production technology than penetration macadam; therefore, they have started to replace it in the designs of surfaces that should be operated on all-year-round. In addition, technological processes and machinery for repairs of damaged compacted asphalt courses are already of a better quality than in the second half of the last century in the era of penetration macadams in forest roads. Bituminous mixture is a mixture of aggregates with a continuous or interrupted granularity curve. The aggregate forms the skeleton in which individual grains touch and wedge into each other and are cemented by an asphalt binder. The most commonly used asphalt mixture in forest roads is asphalt concrete. Asphalt mixtures are continuously spread by finishers, exceptionally, use of a grader or manual implementation is possible. Compaction needs to be performed by means of high-performance vibrating or oscillating rollers, heavy static rollers and tyred rollers. Tyred rollers are convenient when compacting thicker subgrade layers of asphalt concrete to prevent cracks, seal the surface, etc. The surface of the wearing course of asphalt concrete is compacted until the static effect of the roller leaves visible traces. Coarsening is done using aggregate of fraction 1 to 3, 2 to 4, or 2 to 5 mm (ČSN 73 6121). Material characteristics of asphalt concrete based on type state have a modulus of elasticity of 5500 MPa, or 7500 Mpa (TP 170, 2010). Asphalt layers are becoming more popular due to their possible all-year-round use for timber transport as well as the dustless character, suitable for hiking, and smooth surface preferred by some of the cyclists. However, from the economic point of view, this solution for forest road reinforcement is the most expensive.

References

ČSN EN 13285 (736155). (2006): Unbound mixtures – Specification. Prague: Český normalizační institut, 24 pp.

ČSN EN 14227-3. (2013): Hydraulically bound mixtures - Specifications - Part 3: Fly ash bound granular mixtures. 36 pp.

ČSN 73 6121 (73 6121). (2008): Road building - Asphalt Pavement Courses - Construction and conformity assessment. Prague: Český normalizační institut, 36 pp.

ČSN 73 6126-1 (736126). (2006): Unbound courses - Part 1: Construction and conformity assessment. Prague: Český normalizační institut, 12 pp.

ČSN 73 6127-2. (2008): Road building – Grouted courses – Part 2: Penetration macadam. Prague: Český normalizační institut. 8 pp.

ČSN 73 6127-4. (2008): Road building – Grouted courses — Part 4: Aggregates bound by fly ash suspension. Prague: Český normalizační institut. 8 pp.
Hrůza, P. (2013): Demonstrative Construction on the Mokradni Forest Road with Natural Reinforcement and Leisure Facilities. In Public Recreation and Landscape Protection-with man hand in hand. 1. ed. Brno: Mendel University in Brno, p. 24-26. ISBN 978-80-7375-746-5.
Johnson, W., P. (2014): The Corduroy Road from Fairfax Court House to Fairfax Station. The Fare Facs Gazette. 11(2). p. 4-11.
Jurík, L., et al. (1984): Lesné cesty. Bratislava: Príroda, 407 p.
Lay, M., G. (1992): Ways of the World: A History of the World's Roads and of the Vehicles that Used Them. Rutgers University Press. p. 43. ISBN 0-8135-2691-4.
Makovník, Š., et al. (1973): Inženierske stavby lesnícke: Projektovanie a stavba lesných ciest, Projektovanie a stavba objektov na leských cestách. 1. ed. Bratislava: Príroda, 709 pp.
TP 170 (2010): Design of road pavements, Prague: MD ČR, 2010. 100 pp.
Winkler, N. (1999): Environmentally sound forest infrastructure development and harvesting in Bhutan. Rome: FAO. 75 p. ISBN 1014-9945.

Souhrn
Zpevňování lesních odvozních cest je široká problematika, která v sobě zahrnuje různé způsoby řešení. Ty musí vzít v úvahu, že prvotním důvodem zpevnění je doprava dříví, kdy dochází, vzhledem k hmotnosti odváženého dříví, k maximálně dovoleným tlakům náprav odvozních souprav na jejich povrch. V některých případech je odvoz dříví spojený i s požadavkem celoročního odvozu dříví, to znamená za každého počasí. Vždy je zde také kladen důraz na ekonomický způsob řešení zpevnění a to vzhledem k tomu, že se jedná o komunikace s nízkou intenzitou dopravy. V neposlední řadě musí zpevnění lesních odvozních cest plnit i narůstající požadavky návštěvníků lesa na jeho estetiku a sportovní využití lesních odvozních cest. To vše společně klade vysoké nároky na výstavbu a způsoby zpevňování lesních odvozních cest tak, aby byly splněny všechny tři výše uvedené požadavky. Tento článek popisuje historický vývoj zpevňování lesních odvozních cest a různé typy zpevnění používané v současné době tak, aby návštěvníci lesa měli představu o technologii jejich výstavby. Společně s tím uvádí, že každá technologie je více nebo méně vhodná pro jednotlivý účel jejich využití.

Contact:
Assoc. Prof. Ing. Petr Hrůza, Ph.D.
Phone: +420 545 134 085; e-mail: petr.hruza@mendelu.cz

THE CONFLICTS IN FLOOD ROUTING THROUGH THE RECREATIONAL RESERVOIR HOSTIVAŘ IN PRAGUE

Jaromír Říha
Institute of Water Structures, Faculty of Civil Engineering, Brno University of Technology, Veveří 95, 602 00 Brno, Czech Republic

Abstract
The main purpose of the Hostivař dam in Prague is recreation when the reservoir level has to be maintained on prescribed level. The second declared purpose of the scheme is flood attenuation at which operational manual recommends to pre-empty the reservoir. Obviuosly these requirements suffer from certain inconsistency in manipulation with water level. During the flood in June 2013 with approximate return period of 500 years several facilities downstream of the dam were flooded by relatively rapid increase of water level in the Botič stream downstream of the Hostivař dam in Prague. The blame was thrown on the improper manipulation with appurtenant works of the dam and the complaints insist on the flood attenuation effect declared in operation manual. The study on the correctness of the operation at the dam during the flood proved proper and optimal operation with only minor flood attenuation effect. The main declared purpose - recreation - does not allow significant pre-emptying of the reservoir which has only limited volume to attenuate more extreme flood discharges.

Key words: purpose of the reservoir, operation manual, dam Hostivař, flood attenuation

Introduction

In general most of water reservoirs in the Czech Republic are managed as multipurpose. However during their design and construction usually one or two purposes were set as principal. During last two decades the emphasis has been layed on the flood protection function of the reservoirs which asked for the reservation of certain flood attenuation volume. This usually brings a conflict between original and newly proposed reservoir purposes. Water supply, hydropower generation or recreation usually call for the full reservoir. On contrary flood attenuation needs some free reservoir volume which can be reached by permanent or temporary drop in reservoir water level.
In June 2013 the Bohemian part of the Czech Republic was exposed to extreme flood reaching locally 500 year´s return period. All affected dams sustained such extreme peak discharges without any safety problems. However the expectations of the society and affected population about the dams´ efficiency in flood attenuation were not fulfilled. Subsequent studies showed that the operation of all dams was performed according to operation rules and with maximum care. Obviously other purposes and functions of the dams have to be taken into account in the operation of dams during floods.
One of such widely discussed cases was the Hostivař dam in Prague. Its main purpose is recreation when the reservoir level has to be maintained on prescribed - contracted operational level. During the peak flood discharge at the Hostivař dam several facilities downstream of the dam were flooded by relatively rapid increase of water level in the Botič stream. The dam owner was accused by improper manipulation with appurtenant works at the dam. The detailed study proved proper and optimal operation. It was shown that relatively small reservoir volume is not capable to attenuate such extreme floods.

The Hostivař dam

The Hostivař dam is located on the territory of the city of Prague on the Botič stream at the stationing 13.55 km. The Botič is a right bank tributary of the Vltava River (Fig. 1). The river basin of the Hostivař Dam has an area of about 94.8 km^2. In the catchment a significant portion of the agricultural and forest land has been transformed into industrial areas with impervious surfaces. This has probably altered runoff conditions in comparison with its original state. On the streams in the catchment there are 8 gauging stations (Fig. 2) with level recorders indicating discharge; 3 of them are also equipped with rain gauges.

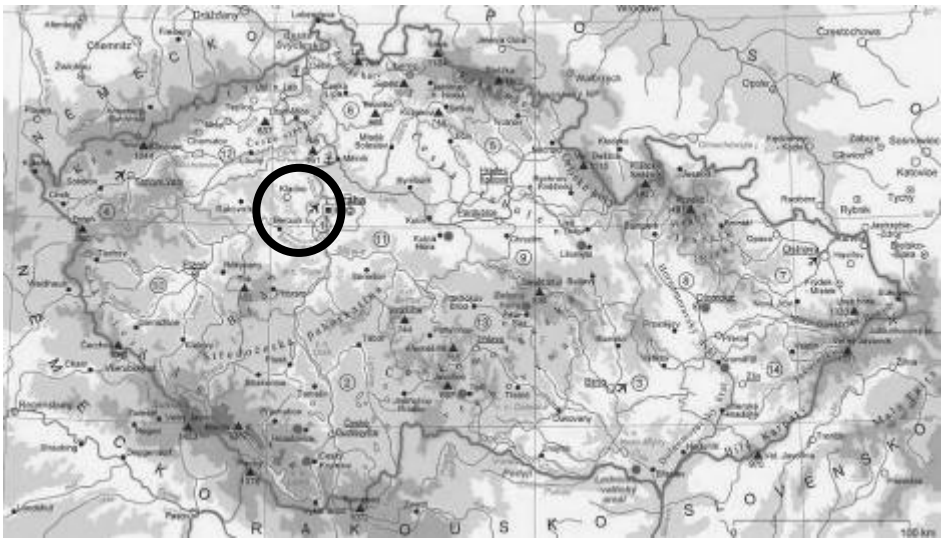

Fig. 1: Map of the Czech Republic featuring the area of interest

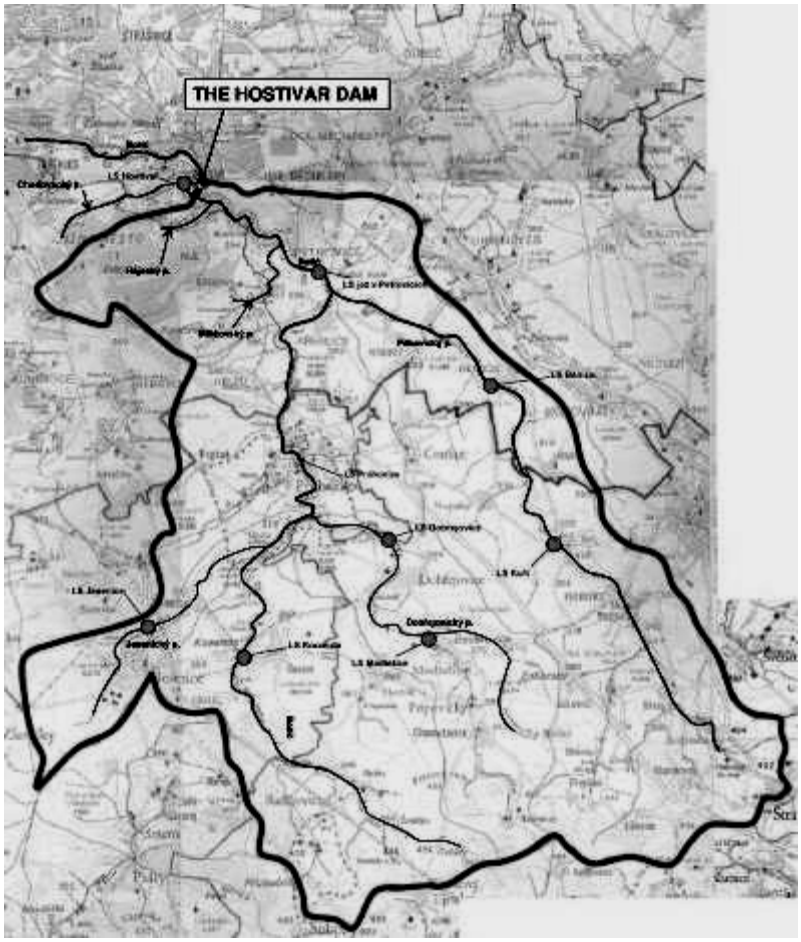

Fig. 2: Map of the Hostivař Dam basin (bullets indicate gauging stations)

The dam was completed in 1961. The maximum dam height is 13 m; maximum reservoir volume is 1.845 mil. m^3. The flood retention volume is 0.375 mil. m^3. The main purpose of the dam is recreation, flood attenuation is declared as supplementary purpose which in fact has only a minor effect in the case of floods with return period $N < 20$ years.

The dam is equipped with bottom outlet - three pipes of diameter 500, 700 mm and 500 mm with total capacity about 8.2 m^3/s. The spillway is composed of four gated sections each with a span of 2.7 m with the total spillway capacity about 70 m^3/s at the maximum reservoir water level and opened gates.

The flood in June 2013

Extreme flooding in Central Europe began after several days of heavy rainfalls in late May and early June 2013. The flooding and damage primarily affected southern and eastern Germany, western regions of the Czech Republic and Austria. The flood wave progressed down from the tributaries to the principal receivers, which included the Danube, Vltava and Elbe rivers.

Records show that floods in the relatively small fan-shaped Botič catchment exhibit quite a steep front, meaning such floods can arrive in few hours. This experience was verified during the 2013 flood at the Botič catchment, where the daily precipitation locally exceeded 115 mm and the inflow to the Hostivař reservoir increased from 20 m^3/s (5-year flood discharge) to 70 m^3/s (200-year flood) within less than 3 hours. After another 4 hours the inflow discharge to the reservoir had increased up to 85 m^3/s, which corresponds approximately to the 500 year´s discharge. The total volume of the flood wave was 8.9 mil. m^3, which exceeded the flood retention volume of the reservoir by about 24 times. Even a preliminary estimate shows the reservoir only had a minor effect on the routing of such an extreme flood.

The flood routing through the Hostivař reservoir was governed by the dam operation manual. After the maximum reservoir water level was exceeded, operators managed to open the gates relatively rapidly with the aim of not exceeding the maximum safety check flood level (249.30 m ASWL).

As the warning system did not sufficiently keep up with the speed of the flood's arrival and the operating procedures employed to deal with it, in the area downstream of the dam some inhabitants were endangered during the flood wave and some moveable properties such as vehicles were not evacuated. This resulted in subsequent complaints and accusations against the dam owner. In order to verify that the dam had been operated and maintained correctly several hydrological and hydraulic studies were carried out including the study detailed below.

Hydrological study

To verify the flood routing procedures also in relation to other reservoir functions (mainly recreation) a detailed comprehensive study of the local rainfall-runoff process, dam operation, and the hydraulic behavior of appurtenant works was carried out. The aim of the study was also to specify flood attenuation potential of the reservoir and to recommend possible improvements.

The study employed all available geographical data about the catchment, data from 6 gauging stations in the reservoir catchment concerning e.g. rainfall, water stage and discharge observations, and information about the water levels in the reservoir during the flood. The capacity of the appurtenant works was assessed via the detailed verification of dimensions, structures and equipment based on available drawings and on-site inspection. The accuracy of measurements of all relevant variables at the dam site was also checked and taken into account. The procedures adopted during the flood which were recorded in the dam book were compared with the data from gauge stations and published weather forecasts.

Rainfall-runoff modeling was carried out using ZABAGED basic topographic data and CORINE maps (COSMC 2009) assembled and adjusted for the Hostivař Dam catchment area (Fig. 2). The modeling of the process was carried out by the HEC-HMS (2010) and GeoHMS (2013) program packages. Precipitation totals were taken from rainfall recorders. The runoff modeling results were compared with the hydrographs calculated at the level recording stations in the catchment and also with outflow hydrograph from the reservoir. Another indicator was the movement of the reservoir water level. The resulting outflow and inflow hydrographs during the flood and the behavior of the reservoir water level over time are shown in Fig. 3.

The modeling showed that the time lag between the reservoir outflow and inflow fronts was about 4.5 hours; the flood attenuation effect was from approx. 85 m^3/s (peak inflow discharge) to approx. 76 m^3/s (outflow), i.e. about 9 m^3/s. This abnormal effect was caused by the delayed opening of the spillway gates and the resultant considerable rise in the reservoir water level up to 248.98 m ASWL (still lower than maximum safety check flood level of 249.30 m ASWL).

In case of reliable flood forecast it is recommended to pre-empty the reservoir by earlier increase of the outflow discharge up to 5 m^3/s. In case of summer pre-emptying the dam owner is obliged to inform all reservoir users who may be aggrieved by the drop of reservoir water level. Those are owners of swimming pools and switchbacks at the banks of the reservoir.

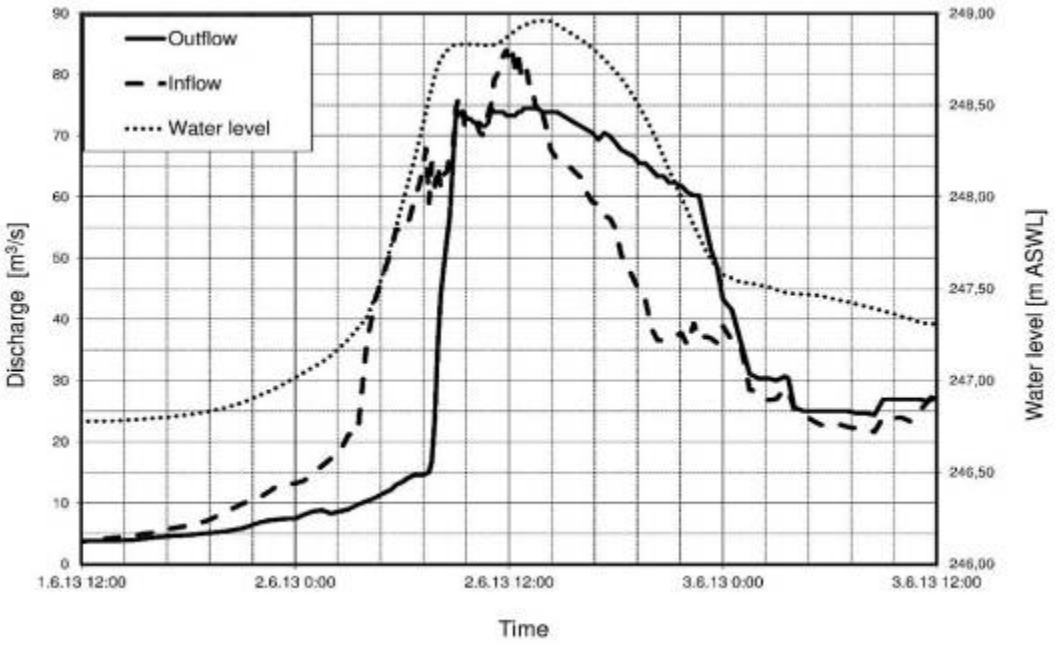

Fig. 3: The outflow and inflow hydrographs, water level

Part of the study involved simulating the outflow hydrograph during dam operation when carried out according to the operation manual. In Fig. 4 it can be seen that if the dam is operated according the operation manual, the peak outflow discharge is about 79.5 m^3/s, which is about 4.5 m^3/s higher than the real peak during the flood in June 2013. Also, the increase in the outflow discharge is more rapid, i.e. it accelerates from 10 m^3/s up to 55 m^3/s in only 5 minutes. This does not correspond with the physically practicable time required for opening the gates. Also, downstream of the dam the arrival time of the real flood in June 2013 was approximately twice longer as that when operated according the operation manual.

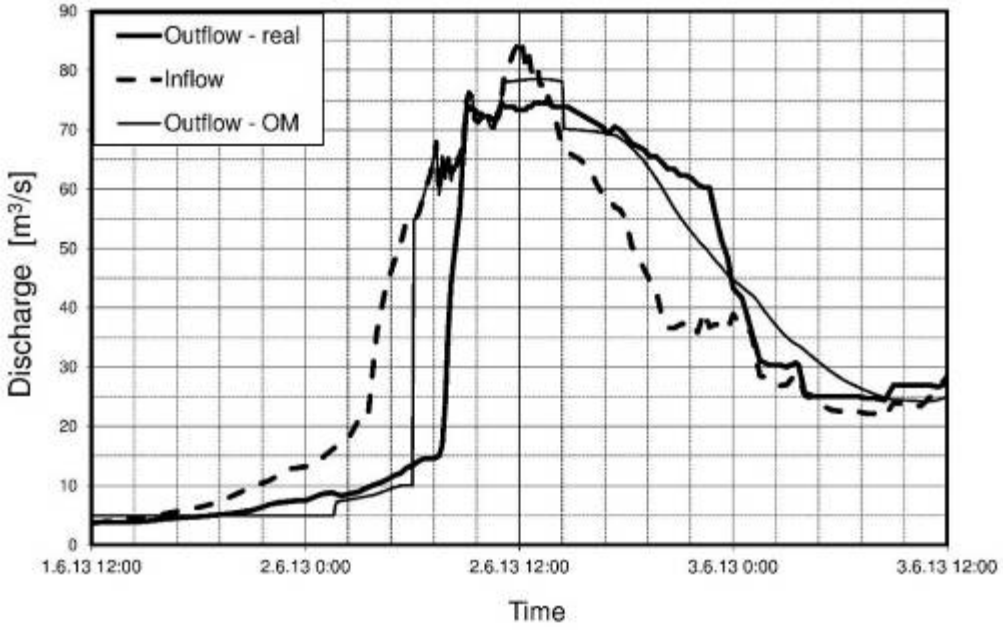

Fig. 4: Comparison of the real and hypothetical outflow occurring if the dam is operated according to the operation manual

Conclusions and recommendations

The study proved that the flood attenuation effect of dams depends strongly on the other purposes for which they are designed, and on the corresponding available flood retention volume at the moment of the flood's arrival. In the case of relatively small catchment areas like that of the Hostivař Dam, the flood intensity and arrival time is significantly influenced by land use changes, i.e. the transformation of agricultural and forest land into industrial areas. A certain effect can also be achieved by the operation

of appurtenant works before and during the flood. However from Figs. 3 and 4 it can be seen that on the rising limb of the hydrographs between the discharges 65 and 70 m^3/s the inflow is equal to outflow with stagnating reservoir water level. This operation overrides the effect of all previous manipulation (including pre-emptying) on the flood attenuation.
In connection with the future performance of the dam and related flood services the following recommendations were made in the study:

- Newly built industrial and warehouse facilities should be equipped with efficient retention and infiltration systems which eliminate rapid runoff from solid impervious surfaces.
- The operation manual must be rewritten and improved, taking into account the new experience obtained during the flood in June 2013. It was recognized that pre-emptying of the reservoir has practically no effect on the flood attenuation. Moreover in the case of faulty or inaccurate flood forecast with lower flood volume the reservoir may suffer from the water deficit which harms the reservoir use for recreation.
- A warning plan should be drawn up for the Hostivař Dam, for the owners of the recreational facilities and also for the area below the dam. It should be based on the general weather forecast (which for such a small catchment is of limited reliability and general significance), data online from the gauging stations in the catchment, and on the current situation at the Hostivař Dam and anticipated operational measures to be taken.

References

COSMC. (2009): *Fundamental basis of geographical data* (ZABAGED). Czech Office for Surveying, Mapping and Cadastre, Prague.
HEC-HMS (2010): *Hydrologic Modeling system*. Version 3.5. USACE, Washington, DC, 2010.
HEC-GeoHMS (2013): *Geospatial Hydrologic Modeling Extension*. Version 10.1. USACE, 2013.

Acknowledgement

This paper is the result of projects entitled *Advanced Materials, Structures and Technologies, code LO1408 AdMaS (Advanced Materials, Structures and Technologies) UP* and *The Use of Infiltration Methods and Their Assessment*, code TA02020386 (Technological Agency of the Czech Republic).

Souhrn

Hlavním účelem vodního díla Hostivař na toku Botič v Praze je rekreace. Poloha hladiny vody v nádrži je v letním období vázána smluvně mezi vlastníkem díla Hlavním městem Praha a nájemci koupaliště a tobogánu. Druhým účelem vodního díla je dle manipulačního řádu zmírnění průběhu povodní. Při prognóze povodně se doporučuje předvypouštět nádrž.
V červnu roku 2013 byla východní část České republiky zasažena extrémní povodní. Doba opakování na přítoku do nádrže Hostivař byla zhruba 500 let. V článku jsou uvedeny výsledky hodnocení průběhu povodně v červnu 2013 v povodí Botiče a způsob manipulace na přehradě Hostivař. Ukázalo se, že nádrž svým relativně malým retenčním ale i celkovým objemem nemá významnější protipovodňový účinek. V případě nespolehlivé - nadhodnocené hydrologické předpovědi může předvypuštění nádrže vést ke stavu, kdy se nádrž po povodni nenaplní a tím dojde k porušení smlouvy mezi vlastníkem díla a provozovateli rekreačních zařízení. Závěrečná doporučení směřují k úpravě manipulačního řádu a vypuštění ochranné funkce z účelů nádrže. Omezený transformační účinek nádrže lze považovat za vedlejší účinek vodního díla.

Contact:
Prof. Ing. Jaromír Říha, CSc.
Phone: +420 541 147 753, e-mail: riha.j@fce.vutbr.cz

THE IMPACTS OF ECOLOGICAL SUCCESSION ON CULTURAL ECOSYSTEM SERVICES IN MALÁ FATRA NATIONAL PARK (WESTERN CARPATHIANS)

Ivan Vološčuk[1], Peter Sabo[1], Martina Škodová[2], Juraj Švajda[2], Anna Dobošová[3]
[1]Institute for research of landscape and regions, Faculty of Natural Sciences, Matej Bel University, Cesta na amfiteáter 1, 974 00 Banská Bystrica, Slovak Republic
[2]Department of Biology nad Ecology, Faculty of Natural Sciences, Matej Bel University; Tajovského 40, 974 01 Banská Bystrica, Slovak Republic
[3] State Nature Conservation of the Slovak Republic, Malá Fatra National Park Directorate, Hrnčiarska ul. 197, 013 03 Varín, Slovak Republic

Abstract
The Cultural Ecosystem Services provide recreational, educational, spiritual and aesthetic benefits to people. The prime areas for natural-based tourism (and other forms of recreation) are evidently those that are legally protected, since they offer the best guarantee for maintaining their attractiveness in the long term. Indeed, the authenticity and quality of an environment, or of some particular feature of it, is frequently the primary motivation for tourists. The landscape of Malá Fatra National Park is very attractive for tourists due to the very diverse geological substrate, with changing varied minerals of different erodoproofness, in shallow layers, which leads to a high diversity of relief. Smoothly modelled shapes of core granites and quartzites are changing with morphological depressions in marls, shales, and sandstones. In contrast, upon limestones and dolomites of Triassic age, karst phenomena have developed including canyons, chasms, gorges, caves, towers, cliffs, etc. A representative example of high landscape attraction for tourists is Vrátna Valley, with small settlement Štefanová. The surrounding landscape of this settlement was for the long term used for agriculture. Traditional management of mountain meadows was based on grass cutting once per year and on extensive usage of pastures for sheep and cattle grazing. Since 1990 these meadows were given back to their original private landowners because of restitutions. However, during last years majority of these landowners have no more managed these meadows (also due to economic reasons). In abandoned meadows started dendroflora succession and landscape in Vrátna Valley is changing in front of our eyes. In 2014 the scientific team of Matej Bel University in Banská Bystrica resumed the bio-ecological research in Vrátna Valley to detect changes in biodiversity and ecosystem structure on a long temporal scale. Special attention will be given to dendroflora succession on meadows, which changes also the landscape character and biodiversity structure.

Key words: ecological succession, cultural ecoservices, ecotourism, recreational activities, abandoned meadows, Malá Fatra National Park

Introduction

Ecosystem services are the benefits that people obtain from ecosystems. These include provisioning, regulating, supporting and cultural services. Provisioning services provide direct ecosystem products (e.g. crops, fruits, game and fishes, fuel, wood, fibre, water, genetic and medicinal resources). Regulatory services provide benefits from regulation of ecosystem services (e.g. regulation of climate, soil protection, pollination). Cultural services denote non-material benefits (e.g. aesthetic, recreational, scientific, educational and spiritual benefits). Supporting services are crucial for safeguarding life on the Earth (e.g. soil formation, photosynthesis, nutrient cycling, habitats for biodiversity).
The human species, while buffered against environmental changes by culture and technology (to a certain extent), is fundamentally dependent on the flow of ecosystem services. The conceptual framework for the Millennium Ecosystem Assessment posits that people are integral parts of ecosystems and that a dynamic interactions exists between them and other parts of ecosystems. The growing anthropogenic pressure approaches or overshoots the biosphere limits (Rockström et al., 2009) and drive, both directly and indirectly, changes of ecosystems, thereby causing changes in human well-being (Millennium Ecosystem Assessment, 2005).
The total global value of the whole ecosystem services in 2011 was calculated to 125 trillion of USD (Costanza et al., 2014). However, we face the degradation of the 60 % of global ecosystem services (Millennium Ecosystem Assessment, 2005). Although the Millennium Ecosystem Assessment emphasizes the linkages between ecosystems and human well-being, it recognizes that the actions people should take that influence ecosystems result not just from a concern about human well-being but also from considerations of the intrinsic value of species and ecosystems. Intrinsic value is the value of something in itself and for its own sake, irrespective of its utility for people.

High biological complexity of organisms and ecosystems causes that changes in drivers that indirectly affect biodiversity (e.g. growth of the human population, consumption, change of the lifestyle and technology), can alter also drivers directly affecting biodiversity (e.g. land.use change, pollution, overexploitation, invasive species and climate change). These result in changes to ecosystems and the services they provide, thereby affecting human well-being. The causes of changes in biodiversity and the ecosystems include, for example, changes in traditional local land use and land cover. After leaving the traditional method of using agricultural land in Vrátna Valley started ecological (mainly dendroflora) succession, which changes landscape characteristic and biodiversity of ecosystems.
In terms of the recreational use, Malá Fatra Mts.became in the 20thcentury the second most attractive mountain areas in Slovakia (the first one arethe High Tatras). Vrátna Vallley has become the center of summer and winter recreation and mountain tourism. This valley includes also the permanent settlement Štefanová actually consisting of about 30 families. From the 19th century surroundings of this settlement were used only for farming – sheep and cattle grazing and mowing meadows. The transfer ofownership of landto the original owners after 1990 and also economic depression of the Slovak agriculture led to the abandonment of traditional agriculture and orientation to tourism led to the rebuilding of housesfor recreational purposes. On the abandoned meadows and fields secondary vegetation succession began, shrubs first and the trees later. This caused a subsequent change in biodiversity of ecosystems and characteristic features of traditional agricultural landscapes.
The attractiveness of the recreation area for a long-term recreation is valued according to weighted proportions of the following recreation factors: climate, water (esp. waterfalls), rugged topography (according to altitude, surface formation and presence of rock and caves), organic life (forest cover, vegetation, wildlife), national monuments, and – in negative sense – pollution and other forms of habitat degradation, e.g wood cutting, soil erosion on touristic trails and trampling of vegetation (Papánek, 1972, 1974, 1975, 1978). All this factors are significant for Vrátna Valley.

Study area
The westernmost mountainous area of the Western Carpathians is Malá (Small) Fatra, which is divided into 2 subunits: Krivánska Fatra and Lúčanská Fatra (Midriak, 2003). The Malá Fatra orographical complex is the third highest in the Western Carpathians after the High and Low Tatras. It is located in north-western part of the Slovak Republic. In 1967 the Krivánska Fatra Mts were declared as Landscape Protected Area (LPA) Malá Fatra (Pagáč, Vološčuk, 1983), and in 1988 this area was declared as the Malá Fatra National Park (NP). The territory of the NP is approximately equal to the Krivánska Fatra orographic complex. The area of the NP is in the shape of an asymmetric ellipse with the length about 26 km and the width about 12,5 km. The total area of the national park territory is 45 892 ha. The core zone is spread over 22 630 ha, whereas the area of the peripheral protection (buffer) zone is 23 262 ha The elevational range of the NP is from 358 m (Hradský potok stream) up to 1709 m (peak Veľký Kriváň). There are 30 strict protected areas (nature reserves) in Malá Fatra NP. The complex geological evolution, the great variety of relief and a full range of altitudes with bright micro and mezo climatic ratios, necessitated a great variety and richness of flora and fauna (Vološčuk, 1999).
Scientific research of Krivánska Fatra Mts. landscape and ecosystems dates back to 18 century. Deepening scientific research occurred in the 19th and 20 th century (Pagáč, Vološčuk et al., 1983). In 1972 – 1974 the former Administration of Malá Fatra LPA organized the complex landscape ecological research. The results of research were published in the scientific monograph (Janík, Stollmann et al., 1988). In the years 1970 - 1988 the Administration of Malá Fatra LPA organized inventory research of all natural reserves in LPA with the aim to apply and transform scientific knowledge into practical management of ecosystems. In 1995 - 1998 Department of Forest Ecology of the Slovak Academy of Sciences in Zvolen realized Grant project No. 95/5305/590 GAT "Quantification of anthropogenic load regions Mala Fatra on biotic and abiotic indicators and biodiversity" (Korňan, 1998).
In 2014 the research teamwork of the Research Institute of Landscape and Regions of the Faculty of Natural Sciences, Matej Bel University in Banská Bystrica, started in Malá Fatra NP a scientific research within the framework of grant project VEGA No 1/0255/14 "The dynamics of landscape structure, diversity of phytocoenoses and indication of solar energy dissipation in selected ecosystems of the Malá Fatra National Park" planned for the years 2014 - 2016.
The repeated landscape-ecological and forest and non forest geobiocoenological research of Malá Fatrais focused on two landscape-ecologically different areas. The first area are unique limestone-dolomite complex ecosystems in National Nature Reserves of Vrátna Valley (Rozsutec, Chleb, Tiesňavy) with adjacent grasslands and communities in altitudinal range of 600 to 1 610 meters. The second group is the geobiocoenoses of crystalline rocks (granodiorite) in the western part of the Malá Fatra, altitudinal range from 360 to 1369 mabove see level.

Materials and Methods

The research areas are situated on meadows surroundings of the Štefanová settlement and on forest beech ecosystems of Rozsutec National Nature Reserve, situated in successional stages of optimal and aging. The ecological studies on grassland communities focused on mown meadows and non-mown meadows located above the village Štefanová, at the foot of National Nature Reserve Rozsutec. In high diapas on meadows merge in to the original beech forests with spruce and maple. Phytosociological records (forest plant communities in an area of 20x20m) collected summer aspect of forest and non-forestplant communities. Phytosociological relevés were performed by the conventional methods of Zürich-Montpellier school (Braun-Blanquet, 1964; Westhoff, van denMaarel, 1978). Abundance and dominance of the vascular plant species were noted according to the modified 9-membered Braun-Blanquet scale (Backman et al., 1964). In the botanical entries of grassland communities helped Dr. Anna Dobošová, botanist of Malá Fatra National Park.

In the forest communities three layers were distinguished-herbaceous layer E1, shrub layer E2 (1-3 m) and tree layer E3 (height more than 3 m). The results were analysed in EXCEL and JUICE programmes (Tichý, 2002). The names of plant species are listed by according to Marhold and Hindák(Marhold, Hindák, 1998). In this paper only partial results of research in the summer 2014th are presented. The analysis of phytosociological relevés enables to describe the temporal changes in vegetation, and to assess the environmental changes based on indirect information provided by the Ellenberg indicator values (Križová, Nič, 1997).

During ecological succession the complexity of the ecosystem increases. Our methodologyof the ecologicalcomplexity assessment isbasedonevaluation of both of its functional and structural dimensions. This includes the assessment of the relativecapacity of individual ecosystems to dissipate solar energy as well as the calculations of species diversity and anthropophytisation of vegetation (Jörgensen, Svirezhev, 2004; Sabo et al., 2011). As the capacity of solar energy dissipation (SED) by ecosystem depends also on other environmental factors (esp. on the flow of solar energy, air and soil temperature and humidity), the SED of individual ecosystems can be compared only if the measurements are realized parallelly and in blocks of relatively stabile anticyclonal weather.

Our research project VEGA is focused also on dendroflora succession in non-forest ecosystems (meadows) on derelict and abandoned meadows and on bio-ecological assessment of extent of promotion or expansibility trees, by the way the timber growing (Vološčuk et al., 2011). The data will be used in order to forecast trends and changes caused by changing of ecological conditions.

The Vrátna Valley in Malá Fatra NP in terms of tourism is a very attractive area. The research on framework of VEGA project in 2015 – 2016 will focus on analysis of the current state of tourism pressure on conservation and then to predict the future development of tourism in order to support the potential of ecotourism for sustainable development of the region.

Results and Discussion

Ecological characteristics of meadows in Vrátna Valley near Štefanová settlement expressed by Ellenberg ecological numbers is shown in Table 1.

Tab. 1: Ecological characteristics of the first studied meadow patches near Štefanová

The site / Ellenberg number	1 Light	Warm	Continen -tality	Moisture	Soil reac-tion (pH)	Nutrients
Mowed meadow site (S1 – 49 °14 '10,9")	7,4	4,6	3,6	5,0	6,4	4,6
Reliability (average proportion of plants evaluated with an Ellenberg number)	0,97	0,31	0,87	0,88	0,69	0,84
Unmowed meadow site (S2)	7,2	5,0	3,9	5,5	6,5	4,6
Reliability of Ellen. numbers calculation (relat. abund. of the evaluated taxons)	0,93	0,55	0,79	0,74	0,57	0,79
Beech forest site (S3)	4,3	4,7	3,7	5,3	6,8	5,4
Reliability of Ellen. numbers calculation (relat. abund. of the evaluated taxons	47	31	43	41	30	41

S1: Shannon - Wiener index: 3,28; Evenness: 0,83; Species richness: 53
S2: Shannon - Wiener index: 3,46; Evenness: 0,87; Species richness: 54
S3: Shannon - Wiener index: 2,87; Evenness: 0,74; Species richness: 49

In the case of abandonment of traditionally mowed meadows the spontaneous succession can be assumed during which grasslands are gradually overgrown by shrubs and trees (beech, maple, fir, spruce less) and former meadows are transformed into forests. Perhaps it can be seen on the

example of former meadows of Štefanová that after leaving cutting 40 years ago, mostly overgrown with spruce mixed in maple and beech. As can be seen from table 1 succesion includes a shift of the phytocoenoses composition towards species requiring more nutrients.
The ecological characteristics of natural beech forest expressed by Ellenberg ecological numbers is shown in Table 2.

Tab. 2: Chemical analysis of Cambisol on marly limestones in beech forest research plot S3 (Vološčuk, 1981)

Depth cm	Soil reaction pH/H_2O	C %	N %	C/N
0 – 3	6,10	-	-	-
3 – 15	7,18	4,97	0,386	12,8
30 – 40	7,88	2,33	0,182	12,8

Ecological succession can be explained by means of the non-equilibrium thermodynamics theory (Kay, 2000). According to it, in the sense of the 2nd Law of Thermodynamics an ecosystem „is compelled“ to react to the growing supply of nutrients and energy accumulated during succession in biomass and in soil. This growth of the supply of available energy leads to the spontanneous development of more complex dissipative structures and dissipative processes (Jörgensen, Svirezhev, 2004). This includes spontaneous change of the biocoenosis composition with the „aim“ to increase its capacity to dissipate both incoming solar energy and accumulated one (in the form of organic compounds) through new pathways. This is the way to renew the ecosystem energetic balance and is reflected also in the increase of the proportion of K-strategists (on the cost of r-strategists decline) and increase of the size of the gilds on higher trophic levels, due to higher amount of energy accumulated on lower trophic levels (Würtz, Anilla, 2010).
Overgrowing by trees and change of meadows into forests has no direct negative impact on recreational land use. However, saving at least some of the abandoned species rich meadows (below the timberline) will contribute to development of new, soft ways of tourism, esp. ecotourism, based on environmentally friendly trips into wildlife (Ceballos – Lascuráin, 1996). Apart from the increased quality of the authentic tourist experience, ecotourism supports also wildlife protection and economy of local communities.
Succession processes of shrubs and trees on abandoned pastures can be evaluated from two aspects. Scientific environmental aspect involves a different view of botanists and foresters. From a botanical scientific point of view overgrowing meadows shrubs and trees causes a reduction in herbs and grasses biodiversity. This can have a negative impact on the cultural ecosystem services. Tourists mostly positive perceive a colorful spring and summer aspect of the foothill grassland communities, because it produce positive aesthetic experience. This aspect also show text on panels of educational nature trails throughout the Vrátna Valley. On one of the panels is the text “I am plucked a flowers and they strife, I caught a butterfly and died in my palm, I understand that beauty can be touched only with the heart”. From the perspective of botany and recreational tourism is overgrowing trees of meadows aegative phenomenon. A similar view has Dobošová on the succession in the sub-alpine meadows of Mala Fatra (Dobošová, 2002).From the point of view of the forest overgrowing of abandoned meadows is natural successional process, which aims to forest climax. In terms of recreation is very important to the tourist trail was a good view of the attractive landscape with dominating cliffs, ridges, waterfallsand canyons.
Forestry ecologists perseived positive transformation of meadows to forsts because of the increased resilience of ecosystems. Botanically researchers point out, however, negative effect of reduction of biodiversity. The gradual overgrowing of grassland areas by trees results in a substantial change in the diversity of the herb layer. This is, however, recognized only by scientists and experts. Tourists in their “short term view” mostly do not see a change of grassland space in to forests as something negative. However, there are studies that manlooking at the landscape suits just an open space with flowering meadows, which are for the average touristits charm. In terms of tourism, it is necessary esp. to recalla very bad state of hiking trails (severe erosion, shortening paths, bare rooted trees, trampling of vegetation) in some parts of the Small Fatra National Park and its national nature reserves.

Conclusion

In this paper we present a gradual change of grassland communities into forests due to abandonment of mowing and grazing by local people of Štefanová village. The theory of non-eqilibrium thermodynamic teaches us that abandonment of the management of the meadows below the timberline necessarily leads to ecological succcesion, the main driving force of which is the energy which accumulates in the biomass of abandoned meadows. This process is in the current socio-

economic situation unstoppable because the people of the Štefanová settlement no longer use their land for agriculture but are focused on tourism development.
Effect of succession of dendroflora in the abandoned meadow communities sharply changes the diversity of herbaceous communities. But currently it does not havea high negative impacton the capacity of cultural ecosystem services-the aesthetic perception of landscape, recreation, leisure, exploring enormously interesting karst relief of gorges and rocky towns, etc. However, also the interest in nature tourism is growing (and is expected to grow) and its sustainable soft form is represented just by ecotourism. From this point of view, the complete loss of species rich seminatural meadows below the timberline would mean also a decrease of available options for future ecotourism trails in the area. Therefore we recommend the local inhabitants, the municipality in Terchová and the tourist agencies to join their capacities and to safeguard mowing of meadows at least on a small and economically feasible proportion of these meadows. This would be an investment both to biodiversity protection as well as to the ecotourism development in the area.

Acknowledgement
Thanks to the support of the project VEGA No 1/0255/14The dynamics of landscape structure, diversity of phytocoenoses and indication of solar energy dissipation in selected ecosystems of the Malá Fatra National Park.

Souhrn
Kulturní služby ekosystémů představují pro člověka rekreační, výchovný, duchovní a estetický užitek. Primárními územími pro přírodní turistiku (a také jiné formy rekreace) jsou evidentně ta území, které mají právní ochranu, protože poskytují nejlepší záruku zachování jejich atraktivity v dlouhodobém horizontu. Pro turistiku zpravidla jsou prvotní motivací autenticita a kvalita přírodního prostředí, nebo některých jeho složek. Krajina Národního parku Malá Fatra je pro turistiku velmi atraktivní díky velké rozmanitosti geologického podkladu, s velkým počtem hornin různé odolnosti vůči erozi, s velkou rozmanitostí povrchových tvarů a vysokou biodiverzitou. Na podloží slínů, břidlic a pískovců se vyskytují měkce modelované povrchové tvary. Na vápencích a dolomitech jsou vyvinuty atraktivní krasové jevy (kaňony, soutěsky, propasti, jeskyně, kamenné věže, mohutné soutěsky, kužely a pod.). Reprezentativní ukázkou atraktivní země pro turisty je Vrátna dolina s malou osadou Štefanová. Okolí této osady se dlouhodobě využívalo na zemědělství. Tradiční management těchto horských luk byl soustředěn na sečení luk jednou ročně a na extenzivní pasení ovcí a dobytka. Po roce 1990 v rámci restituce tyto louky a pole byly vráceny původním vlastníkům. V posledních desetiletích je však vlastníci pozemků nevyužívají tradičním způsobem (příčinou jsou i ekonomické podmínky). Na opuštěných loukách a pastvinách se začala šířit dřevinná vegetace a krajina Vrátné doliny se na mnoha místech očividně změnila. V roce 2014 tým vědců Univerzity Mateja Bela v Banské Bystrici v rámci vědeckého grantu začal uskutečňovat bioekoliogický výzkum ve Vrátné dolině, zaměřený na studium sukcese dendroflórou na opuštěných loukách v okolí osady Štefanová, která způsobuje změnu krajinného rázu a struktury biodiverzity.

References
Barkman, J.J., Doing, H., Segal, S., (1964): Kritische Bemerkungen und Vorschlänge zur quantitativen Vegetationsanalyse. In Acta Bot. Neerl., 13, p. 349 – 419.
Braun-Blanquet, J., (1961): Die inneralpine Trockenvegetation; von der Provence bis zur Steiermark. Gustav Fischer Verlag, Stuttgart.
Braun.Blanquet, J., (1964): Pflanzensoziologie. Grunzuge der Vegetationskunde. Ed. 3. Springer-Verlag, Wien, New York, 865 pp.
Ceballob - Lascurain, H., (1996): Tourism, ecotourism and protected areas, IUCN, The World Conservation Union, Gland, 301 pp.
Costanza, R., De Groot, R., Sutton, P., Van Der Ploeg, S., Anderson S.J., Kubisyewski, I., Farber, S., Turner, R.K., (2014): Changes in the global value of ecosystem services. Global Environmental Change, vol. 26 (May 2014), s.152-158.
Ellenberg, H., Weber, H.E., Dull, R., Wirth, V., Werner, W., Paulissen, D., (1992): Zeigerwerte von Pflanzen in Mitteleuropa. Scripta Botanica XVIII. Verlag Erich Golze, Göttingen, p. 90 - 166.
Janik, M., Štollmann, A. (eds.), (1981): Rozsutec štátna prírodná rezervácia. Vydavateľstvo Osveta Martin1132 pp.
Jorgensen, S.E., Svirezhev, Y.M., (2004): Towards a Thermodynamic Theory for Ecological Systems. Elsevier, Oxford, United Kingdom, 366 pp. ISBN 0-08-044166-1

Kay, J. J., (2000): Ecosystems As Self-Organizing Holarchic Open Systems: Narratives and the Second Law of Thermodynamics, In: Jorgenses,S.E., Müller, F. (eds): Handbook of Ecosystem Theories and anagement, CRC Press –Lewis Publishers, p. 135-160.
Kornan, M. (ed.), (1998): Výskum a ochrana Krivánskej Fatry. Technická univerzita vo Zvolene. ISBN 80-968107-2-3.
Križová, E., Nič, J., (1997): Fytocenológia a lesnícka typológia. Návody na cvičenia, Zvolen: Technická univerzita, 106 pp.
Marhold, K., Hindak, F. (eds.), (1998): Zoznam nižších a vyšších rastlín Slovenska. Veda, Bratislava, 687 pp.
MILLENNIUM ECOSYSTEM ASSESSMENT, (2005): Ecosystem and Human Well-Being. Synthesis. Island Press, Washington, DC.
Midriak, R. (ed.), (2011): Spustnuté pôdy a pustnutie krajiny Slovenska. Inštitút výskumu krajiny a regiónov, Centrum vedy a výskumu, Univerzita Mateja Bela, pp. 184 – 213.
Midriak, R., (2003): The Mountain Areas of the National Parks in the Slovak Republic. The Monographical Studies on National Parks , 4. Technická univerzita vo Zvolene, 58 pp. ISBN 80-228-1357-5.
Pagáč, J., Vološčuk, I. (eds.), (1983): Malá Fatra chránená krajinná oblasť. Vydala Príroda, Bratislava, 356 pp.
Papánek, F., (1972): Rajonizácia lesov podľa ich rekreačnej funkcie. Záverečná správa VÚLH Zvolen. Archív VÚLH vo Zvolene.
Papánek, F., (1974): Ocenenie rekreačnej funkcie lesa. Vedecké práce Výskumného ústavu lesného hospodárstva, 19, Príroda, Bratislava, 231-256 pp.
Papánek, F., (1975): Rekreácia ako environmentálny úžitok lesa. Lesnícky časopis č. 2/1975.
Papánek, F., (1978): Teória a prax funkčne integrovaného lesného hospodárstva. Lesnícke štúdie č. 29. Vydala Príroda, Bratislava pre Výskumný ústav lesného hospodárstva vo Zvolene, 218 pp.
Rockstrom, J., Steffen, W., Noone, et al. Planetary Boundaries: Exploring the Safe Operating Space for Humanity.Ecology and Society 14(2). 32 s.
Sabo, P., Turisová, I., Uhliarová, E., Švidroň, I.,Hladká, D., (2011): Ekologická integrita ekosystémov a krajiny a jej zmeny na vybraných spustnutých pôdach a zalesnených plochách. In
Tichý, L., 2002. JUICE, software for vegetation classification. Journal of Vegetation Science, 13:451–454.
Vološčuk, I. (eds.), (1999): The National Parks and Biosphere Reserves in Carpathians. The Last Nature Paradises. ACANAP Tatranská Lomnica, 248 pp. ISBN 80-88680-31-X.
Vološčuk, I. et al., (2011): Dynamika sukcesných procesov dendroflóry, štruktúry a ekologickej integrity ekosystémov Slovenského krasu. Univerzita Mateja Bela, 340 pp. ISBN 978-80-557-0296-4.
Westhoff, V, Van Den Maarel, E., (1978): The Braun-Blanquet approach. In: Whittaker, R.H. (ed.). Classification of plant communities, W Junk, The Hague, p. 289 – 399.
Wurtz, P., Anilla, A., (2010): Ecological succession as an energy dispersal process. Biosystems, 100 (1), 70 – 78.

Contact:
Prof. Ing. Ivan Vološčuk, DrSc,
E-mail: ivoloscuk@azet.sk

Ing. Peter Sabo, CSc,
E-mail: peter.sabo@umb.sk

RNDr. Martina Škodová, PhD,
E-mail: martina.skodova@umb.sk

Ing. Juraj Švajda, PhD,
E-mail: juraj.svajda@umb.sk

RNDr. Anna Dobošová
E-mail: anna.dobosova@sopsr.sk

Annexes

Fig. 1: Meadows around Stefanová serttlement in Vrátna Valley

Fig. 2: Mowed (right) and nonmowed (left) meadow

Fig. 3: Succession of dendroflora on nonmowed meadow

Fig 4: Succession of spruce on subalpine meadows in Medziholie saddle under Veľký Rozsutec peak

Fig. 5: Climax Beech Forest under Veľký Rozsutec peak (research area S3)

Fig. 6: Bad state of hiking trails –bare rooted trees

Fig. 7: Erosion on hiking trail

THE RESTORATION OF AN OLD EXTENSIVE ORCHARDS - THE REALIZATION PERSPECTIVE

Jan Deutscher
Department of Landscape Management, Faculty of Forestry and Wood Technology,
Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic

Abstract
The current European Operational Programs in environmental conservation and protection available in the Czech Republic for the past 5 years significantly affected the selection of implemented measures. Among the supported environmental friendly measures was the restoration of old extensive orchards. This brought up many questions as well as challenges on how to best address the issues connected with the projection, planning and implementation of the renewed orchards all finally leading to the restoration itself. It also showcased the rather unpleasant current state of these often abandoned landscape features. Using own experience with the creation of such orchards, the author discusses the aims of their restorations, their traditional as well as recent usage but most importantly, the staging of the restoration itself like ground preparation, turf establishment, tree planting and tree protection. Finally potential aftercare and maintenance is presented.

Key words: European Operational Programs, tree planting, orchard maintenance

Introduction

The traditional orchards where often founded on communal land and were managed by the municipality. They would be founded on steep slopes, in rough terrain or other places not suitable for agriculture. Therefore, the shape of old orchards was often small irregular and somewhat nature-like. As opposed to productive orchards, trees would be used in standard (or half-standard) forms with trunks of 2 meters or more to ensure longevity. Oftentimes, the municipality would rent individual trees in a public auction each year to the people who would then take care of the trees in their own way, being able to sell or use the fruit from the tree as their own. This way the whole community would participate in the management of the orchard and the orchard would become a permanent source of income for the municipality and the people alike. Certain families or individuals would hire the same tree each year. This way, important bonds would be formed by the people to the landscape. The sward of the orchard floor would be oftentimes used for either grazing grounds for cattle or as a source of hay, therefore repeated management measures would be carried out somewhat unconsciously, yet functionally. The trees would get pruned by their tenants and the sward would be mowed or grazed. This way, traditional extensive orchards have become a semi-natural habitat that has played an important integral role in the rural landscape for centuries as a source of livelihood, aesthetic and cultural value, recreation, biodiversity and in many cases erosion control (Ekodomov, 2012, Barašová, 2013).

A big portion of the traditional orchards have been abandoned and neglected in the last 20-30 years in the Czech Republic (CR), following the changes in 1989 (The Velvet revolution). The reasons are many, mostly connected to the instability of the political regime leading to shattered land ownership and breakage of the bonds people formed to the landscape, people refusing to live on the countryside and moving to cities as a result of change in the social paradigm. Nonetheless, abandoned orchards are a common thing in the current countryside. The condition of the neglected orchards and its trees may vary. Usually after 20-30 years of spontaneous natural development, the old fruit trees are swamped by dense thicket of scrub (rose *Rosa canina*, hawthorn *Crataegus monogyna*, blackthorn *Prunus spinosa*, hazel *Corylus avellana* etc.) or shadowed by fast-growing forest tree species (Aspen *Populus tremula*, field maple *Acer campestre*, hornbeam *Carpinus betulus*, ash *Fraxinus excelsior* and other species). The restoration is therefore a rather complex task often requiring a lot of ground works and mechanization. Careful assessment is vital for deciding what management measures should be undertaken in order to restore the orchard. However, they should always include the management of the old trees, planting new trees and the management of the orchard floor and any other important features such as hedgerows, ponds etc.

With the introduction of European operational programs in 2007, a paradigm shift took place in what is actually possible to carry out in the landscape. Before this “age of grants” the activities of nature protection and conservation were mostly limited to special protected areas. In 2007, the open landscape became the playground of choice, thus enabling to finally take care of old abandoned landscape formation, such as old extensive orchards.

Materials and methods

As stated above, the original purpose of the orchard was mostly fruit production along with grazing. However, this might not be the case when restoring it. It is important to take into account the future usage of the orchard. Usually it will be a combination of modest fruit production and grazing possibilities, preservation of its aesthetic, historical and cultural value and nature protection. Any human activities such as bee-keeping, haymaking, juice production should be welcomed and supported. All of this will help the orchard to "stay alive" and not be neglected again. The aims and objectives will likely affect the way the whole restoration goes, types of tree planted, management of old trees, fencing, tree guards etc.

Once the assessment has been done and aims have been defined, the restoration should proceed in following stages: 1. Orchard floor preparation, 2. Old tree management, 3. Turf establishment, 4. Tree planting, 5. Maintenance

Orchard floor preparation

Orchard floor preparation includes all the works needed to obtain a clean-tilled orchard floor for future turf establishment and tree planting. It consists of eradication of unwanted tree species and scrubs and tillage to achieve a flatter orchard floor (Herrera, 2005). The fruit trees need a special micro-climate with sufficient sun and air. Even though, some shrub species might be of botanical or wildlife interest, those should be only confined to grow in the peripheral parts of the orchards along its edges. Amongst the fruit trees all shrubs and other vegetation should be removed. Practice shows that it is possible and very efficient to burn the wood material on the spot as long as there are open spaces in the orchard where the fire can burn without damaging the fruit trees. Very important is to remove all the belowground parts of shrubs as well to prevent them from coppicing. Coppicing of stumps is a rapid process in the 3-5 years after thinning and can cause huge problems with proper turf establishment and orchard management and requires demanding field work which is both pricy and time consuming. Also if the cutting of coppice is not carried out periodically it can cause the failure of the whole restoration. The easiest way is to use a forestry mower/mulcher of acceptable size that is capable of preparing the orchard floor up to 20 cm below ground which should be sufficient to prevent the coppicing of stumps and roots. Also, the mulch material is appropriate for following turf establishment.

Old tree management

Old trees take a long time to grow and their aesthetic, cultural and historic value increases over time. It can be argued that the trees are the most important part of the orchard. Therefore special care should be devoted to them. The trees should be checked individually. However, their condition is very hard to evaluate if located in a dense canopy of overgrowing shrubs and forest trees. Oftentimes, proper assessment is only possible after the orchard floor has been cleared. It is useful to divide the trees into categories according to the type of treatment. It should be sufficient to define trees that will be either cut down or pruned or left as torsos. Most of the trees should be restoratively pruned and remedied if at all possible. However, their expected life span should be taken into account (apple/cherry 80-120 years) (TIN018, 2010). If their potential future is short, close to 10 years, it is reasonable to consider their replacement. At the same time if the trees are damaged by a pathogen or cause a hazard to people and livestock their removal is well justifiable. A nice way of preserving the value of old trees as well as their function as habitat for insects, birds and wildlife as a whole is to leave some dead trees standing as torsos. Branches should be shortened and the tree should be cut lower to minimize the hazard of fall. This way, the tree does not take up much space, yet provides an increased ecological value to the locality.

Turf establishment

In the extensive orchards the turf plays a very important role. Not only is it a level, solid working area for labor and equipment as in productive orchards (Huffman, 2013) but more importantly is a habitat for helpful insects for pest control such as Ladybird *Coccinela* sp., Lacewing *Chrysoperla* sp., Ground beetle *Carabus* sp., Giant Ichneumon *Rhyssa* sp. or arachnids. Therefore it is important to use a mixture of grass and plant species typical for rich florid meadows (Ekodomov o.s., 2012). At the same time some fruit tree pests develop on certain hosts which should be avoided, such as reed *Phragmites* sp., hops *Homulus lupulus* (Pultar, 2007). The best time to plant grass seed is early fall. Ideally, the grass seed should be planted on a wetter day after all mechanization has finished to avoid compaction and rutting to obtain the best possible conditions: a proper seedbed, cooler temperatures, and good soil moisture.

Tree planting
Tree planting should be carried out according to the legislative framework by the norms ČSN DIN 18 915 -18 920 Sadovnictví a krajinářství (horticulture and landscaping). It is important to choose appropriate planting material. It is most suitable to use the same tree forms and species and planting pattern as in the original orchard, usually standard- or half-standard-form trees. That way the continuity of the orchard is ensured and the restoration can be gently integrated in the landscape. The key action remains proper tree guard. There are a number of options and each of them has its limitations. As usual, a combination of several attitudes brings the best results. Where it is reasonable, standard forestry fencing should be used. It is the best possible protection against big game and roe-deer in the early years after planting and can be easily removed after the danger has passed (approximately 5 years). However, the fence does not protect against another important species, the hare is capable of jumping right through the fence. Therefore individual tree protection is also required. Also, the young trees need to be protected from weed, most importantly during the first 3 month after planting. To ensure a big enough weed-free area around young trees, mulching can be used as it suppresses weeds as well as keeps moisture in the soil.

Maintenance
The maintenance can be divided into two parts, maintenance of the turf and maintenance of the trees. According to the objectives and purposes of the restored orchard defined before its restoration, the maintenance may differ as well. Nonetheless, the grass will come up 2-3 weeks after a good rain and it is important to start the first mowing early enough to prevent weed escapes from choking out the grass and/or going to seed. Following this early period the turf should be mowed repeatedly and periodically 2 times a year. The time of the mowing should correspond to the mixture of the species in the turf to allow full flowering of the species. The maintenance of the trees in an extensive orchard has its own specifics. The pruning should maintain the balance between the needs of the tree and the organism living in it. The pruning should not be done too often rather the tree should be left to grow according to its own nature. However maintenance pruning should be carried out to remove dead or damaged parts of the tree, when showing obvious signs of disease, decay etc. It is best if the pruning is carried out in the long-term repeatedly every once 3-5 years, rather than heavy pruning in a one-off hack, which may result in over-pruning and damage to the tree vitality (Boček, 2008).

Results
With the current changes and paradigm shifts to both the society and the grant politics of European Union the attention in nature protection and conservation in the CR turns to the open landscape scale. This means that it is reasonable to expect an increased attention of stakeholders (mainly municipalities) towards old extensive orchards as one of the most interesting landscape features in the countryside. Many of the old orchards have been neglected and abandoned in the last 20-30 years. Because of the current high demand for building sites and arable land it will probably not be too common to create new orchards, rather the restoration of old abandoned ones will be demanded. While the original purpose of the extensive orchards was mostly fruit production along with grazing, it will probably not be the exact same case when restoring it. Usually it will be a combination of modest fruit production and grazing possibilities, while at the same time the preservation of its aesthetic, historical and cultural value and nature protection. Any human activities such as bee-keeping, haymaking, juice production should be welcomed and supported. All of this will help the orchard to “stay alive” and not be neglected again.
Before any restoration activities take place in the orchard a thorough assessment should be elaborated. During this assessment the expected purposes of the restored orchard should be defined so that they can be properly addressed during the restoration process. The restoration process itself consists of consecutive steps. The first step is the orchard floor preparation. The easiest way is to use forestry mower/mulcher of acceptable size that is capable of preparing the orchard floor up to 20 cm below ground which should be sufficient to prevent the coppicing of stumps and roots. Secondly, after the orchard floor has been prepared, proper assessment of trees is enabled. It is useful to divide the trees into categories according to the type of treatment. It should be sufficient to define trees that will be either cut down or pruned or left as torsos. Next step is the turf establishment. It is important to use a mixture of grass and plant species typical for rich florid meadows to enable a nature-like vegetation to grow underneath the trees to support the habitat for helpful insects for pest control. Tree planting should follow according to the legislative framework by the Czech standards for horticulture and landscaping. It is vital to use proper tree guard against game damage and mulching against weed. The maintenance can be divided into two parts, maintenance of the turf and maintenance of the trees. The turf should be mowed repeatedly and periodically 2 times a year while the pruning of the trees

should be carried out in the long-term repeatedly every once 3-5 years, rather than heavy pruning in a one-off hack, which may result in over-pruning and damage to the tree vitality.

Conclusion

The traditional extensive orchards have become over the years a semi-natural habitat that plays an important integral role in the rural landscape as a source of livelihood, aesthetic and cultural value, recreation, biodiversity and in many cases erosion control. Rather than create new extensive orchard, the restoration of old abandoned orchards should be encouraged and supported. Since a social paradigm shift is happening these days where people are turning back to their origins and traditional land use, the restoration of extensive orchards plays a key supportive role not only in future nature conservation and protection but also as way of maintaining traditions and historic cultural values.

References

Boček S. et al. (2008): Ovocné dřeviny v krajině. Sborník přednášek a seminárních prací. Hostětín, ISBN 978-80-904109-2-3

ČSN DIN 18 915 -18 920 Sadovnictví a krajinářství

Huffman L. (2013): Orchard floor management in new apple orchards. Soil Management For Orchards And Vineyards, OMAF and MRA Factsheet Order No. 92-120. Available at: http://www.omafra.gov.on.ca/english/crops/hort/news/hortmatt/2013/13hrt13a4.htm

Pultar O. (2007): Využití odporu prostředí, biologických a bioracionalních metod k ochraně ovocných dřevin proti škůdcům. In Boček, S. Ovocné dřeviny jako součást dřevinných formací v kulturní zemědělské krajině II. Brno: Mendelova zemědělska a lesnicka univerzita v Brně, 2007. s 46–66. ISBN 978-80-7375-096-1

TIN018 Natural England Technical Information Note. 2010. Traditional orchards: restoring and managing mature and neglected orchards. Natural England, 1 East Parade, Sheffield, S1 2ET.

Souhrn

Zaměření operačních programů Evropské unie během uplynulých 5 let v ochraně přírody a krajiny směrem k volné krajině umožnilo mimo jiné obnovovat staré zanedbané extensivní sady. Z tohoto důvodu je nutné zodpovědět otázky spojené projektováním, plánováním a realizací těchto obnov. S využitím vlastních zkušeností při realizaci obnov opuštěných extensivních sadů autor popisuje možné cíle obnovy sadů, jejich tradiční a současné využívání a zejména jednotlivé realizační kroky při jejich obnově.

Contact:
Ing. Jan Deutscher, Ph.D.
Phone: +420 777 594 967, e-mail: jan.deutscher@mendelu.cz

THE STATISTICAL ANALYSIS OF THE RESILIENCE MODULE

Ortiz de Zarate Gorka, Lenka Ševelová
Department of Landscape Management, Faculty of Forestry and Wood Technology,
Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic

Abstract
The design of each structure and its subsequent life and reliability, in general, depends on many factors. From the properties of structural materials, through the use of the calculation model and the method of determining the characteristics of the material input to the technological application. In each activity some uncertainties and even human error could occur, similarly also in the process of selection and execution of the tests. The most important input data for the design of pavements of rural roads is the resilience module of the subsoil. It is also important to know the phenomena that affect its behaviour and how do they modify it. The uncertainties of the input variables that affect the behaviour of the structure can be respected by using modern numerical simulation methods, which need proper and quality input parameters. This article presents the statistical treatment of resilience module obtained from the CBR test cyclic peformed in the laboratory.

Key words: Cyclic CBR, module of resilience, rural roads, Box-Cox transformation, Spearman's correlation coefficient

Introduction

The Low Volume Roads (LVRs) offer almost endless possibilities for users. They are named as that because the number of vehicles using them is lower than in a conventional road, for the reason that they are located in difficult places to reach where the environmental value is high. Therefore, this type of pavement can offer many possibilities for the users, due to the fact that it can be used by recreational or industrial vehicles, or pedestrians, cyclists etc. But at the same time, they must fulfil with the technical exigencies of the heavy traffic loads as well as with the necessities of the leisure activities.

The performance of the constructions are generally influenced by objective factors, such as type of pavement, dimensioning of the layers, received loads, variation of the mechanical properties of the soil and the moisture. However, there are certain types of uncertainties that must be analysed. These variabilities are collected in the reliability theory, in which three types of uncertainties are discussed: physical uncertainties, where the applied loads, geometry of the structure and properties of the material are analysed; statistical uncertainties and model uncertainties, taking into consideration difference between idealizations used in the model and real behaviour.

In order to design more reliable, durable and effective rural roads, a numerical simulation model was created based on the finite element method (FEM), to analyse various types of uncertainties that affect the behaviour of pavement construction. This type of model requires appropriate input variables, which must be compatible with the material of the model of the FEM method. The main objective is to obtain the elastic modulus of the material, as it is the most important characteristic of the soil input variables. The elastic modulus represents the relationship between load and deformation, and varies depending on humidity and density. Its detailed preparation influences the accuracy of the design.

From all the modules offered by the geotechnical practice, the resilience module (M_R) of the cyclic test was selected, as recommended by ASSHTO (American Association of State Highway and Transportation Officials), which aptly describes the behaviour of the natural material after the application of the load, and at the same time is able to introduce the influence of moisture. In order to get that module, cyclical test CBR test T2 was applied with a constant penetration, according to the Dutch theory (Molenaar, 2009) and test T3,with a constant stress, developed by Mendelu University in Brno (Ševelová, Hauser, 2014; Arbid, Ševelová, 2013).

For the analysis, samples have been taken from 7 rural roads, divided into a minimum of 10 profiles each. 12 samples have been tested from each profile, 6 with optimal moisture and 6 saturated. These gives a total of more than 800 samples analysed.

All samples also have been classified by the Unified Soil Classification Systems (USCS), through a system of tests according to Czech normative (Table 2). Furthermore, the optimal humidity and maximum density were obtained from each sample by using the test Proctor Standard (ČSN EN 13286–2, 2005).

Statistical analysis

The content of this article is focused on the statistical uncertainties. These are dependent of the amount of data available for the analysis and they increase with the absence of information. In the majority of the cases, uncertainties involved in the problem are solved by assigning a probability function with estimated parameters distribution from the information collected and/or based on subjective information or past personal experience. These parameters are dependant of the amount of data collected. For time reasons, as a cyclic test takes about 5 hours to be completed and the quantity of planned tests is really high, only 6 samples have been analysed from each profile, in order todetermine the resilient module M_R.

Before starting with the statistical analysis, a review of the collected data was performed in order to rule out the remote measurements, to eliminate the errors in the preparation of the sample or the ones that could occur during the tests.

Analysis of normality

Once the reject was done, the statistical analysis could start. The first hypothesis was that the distribution of the data should be normal, due to the fact that the difference of moisture and density between samples of the same profile was really low. Therefore, it was decided to use Gauss curve to obtain the probability that had a random chosen data to be within the stabilized limits.

To apply this method, first of all, the average of the resilience module of the 6 samples was obtained, as well as the standard deviation of the data. Once these parameters were obtained the limits were stablished. After looking at the data, it was assumed that a difference of 10% between lower and upper limit would be the most appropriate. So to calculate the settled limits, the values were the 95% and the 105% of the average module. With those parameters chosen, the variable must be typified and the probability, of a random chosen data to be within the confidence limits, calculated. It can be seen in the example of Table 1.

Tab. 1:Example of data collection method and values of Gauss campaign

TYPE OF SOIL	PROFILE / ROAD	DATA OF THE SAMPLES				TEST 2					
		W opt	p max	W real	p real	M_R, CBR2	CAMPAIGN OF GAUSS				
		%	kgm -3	%	kgm -3	MPa	AVERAGE	DEVITION	LIM MIN	LIM MAX	PROBABILITY
G4GM	P-4 / Nove mesto	16,2	1769	15,80	1766	29,57	38,80	17,19	36,86	40,74	8,76
				15,83	1800	31,68					
				14,55	1822	27,65					
				15,84	1818	36,08					
				16,50	1804	69,04					
	P-4 / Kubenka	11,5	1988	11,76	1982	9,46	10,31	2,14	9,79	10,83	18,96
				13,15	1982	12,32					
				12,64	1988	9,25					
				12,78	1970	7,77					
				13,08	1970	12,75					
	P-6 / Kubenka	11,5	1970	10,90	1989	16,90	17,14	2,39	16,28	18,00	28,12
				11,92	1975	21,20					
				11,84	1973	14,00					
				10,67	2004	16,34					
				10,30	2002	16,34					
				11,03	1998	18,05					
	P-7 / Kubenka	12,4	1950	11,82	1910	52,42	45,65	10,65	43,37	47,94	16,64
				12,24	1895	56,05					
				12,55	1894	34,82					
				13,34	1888	35,23					
				11,47	1912	57,15					
				12,03	1907	38,25					

As can be seen in the probability column, the values are quite low. Specifically, and after analysing all data of all roads, the average of the probability is only 18%. Because of that, another type of distribution should be found in order to get closer to the real situation. So to get it, statistic software has been used, called Minitab 16. By means of this tool, different trends that could follow the data have been analysed. For this, the analysis has focused on the distributions: normal, lognormal, exponential, Weibull and Box-Cox transformation.

Once the results were analysed, even though there was not a clear trend for all the soils, it was observed that the Box-Cox transformation would get the highest average probability, specifically 60%, as it is shown in Figure 2. For this reason, it was necessary to analyse this statistical method, since it is quite unknown.

Box-Cox transformation

Box-Cox transformation is a potential transformation used in statistics to correct biases in the distribution, to correct unequal variances and mainly to correct the non-linearity in the relationship (improve correlation between variables). This transformation gets the name of the statisticians George E. P. Box and David Cox (1964).

Very often, it is necessary to transform the data of the variables of a given observation in such a way that it is adapted to comply with the requirement of normality and that approaches the normal distribution to be able to make a statistical analysis or modelling. Since many of the statistical analyses only work under normal conditions, this transformation allows to apply many techniques from statistics, that otherwise would not be valid.

To achieve such normality with lowest error as possible, a fit must be done between a predictor variable and other to predict, by using iterations. This process is called "Box-Cox method" and its formula can be seen in equation (1). In this formula, *x* is the data to transform and *α* is the parameter of change, as *λ*.

$$\tilde{x} = \begin{cases} \dfrac{(x+\alpha)^{\lambda}-1}{\lambda} & \lambda \neq 0 \\ \log(x+\alpha)\lambda = 0 \end{cases} \qquad (1)$$

The aim of the Box-Cox transformation is to convert the variable *x* in such a way that it is $\tilde{x}$ which will be as close as possible to the normal distribution.

Usually the iterative process called "Golden Search" is used. This algorithm starts with the minimum value of lambda established, then the Box-Cox transformation is applied and finally the error is calculated with the previous function. This process is repeated continuously for several lambda values (until the maximum value of lambda is reached) while adjusting the value of it in which the error of the function is minimal.

All this would transform the data in the most optimal way. The last step is to verify whether the transformed variable really gets significantly close to the normal distribution. For this purpose a study of normality has to be done to the initial data as well as to the transformed one, in order to see the difference. It can be seen in the example of Figure 1 that the difference is considerable, due to the fact that in the original data the curve is much more extended and the curve unclear, as can be seen in the Figure 1A. While, in the transformed data, Figure 1B, the handing out is much more concentrated around the average, so the distribution is clearly more reliable.

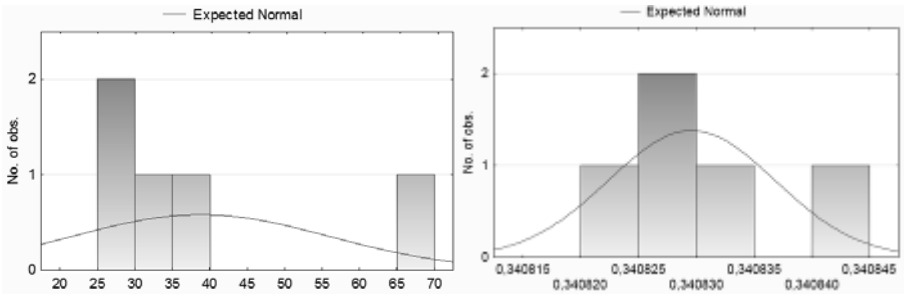

Fig. 1A: Distribution of the data without transformation

Fig. 1B: Distribution of the data after the Box-Cox transformation

Once it is observed that the distribution is closer to the normal, the statistical analysis with the new data could be carried out. Specifically, the most suitable average of the module has to be found. For that purpose the average of the transformed variable must be found because it would be the value that better represents the behaviour of the soil of that profile. With the average obtained, by using the inverse of the Table 1, the value would be transformed to get the real average in the initial scale, MPa (using the value of lambda and alpha obtained).

Spearman's correlation coefficient

Afterwards having done the statistical calculus to get the M_R value, the relationship between module and the effects of moisture and density was found. The relationships between these parameters were obtained by the Spearman's correlation (ρ) (Bonett DG, Wright TA, 2000).

This coefficient is a measure of correlation between two continuous random variables. To calculate its value the data are ordered and replaced by its respective order. Then the equation (2) is applied.

$$\rho = 1 - \frac{6\Sigma D^2}{N(N^2-1)} \quad (2)$$

Where,
D = difference between the corresponding values of the order x-y
N = number of couples analysed
It ranges between -1 and 1, indicating negative and positive associations respectively. That is, if the correlation is of 1, it would indicate a direct strong correlation, while if it is of -1 the correlation would be reverse and strong. In case the coefficient is of 0, it would represent that there is no correlation.

Results

Results of the analysis of normality

As it is explained above, after having seen that the probability that randomly selected data would be located within the confidence limits was so low (18%), it was decided to discard the procedure of the Gauss curve. Therefore, another distribution that identify better with the data should be found. To do so, some distributions were analysed: normal, lognormal, exponential, Box-Cox transformation and Weibull.

Once the optimal distribution for each profile was found, it was observed that the normal and lognormal distributions had an average probability of around 45%. Conversely, Weibull and exponential average likelihood were of less than 15%. But between all of them the highest average probability was obtained by the Box-Cox transformation, with a 60%. For those reasons the Box-Cox transformation was selected for statistical analysis in order to determine the mean value of the Resilient modulus.

The results of the different odds in each soil profile can be seen in the Figure 2, where in the X axis a number have been given to each profile depending the type of soil, starting with G4GM and finishing with F8CH according to the order shown in Table 2. In the Y axis, the probability values of the analysed distributions are located.

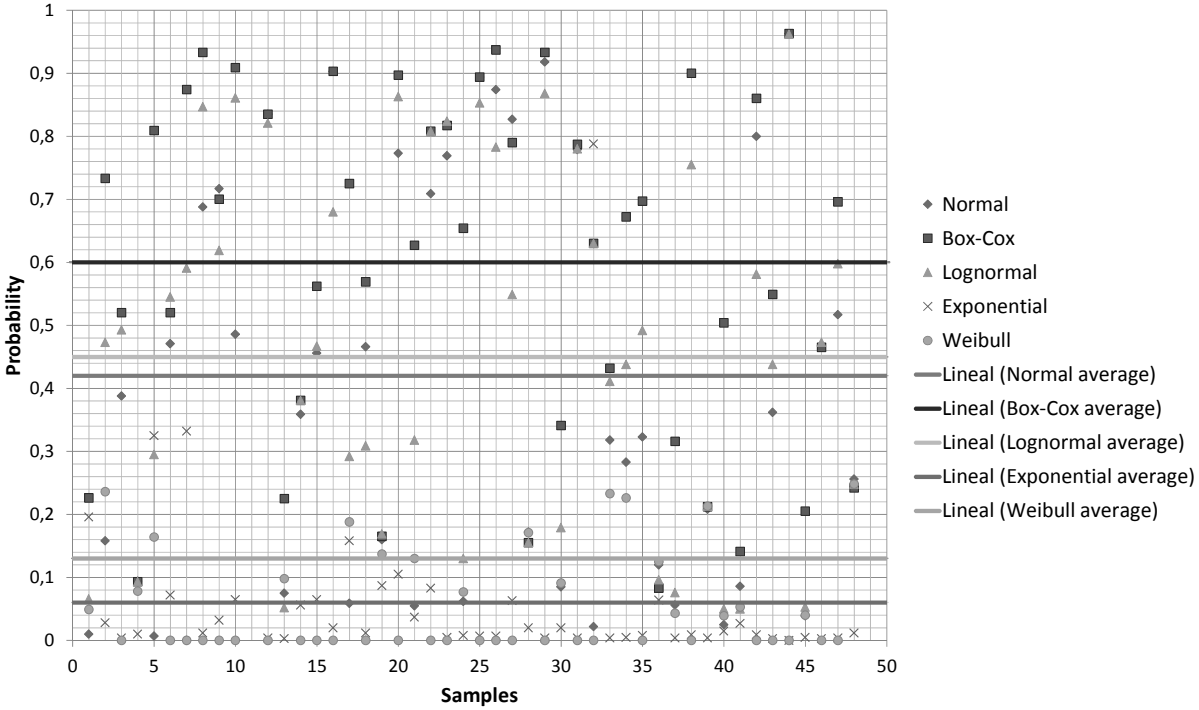

Fig. 2: Probability that the data follow the distributions analysed

Results of the Box-Cox transformation

The Box-Cox transformation is the statistical method that can get the best values of mean resilience module. This is because the probability of a randomly selected data to fit that distribution is 60%. Moreover, using traditional statistical methods, such as the Gauss curve, the results were not reliable due to the fact that only the 18% of the data would be within the confidence limits. Apart from that, the samples of each profile are not enough, so the Box-Cox transformation also helps with the lack of them. Taking all that into account the Box-Cox transformation was chosen as the best method to get

the mean value of the resilience module of each soil profile. Once the Box-Cox transformation was applied as it is explained above, the most real mean values of the modules were obtained, as it is shown in the Table 2.

Tab. 2: Results of mean modules and Spearman's correlation

TYPE OF SOIL	PROFILE / ROAD	DATA OF THE SAMPLES		TEST CBR CYCLIC			
				AVERAGE MODULES		SPEARMAN`S CORRELATION	
		W opt	p max	GAUSS	BOX-COX	W and M_R, CBR	p and M_R, CBR
		%	kgm -3	MPa	MPa		
G4GM	P-4 / Nove mesto	16,2	1769	38,80	32,84	1,00	-0,10
	P-4 / Kubenka	11,5	1988	10,31	10,14	0,50	0,10
	P-6 / Kubenka	11,5	1970	17,14	16,88	0,41	-0,06
	P-7 / Kubenka	12,4	1950	45,65	44,67	-0,77	0,77
S3SF	P-5 / Nove mesto	15,3	1723	101,02	98,24	0,60	-0,50
	P-9 / Nove mesto	13,4	1784	100,77	98,90	0,81	-0,71
S4SM	P-1 / Nove mesto	14,4	1847	180,81	169,32	0,45	-0,30
	P-3 / Nove mesto	12,9	1878	63,27	58,49	-0,60	-0,30
	P-6 / Nove mesto	15,7	1757	142,79	140,74	0,10	0,90
	P-8 / Nove mesto	13,3	1881	161,77	162,87	-0,70	0,67
	P-10 / Nove mesto	15,4	1708	47,10	44,55	-0,06	-0,26
	P-3 / Rasna	14,0	1852	337,24	335,04	-0,40	0,80
	P-6 / Rasna	12,0	1938	156,12	146,19	0,80	-0,40
	P-10 / Kubenka	15,5	1751	22,17	22,52	0,60	0,50
	P-7 / Nove mesto	14,6	1860	39,43	36,78	-0,26	0,66
S5SC	P-12 / Kubenka	10,1	2061	50,89	49,74	-0,30	-0,50
F2CG	P-2 / Navojna	23,1	1548	81,84	83,48	-1,00	0,90
	P-5 / Navojna	24,6	1475	252,20	243,29	1,00	0,40
	P-1 / Kultury	23,1	1577	69,08	68,53	0,09	-0,26
F3MS	P-2 / Rasna	15,3	1782	71,36	69,36	0,40	0,90
	P-3 / Kultury	21,4	1578	241,56	240,85	-0,94	-0,77
	P-3 / Kubenka	10,8	1969	114,30	115,36	0,90	-0,70
	P-5 / Kubenka	13,3	1862	23,58	23,15	0,03	-0,03
	P-11 / Kubenka	14,5	1832	38,68	37,21	0,09	-0,09
	P-13 / Kubenka	10,9	2013	66,70	67,02	-0,37	0,60
F4CS	P-1 / Rasna	16,0	1778	150,50	138,68	-1,00	0,10
	P-5 / Rasna	14,2	1818	91,63	91,16	0,20	-0,60
	P-4 / Kultury	21,1	1599	111,52	109,91	0,49	-0,31
F5ML	P-2,3 / Borovice	15,1	1780	172,78	167,43	0,00	0,00
F6CI	P-4 / Borovice	16,4	1752	195,24	168,46	-0,60	0,41
	P-6 / Borovice	16,7	1747	171,98	165,67	-0,06	0,06
	P-10 / Kultury	25,5	1492	21,92	22,10	-0,37	0,60
F8CH	P-1 / Borovice	24,8	1471	133,14	129,68	0,43	-0,49
	P-1 / Navojna	24,6	1492	81,73	81,62	-0,80	-0,20
	P9 / Navojna	21,3	1626	376,88	396,63	-0,70	0,70
	P10 / Navojna	20,3	1610	300,53	298,17	0,10	-0,20
	P-2 / Kultury	22,9	1594	46,43	45,59	0,20	-0,77
	P-5 / Kultury	22,2	1572	111,72	111,60	-0,54	0,66
	P-6 / Kultury	23,5	1576	98,37	96,68	-0,40	-0,30
	P-7 / Kultury	22,8	1576	44,67	44,74	0,14	0,14
	P-8 / Kultury	20,8	1630	66,67	65,09	-0,54	0,83
	P-9 / Kultury	27,3	1493	51,74	49,64	0,83	-0,71

Results of the Spearman`s correlation

In order to try to find the relationship between the module and the parameters of moisture and density, the correlation of Spearman was applied as explained above. The results obtained from the correlation coefficient are could be seen in Figure 4. Apart from that, it was thought that there should be correlations that are not obvious at first glance. Because, as the experience has shown, the correlation

between parameter above or below the optimal value is not the same. That is why the analysis should be divided in two parts. The first would be the soil profiles where the humidity or density during the test is lower than the optimal. In the second group there would be the soils where the real humidity or density is higher than the optimal.
For that analysis, first those 43 profiles were divided into the two groups. 13 tested profiles have been found with moisture contents below the optimal. From which 8 had a positive correlation coefficient. On the other hand, 17 profiles were found with moistures above the optimal. Where, 9 of those followed a negative correlation. In addition, there were certain profiles where moistures have been very close to the optimum, that is, there were values of moisture above and below the optimum, exactly 13 profiles. From which, 6 have a possible correlation, but not obvious because of the heterogeneous distribution of the parameters.
The last correlation to be analysed was the one between density and resilience module. For this reason the 43 profiles were divided again into the 2 groups. There are 14 profiles which have a density below the maximum density, of which, 10 have a positive correlation. In the other group there are 25 profiles of which 17 have a negative correlation. Finally, 4 profiles with variable density above and below the maximum density were found. Among them, there are 2 that could have a possible but non-obvious correlation.

Conclusions
After analysing all data, there has been considerable shift change in the approach to the variability of mechanical properties of the soil. Initially it could be thought that the difference between samples of the same profile of the road should not be too large, due to the fact that they are obtained from the same place. We might also fall into the mistake of thinking that the difference between profiles should not be very large because they are a few meters away, but this is not so, since the mechanical properties are very different from each other, varying the resilience module even in a 200%. This is because even the type of soil is different, according to the soils classification USCS or also because of the impossibility of preparing samples in an identical manner.
Ones the Spearman's correlation is analysed, it can be said that it was not a clear behaviour of the soil at first glance. But after dividing the profiles into groups depending on whether the humidity and density of the samples were above or below the optimal humidity and maximum density a relationship have been found. More specifically, when the humidity or density of the samples are placed below the optimal, the correlation is positive, this is, that if moisture or density grows the module would grow. On the contrary, if the samples are above the ideal, the correlation will be negative, so if the humidity or density increases the module would decrease. Therefore, it can be said that it follows the expected behaviour, because when the values of the parameters of the samples get closer to the optimal the module gets higher.
Despite this, the need to increase the number of samples per profile was detected, to confirm the correlation between the module of resilience and the density or humidity. Due to the fact that there are several profiles that do not follow the expected behaviour. Finally, an increase of the samples is needed to develop the behaviour of humidity and density during T3 of the CBR cyclic test.

References
Moolenar, A.A.A (2009): Repeated load CBR testing, a simple but effective tool for the characterization of fine soils and unbound materials. Delft, the Netherlands
Ševelová, L., Hauser, J., P (2014): Automatic control equipment geotechnical equipment for measuring soil bearing capacity and methods of work with this device
Arbide Ostolaiz, M., Ševelová, L. (2013) Verification of cyclic CBR test with constant stress. *Journal of Landscape Management.* sv. 2, č. 4, s. 43--47.ISSN 1804-2821.
ČSN EN 13286–2 Nestmelené směsi a směsi stmelené hydraulickými pojivy - Část 2: Zkušební metody pro stanovení laboratorní srovnávací objemové hmotnosti a vlhkosti - Český normalizační institut, 2005.
Classification of Soils for Engineering Purposes: Annual Book of ASTM Standards, D 2487-83, 04.08, American Society for Testing and Materials, 1985, pp. 395–408
Bonett DG, Wright, TA (2000): Sample size requirements for Pearson, Kendall, and Spearman correlations. *Psychometrika.* 65: 23–28.
TP 170 Navrhování vozovek pozemních komunikací. Ministerstvo dopravy ČR, 2008.

Acknowledgment
The work was supported by the Technology Agency of the Czech Republic as the project TA01020326 "Optimization of design and realization of low capacity roads pavements".

Souhrn
Životnost a spolehlivost každé konstrukce závisí na mnoha faktorech. Od stanovení materiálových vlastností, přes použitý výpočetní model a jeho schopnost adekvátně vystihovat popisovanou realitu, až po technologii realizace. Každý z těchto faktorů vnáší do procesu nejistoty dané proměnlivostí vlastností použitých materiálů, přirozenou variabilitou procesů až po chyby způsobené lidským selháním. Moderní numerické simulační metody jsou schopny vliv těchto nejistot ve vstupních veličinách respektovat a začlenit do výpočtu. Nezbytnou podmínkou je vedle vhodného materiálového modelu také adekvátní příprava vstupních materiálových veličin, a to v dostatečném množství pro statistické vyhodnocení. Modul pružnosti podloží je zásadní materiálovou charakteristikou citlivou dle výsledků testů zejména na vlhkost a objemovou hmotnost, a tím i na laboratorní přípravu vzorků pro jeho stanovení.
Příspěvek předkládá statistické zpracování laboratorních výsledků modulu pružnosti (Resilient Modulus M_R) podloží z inovativního cyklického CBR testu. Byly realizovány dva postupy stanovení modulu; test stanovení modulu pružnosti při konstantní penetraci podle nizozemské teorie (Molenaar, 2009) a jeho modifikace probíhající při konstantním napětí (Ševelová, Hauser, 2014). Byly testovány materiály podloží sedmi účelových komunikací, tzv. nízkokapacitní vozovek LVRs, vždy na šesti nebo deseti profilech, ze kterých bylo připraveno 400 vzorků při optimální vlhkosti a maximální objemové hmotnosti podle zkoušky Proctor standard.
Výsledky laboratorních zkoušek cyklického CBR testu byly podrobeny statistické analýze s cílem stanovit průměrnou hodnotu měřeného modulu pružnosti M_R s ohledem na pravděpodobnost chování a dále ověřit citlivost této veličiny na jiné materiálové charakteristiky. Jak ukazují hodnoty vlhkostí a objemových hmotností vzorků z cyklického testu CBR, naměřené moduly pružnosti se pohybovaly ve značně širokých intervalech i při přesném dodržení postupů přípravy vzorků. Pro statistickou analýzu byly vybrány základní druhy rozdělení: Gaussovo normální rozdělení, lognormální, exponenciální a Weibullovo. Nejednoznačnost získaných výsledků a nemožnost stanovit společnou pravděpodobnostní funkci vedla k aplikaci transformace Box-Cox, při které bylo dosaženo uspokojivé pravděpodobnosti a bylo možné stanovit průměrné hodnoty modulů pružnosti.
Pro citlivostí analýzu stanovení vlivu vlhkosti a objemové hmotnosti na modul pružnosti byl použit Spearmenův korelační koeficient. Míru vlivu bylo možno posoudit po rozdělení sledovaného souboru dat na vzorky s hodnotou vlhkosti, resp. objemové hmotností, pod optimální vlhkostí, resp. pod maximálni objemovou hmotností a na vzorky nad těmito hodnotami. Toto rozdělení prokázalo jednoznačnou přímou závislost mezi modulem a danými materiálovými charakteristikami. Při rostoucí vlhkosti do její optimální hodnoty rostla hodnota modulu pružnosti. Při dalším růstu nad vlhkostní optimum modul klesala Stejný proces bylo možno sledovat i pro vliv objemové hmotnosti. S jejím růstem k maximální hodnotě tento modul rostl, po jejím překročení klesal. S ohledem na velmi malé změny ve vlhkostech cca 2-3 %, resp. objemových hmotnostech cca 1-3 %, lze konstatovat vysokou citlivost modulu pružnosti na změny vlhkosti, resp. na zhutnění materiálu. Získané výsledky prokazují vysokou proměnlivost mechanických vlastností přírodních materiálů zemin a s tím související problematiku přípravy vzorků.

Contact
Ing. Lenka Ševelová, Ph.D.
Phone: +420 545 134 524, e-mail: lenka.sevelova@mendelu.cz

TOURIST AND RECREATION MANAGEMENT OF ROZTOCZAŃSKI NATIONAL PARK – PRESENT STATE AND PERSPECTIVES

Emilia Janeczko[1], Małgorzata Woźnicka[1], Krzysztof Janeczko[2]
[1] Department of Forest Utilization, Faculty of Forestry Warsaw University of Life Sciences - SGGW, Nowoursynowska 159, 02-776 Warsaw, Poland
[2] Department of Forest Management Planning, Geomatics and Forest Economics, Faculty of Forestry Warsaw University of Life Sciences - SGGW, Nowoursynowska 159, 02-776 Warsaw, Poland

Abstract
This paper presents the results of the inventory of tourist and recreation facilities in Roztoczański National Park, the where forest cover up to 95%. Roztoczanski National Park is a Particular area because of the unique qualities of the natural environment. It is also very attractive Perceived as because of the Possibility of Achieving the Objectives of tourism and recreation. The inventory of tourism and recreation facilities together with recognition of environmental-risk Arising from its use, recognition of tourism need and preferences and the estimation of tourism capacity can serve as a basis for identifying principles of tourism and recreational use of Roztoczański National Park.

Key words: protected areas, tourism and recreation development, tourism planning

Introduction

Tourism is seen as a form of economic activity with most significant potential to generate future employment and growth in the EU's gross domestic level (Message from the Commission, 2007). Tourist activity is one of the measures of standard of living and an indicator of the development of civilized societies. Its development helps to generate new jobs and entrepreneurship, improving the quality of life of local communities, increasing the competitiveness of the regions, activation of both urban and rural areas. Important positive aspect of tourism development is greater attention to spatial order, aesthetics and the natural environment. However, like any other tourism manifestation of human activity that may be the source of many environmental risks. The share of tourism in environmental degradation is estimated at 5-7%, with 40% from industry, agriculture or 15% (Labaj 2003). The threat to the quality of the environment is also ill-planned tourism infrastructure. Tourism is seen as one of the factors leading to landscape fragmentation. Tourism and recreation can not be done in a manner invasive and exploiting the natural and landscape. Its sustainability is particularly important, given that currently in Europe, the number of visitors in natural areas is increasing, including national parks primarily. These areas are, by Coccossis *et al.* (2002), a target destination place for about 40 - 60% of tourists and tourism in such protected natural areas is currently 7% of all international tourism expenditure. The aim of the article is to indicate the possible direction of the development of tourism and recreation in the National Park Roztoczański based on tourist-recreation infrastructure resources , and to determine the characteristics of tourism and to analyze indicators of tourist capacity of the Park.

The subject of the research

Roztoczański National Park is one of 23 national parks in Poland, covering a total area of 316 748 hectares, which is about 1% of the country. The park was established in 1974 to protect the most valuable natural areas mites. Originally the Park area was 4801 ha and has now increased to 8483ha, out of which 8102 ha (95.5%) is covered by forests. The park is located in the central eastern part of Poland, in Lublin province. The main watercourse flowing through the area of the park is the river Wieprz. Some streams start here: Świerszcz and Szum. The Park there were also created four artificial lakes: Echo, Florianka, Kościelny, and Czarny (Grabowski 2007). The diversified terrain, as well as the diversity of geological, hydrological and soil mean that the Park has as many as 21 forests and 28 non-forest plant communities . The most valuable of them are: fir forest, which is 8% of the forest area and the carpathian beech forest covering 25% of the RPN.
Roztoczański National Park is not only a characteristic area because of the unique qualities of the natural environment, but also the area is perceived as very attractive due to cultural values. The Park and its immediate surroundings were a place of fighting during the First and Second World War, and as a result of previous acts of war, in the Park we have eg. the cemetery which reminds of the pacification of Socha village in 1943, made accessible through the natural path to Beech Mountain and the Pole Hill monument commemorating the Battle of Panasówka in 1863.
The current shape and character of the settlement buildings and the park is the result of activities Zamoyski Code, as well as the result of war and the subsequent disruption of post-war land parceling

(Cygnarowski 2007). The largest urban center in the area is Zwierzyniec, which is the headquarters for Roztoczański National Park.

Tourist and recreational management of the Roztoczański National Park

The Park is a place conducive to any active tourism and sightseeing. The Park and its vicinity allowes other forms of tourism, and hence, there are many options for getting around the area eg. equestrian tourism and water tourism (Grabowski 2004).

For users doing the park area on foot, there are nine tracks with a total length of 18 km. They show the natural wealth of the Park, its diversity of landscapes and unique cultural values. In the future it is planned to lay six additional tracks cognitive ie: multisensory Geological path, the path to the White Mountain, the path to the Bear Mountain, Zwierzyńczyk trail, bike route - Rybakówka - Socha and Rudka-Słupy-Kosobudy (RPN Protection Plan)

Through the area of the Park there also runs five transit hiking, whose total length, within the RPN, is 34 km away. Cycling in the Park is developed on the basis of four bike trails with a total length of 17 km. The Park runs a reserve Polish horse breeding. Suitable conditions allows off-road horse riding tourism. It is possible learn individually to ride a horse at Rybakówka, as well as explore the nearby village on carriage rides, after prior consultation with the Boss of the park. Using the horse drawn carriage in the Park is allowed only on the way to Florianka, sightseeing on suitable public roads.

Roztoczański National Park was established to protect the unique landscape, which consists of: nature and harmoniously integrated into monuments of Roztocze. You can admire the landscapes, among others, through observation points located on Beech Mountain, on a sand dune in the vicinity of the "Echo ponds", along the route to Florianka, on Polak Hill.

In the park there are special facilities for the disabled. Suitable for people with physical disability is the path to "Echo Ponds", and the viewing platform above the same pond.

Outside the designated nature trails, hiking and cycling routes, a very popular place for recreation in the park are the „Echo ponds", created in the years 1929-1934 on the site of wetlands located in the flat valley of the river Świerszcz. The team of four ponds fed by the waters Świerszcz. Its depth varies from 0.5 to 1.5 m. The ponds are filled in early spring, when autumn water is drained. Adjacent to wooded dunes, the largest of the ponds is a popular vacation spot and for many years serves as a resort(Grabowski 2004).

The objectives related to tourism, recreation and education are following: Educationa Museum Centre – Zwierzyniec, Forest Chamber in Florianka and a farm of Dębowiec Warblers (formerly Krzywe). The Museum and Education Center was open for use in 1994. Cooperation with nearby schools, organizing fieldwork and provides an extensive collection of literature as natural. Chamber of Forest and Forester Komanówka are located in Florianka, about 6.5 km from the Zwierzyniec. Forest Chamber was established in 2004 on the basis of the reconstructed buildings of forester from 1830. The aim of the revitalization of this object was to demonstrate the habitat and the agro-forestry economy conducted in the late thirties of the twentieth century. It is lacated at this point a tour desk carrying educational activities. The Forester Komanówka base has served as educational tourism since 2007. Here are implemented programs relating to the functioning of a nearby path dendrochronologically. There are so called wooden books, allowing to acquire knowledge of the species of trees and shrubs met on the track, as well as cabinets and panels make learning easy. Educational objectives also meets today Dębowiec Forester. Within the pens you can admire the old outbuildings and orchard, which is dominated by old varieties of trees. Now, in the summer, the settlement Dębowiec Roztocze is the seat of the Horse Guard Association for Nature Conservation them. Wielkopolska Cavalry Regiment 25 (Niczyporuk 2005).

The increased influx of tourists into the Roztoczański PN, especially in the summer, favors the development of the village adjacent to the Park. Park does not have its own catering, and the possibility of renting buildings for accommodation is limited. The accommodation facilities in the vicinity of the park is dominated by agro-tourism and private houses. They occur most frequently in Zwierzyniec, as well as in the village Socha and along many routes frequented by tourists Zwierzyniec Krasnobrów (Grabowski et al 2011).

Tourism and recreation in the Roztoczański National Park

In Roztoczański National Park there are not any constant, systematic studies and observations on tourism. According to the decree 7/2014 Director PN Roztoczański penetration in the Park can be carried out during the year, in daylight, from sunrise to sunset. Interest group sightseeing Park can not exceed 60 people. Walking through the Park's nature trail on Beech Mountain in a group of more than 10 people is allowed only with a guide RPN authorized by Director or other person authorized by the Director of the Park. The tourist season begins in May and lasts until September and peak traffic falls

for the holiday period: July, August. Useful for estimating tourism is the statement made by the Centre for Museum Education (OEM) Grabowski 2011. For example, in 2011 the number of visitors to the OEM amounted to 23,088 people in the next year rose to 23,293 people. Forest Chamber in 2012, a total of 1805 tourists, about 547 more than last year. The increasing number of people participate in the open air photographic competitions organized by the park, school ecological events. Based on the records of tourists, it is estimated that since the 90s the Park is visited annually by about 120 thousand people, but the number of organized tourist groups ranges from 400 to 600. In this case, there has also been a slow increase in the number of tourists in groups of family and friends (Grabowski et al 2011)
From the survey (Gucma 2013) conducted among users of cycle routes in RPN most tourists in RPN are young people aged 26-35 years old (about 35%) and 18-25 years (approximately 20% of the respondents). Quite a large group (18%) were aged 56-65 tourists in years. The vast majority of tourists (70%) had a higher education. 6% and 8% of respondents had basic vocational education. Among the tourists dominated by residents of large cities (about 53% of respondents). The lowest percentage of respondents (13%) were residents of rural areas.

Tourist capacity of Park
For the first time tourist absorbency in the Park was set in 1998 in the framework of the Plan for Protection RPN (Gucma 2014). Then it was determined that the bandwidth of nature trails is 520 people / day, hiking 1,200 people / day, and the capacity of bathing in ponds "Echo" 580 people / day. With the development of infrastructure, tourism and recreation park there was a need to verify these indicators. Currently the project Protection Plan of Roztoczański National Park for the years 2012-2031 re-set the maximum number of persons likely to use each of the sites available for recreational purposes. And so the ponds "Echo" can be frequented by 3,500 people of whom 250 can stay in the House of the Forest in Florianka, in the Centre for Education and the Museum - 250 people. For educational purposes, the OEM can use 150 visitors at the same time (up to 1,500 per day), with the Warblers Komanówka - 20 people, Warblers Curves - 60 people in Wojdzie Forester - Forester Obrocz 60 and - 12 people. Because of hiking trails at the same time can use 1,540, cyclists - 1080, while the paths of cognition 1630 people. It should be noted, however, that the project Protection Plan RPN finds it hard to see a methodological foundation, which was established on the basis of the above capacitive threshold. Detailed research in this area has been taken by Gucma (2014). They show that the capacity of swimming at Ponds Echo, accompanied by a beach with an area of 0.56 ha is 560 people / day. On the other hand, in a clearing on Florianka resort, with an area of 0.15H can stay at the same time a total of 15 people, which, with the opening (ten hours per day) gives 150 persons / day. Capacity of all hiking trails running through the park is by Gucma (2014), taking into account individual tourists, is only 3570 persons / day, while taking into account both individual travelers and groups - 17850 people / day.
Throughput of biking tourist routs used by individual tourists is 5950 persons / day and 29,750 people / day, taking into account the groups. The total capacity of educational paths within the park were set for individual travelers and groups of tourists for 885 persons / day and 2655 persons / day. The aggregate throughput of all hiking trails, mountain biking and educational paths running through the park is therefore 10,405 people / day (considering only individual travelers) and 50255 people / day, taking into account individual and group travelers. The total capacity of the site in Roztoczański National Park which is the sum of the daily clearing capacity for Florianka resort, swimming ponds Echo and capacity of tourism and recreation routes set at 11,115 people / day in the case of individual visitors and 50,965 people / day, after taking into account both individual travelers and groups. Comparing these data with the guidelines contained in the draft Protection Plan RPN turns out that the possibility of the development of tourism and recreation in the park are much larger than assumed in the Plan of Conservation.

References
Coccossis H., Mexa A., Collovini A. (2002): Defining, measuring and Evaluating carrying capacity in european tourism destinations. B4-3040 / 2000/294577 / MAR / D2, University of the Aegean, Athens.
Cygnarowski A., (2007): Zwierzyniec in an old postcard and photographs. Society of Friends of Zwierzyniec, Zwierzyniec
Grabowski T. (2004): South axis of educational nature Zwierzyniec - Florianka - Górecko Kościelne, Ed. Roztoczański National Park, Zwierzyniec
Grabowski T., (2007): Tourist and educational Guidebook. Ed. Roztoczański National Park, Zwierzyniec

T. Grabowski, Kałamucka W., Kałamucki K., (2011): Making Roztoczański National Park for tourism in CEPL Studies and Research in Rogow, R.13, Volume 3/28, pp. 42-47
Gucma M. (2013): Social Preferences on bicycle routes in Roztoczański National Park, the work of the Faculty of Forestry Engineering Agricultural University (supervisor: E.Janeczko), Warsaw
Gucma M. (2014): Assessment of tourist capacity Roztoczański National Park, thesis at the Faculty of Forestry University of Life Sciences (supervisor: E.Janeczko), Warsaw
Communication from the Commission Agenda for a sustainable and competitive European tourism COM (2007) 621, Brussels
Labaj M., (2003): Protecting the landscape and the environment: Recreational tourism, and tourism specialist, (ed.) Burzynski T., Labaj M, Warsaw
Nieczyporuk P., (2005): In the service of forests – History of Ordynacki Warblers cu in Roztocze Meeting, Ed TV. Roztoczański National Park, Zwierzyniec
Protection Plan Roztoczański National Park (draft)
http://www.bip.roztoczanskipn.pl/content.php?cms_id=210
Tourism development program for 2020 (draft). Ministry of Sport and Tourism, Warsaw 2014

Souhrn
Vyváženým rozvojem cestovního ruchu se rozumí použití přírodních zdrojů takovým způsobem, který zajišťuje dlouhodobou ochranu svých aktiv. Patří mezi ně řádně naplánovaná a uskutečňovaná opatření na podporu rozvoje cestovního ruchu ochranu přírodního a kulturního dědictví a péči o místní a regionální tradice. Národní park Roztoczański z důvodu přírodních a kulturních hodnot je oblastí zvláštního významu pro rozvoj cestovního ruchu a rekreace. Současný rozvoj cestovního ruchu a rekreace parku nabízí dostatek příležitostí. Zájem o rekreaci v parku by neměla představovat hrozbu pro jeho fungování, s ohledem na ukazatele kapacity.

Contact:
Dr hab. inż. Emilia Janeczko
Phone: +48 22 59 38 134, e-mail: janeczko.emilia@gmail.com

TRAINING FOREST ENTERPRISE MASARYK FOREST KŘTINY – EXCURSION GUIDE

Pavel Mauer
Training Forest Enterprise Masaryk Forest Křtiny, Mendel University in Brno, 679 05 Křtiny 175, Czech Republic

In 2014, the Mendel University in Brno (MENDELU) reminded 95th anniversary of foundation and in year 2013 It's 90 years since the establishment one of organizational units – Training Forest Enterprise Masaryk Forest Křtiny (TFE)

The company was established in 1923, 1st January with original name School forestry grange Adamov of Agricultural University in Brno. This happened after takeover of Liechtenstein confiscated property by the State which it forwarded to former Agricultural University in Brno – today MENDELU – like a school and test object. Honorary title Masaryk's forest was awarded to company by the Ministry of Agriculture in 1932, 14th April with the consent of the first president of Czechoslovakia – T. G. Masaryk.

TFE fulfills three main functions:

- provides within the pedagogical and research activities, practical facilities to students of MENDELU especially to students of degree programs Faculty of Forestry and Wood Technology (FFWT). Creates conditions to university teachers for pedagogical solutions, research and testing projects;
- ensures proper management of university forest property with the prestige of being one of the leaders in the sector;
- serve to general public, taking advantage of their superior level of forests aesthetics and richness which provide useful functions of forests.

University forest lands have an area 10 228 ha, form a continuous complex immediately following to the northern edge of South Moravian city Brno and dating back to the town of Blansko. The forests are situated at an altitude of 210 – 574 m and mostly belong to the PLO 30 Drahanská vrchovina. The average annual temperature reaches 7.5 °C. The average annual rainfall is limiting factor and it's only 610 mm. Described forest vegetation zones are: 1st oak zone (4 %), 2nd beech-oak zone (27 %), 3rd oak-beech zone (53 %) and 4th beech zone (16 %). Nutrient habitat predominate (63 %), the remainder being acid sites (10 %) and treated (27 %). Mainly mixed stands, characterized by a great variety of natural conditions, are formed 38 % coniferous trees and 62 % broadleaved trees. The main coniferous trees are spruce (18.8 % stand area), pine (8.3 %) and larch (8.1 %). The main broadleaved trees are beech (34.0 %), oak (14.7 %) and hornbeam (7.9 %). The average supply timber reaches 266 $m^3 \cdot ha^{-1}$ b.k, total current increment is 7.4 $m^3 \cdot ha^{-1}$ b.k.
The terrain is very rugged with distinctive deep valleys and gorges, especially in the vicinity of the river Svitava and Křtinský potok. Geological subsoil is formed by granodiorites, Culm greywacke and limestone. One third of company area is located in the CHKO Moravský Kras (2 944.87 ha). This contributes to the fulfillment of aesthetic and educational functions of forests. In the past have been preserved the whole stands without any intervention with a natural species composition. From this stands gradually evolve today's network 22MZCHÚ (three national nature reserves, fourteen nature reserves, one national natural monument and four natural monuments) with total area of 860.83 ha on land designated for forestry functions. TFE has three arboretum (Křtiny, Řícmanice and Habrůvka) with valuable collection of trees, designed to study and relax. Natural beauty is deliberately added. It is held view into the surrounding nature, modified forest glades with planting of exotic trees, underpinnings of sources for establish of wells. At selected locations are placed memorials and commemorative plaques local rarity – Lesnický Slavín. Everything serves not just to needs of the university, but also general public, walking visitors and cyclists.
Tradition Silviculture TFE lies mainly in the use of finer ways of forest management with minimal clear cutting elements and use of natural regeneration. It's possible to find forest areas where is apply selected management. It is in Czech condition unique way of management. Series of research projects is long-term solved and it is implemented a wide educational and scientific cooperation in framework of international programs. For this purpose are used forestry (eg. research area of thinning in stands of beech, spruce, fir and mixed, provenance plots of larch (*Larix decidua)*, spruce (*Picea abies*), fir (*Abies alba*) and lodgepole pine (*Pinus contorta*), three genetic bases for beech, oak and fir; seed orchards for larch, Scots pine, aspen and mountain elm) and timber (eg. Olomučany saw) demonstration objects. Already acquired and published data and results can be used for the

professional work and study. Care is focused on upgrading existing and building new educational facilities and demonstration objects (ed. nursery centers, research stations Křtiny or timber center in Brno – Útěchov).
All growing and harvesting work, forest protection and others activities are performed by TFE on three polesian (Vranov u Brna, Habrůvka and Bílovice nad Svitavou) in the course of a business. In the sawmill in Olomučany equipped by one frame and two band saws, three lumber drying, steaming chamber and assortment line; there is processed own harvested timber including the subsequent sale of lumber and implementation of fuel program. The service center in Adamov possessing repair workshops, timber transport and mechanization for terrestrial and building works is available for own company and foreign customers. Centre of seedlings, arboretums and green vegetation produces a suitable planting stock for reforestation and revegetation, including so-called execution on key. Research Station in Křtiny develops and produces forestry equipment – winches, rill planters, nursery equipment, mechanics for disrupt of land and especially several models of forest lifts LARIX. In a renovated chateau Křtiny, reshaped in modern educational center, there is possible to ordered complete provision of professional, cultural and social events including accommodation. Game management in hunting grounds of MENDELU, managed by TFE, is own-account – exercise of hunting rights is not rent but is carried on by holder of hunting grounds. Hunting right is practiced by employees of MENDELU (TFE, Faculties), students of FFWT hunting and keepers of hunting permits. Total fourteen hunting ground with area of 10 594 ha (TFE Křtiny, Hády, Bažantnice Rajhrad and Obora sokolnice) is used for practical teaching of hunting for MENDELU students, including solutions for professional work. The main game at TFE is roe, black and mouflon. Red deer and fellow deer is standardized too. The next game is hare and pheasant.

TFE is based on the tradition of leading professors specialized forest departments which were especially Rudolf Haša, Josef Konšel, Josef Opletal, Ferdinand Müller, Antonín Dyk, Alois Tichý and Gustav Artner, later for example Alois Zlatník, Bohumil Doležal, Miroslav Vyskot or Jaroslav Beneš. Currently the pivotal teachers of Faculty of forestry and wood technology and teachers of others faculties of MENDELU have own specialized laboratory, the workplace for verification of their expert opinions and new ideas, space for realization of practical education of students.

TFE holds environmental certificates – FSC since 1997, PEFC since 2003. In 2011 there has been proclaimed Forest Park Masaryk's Forest Křtiny and more than one third forest stands belongs to the NATURA 2000 program. Not only for these reasons, but mainly for the way forest management, forest aesthetic treatment, many purposes, demonstration equipment, advanced production and database research results is the goal of both domestic and foreign excursions, student placements and internships, practical foresters and other visitors. As an important object pedagogical activities and scientific research of students and pedagogues of MENDELU, also students and professionals from the Czech Republic and abroad, Training Forest Enterprise Masaryk Forest Křtiny of Mendel University fulfills its mission, under the current Law on University Education no. 111/1998 Sb.

Contact:
Ing. Pavel Mauer
Phone: +420 516 428 822, e-mail: pavel.mauer@slpkrtiny.cz

TRAINING FOREST ENTERPRISE MASARYK FOREST KŘTINY AND THE VISITORS MONITORING

Jitka Fialová
Department of Landscape Management, Faculty of Forestry and Wood Technology,
Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic

Abstract
The monitoring of visitors in the area of Training forest enterprise Masaryk forest Křtiny was held in the years 2013 and 2014. The monitoring was done by the usage of the automatic reader. The reader was installed on the Kopanin forest road. The road leads down the valley to the Bilovice nad Svitavou. The results was compared and the statistical differences has been described. The most interesting results was the difference between the total number of visits. The total visits in the year 2014 was 11,547 visits higher than in the year 2013 (year 2013 – 29,216 visits, 2014 – 40,763 visits).

Key words: Eco-counter, forest roads, daily maximum, daily minimum

Introduction

As Navratil et al (2014) stated the main goal of comprehensive monitoring of tourism and traffic in general is to provide basic information about the number of visitors, together with data on the temporal variability of traffic (within a day, week, months of the year and the seasons) and spatial distribution of traffic within the target area. Standard output is also data about visitors to the structure of thought. Monitoring visits in the recentperiod is one of the main activities of administrations over a large area of protected areas in the field of tourism (Blaha, 2010; Kala & Salov, 2010; Kos, 2010 in Navratil, 2014). About recreational land use in different contexts is also mentioned, for example Ondrejka (2013a, 2013b), Fialová et al (2014) and Galas (2013).

Methods

The Partnerství, o.p.s., has installed automatic reader of hikers and bikers to the road in the district for the purposes of visitor monitoring of selected forest hauling road in Training forest enterprise Masaryk forest Křtiny (TFE). The monitoring device was installed in July 20143 and the monitoring was conducted until November 2014. Students of MENDELU in Brno performed manual calibration counting in July 14-20, 2014, in the monitoring place.
The trail visitor monitoring used automatic reader Pyro Box Compact from Eco-counter. This device counts all users of trails (hikers, bikers, in-liners, etc.) without distinguishing among them. Counting is based on the temperature difference between a human body and the surroundings. The readers can distinguish the direction of the movement and are installed in the narrowest places of the trails in the way which prevents counting two persons walking side by side as one. The data are stored in one-hour intervals.
The selected road is characterized in Tab. 1 - the location, or the location of the monitoring device is shown in Fig. 1.
The trail is a bicycle route no. 5005 as well, green trail and nature trail Hády and Říčka valley are lead here too. Due to the width of the paths can be assumed partial underestimation of the number of users, as they can pass around adder in a plurality of adjacent aligned. For a detailed evaluation of individual sites calibrated data was used.

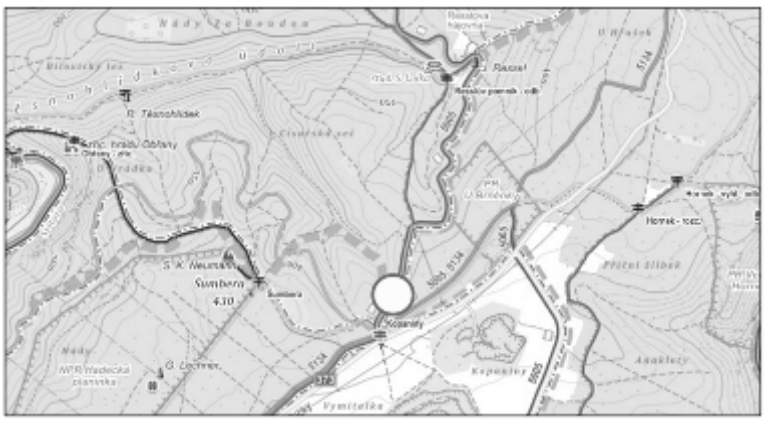

Fig. 1: Approximate location of the counter

Tab.1: The locations of visitor monitoring of selected forest hauling road in the area of TFE, Bílovice nad Svitavou forest district

Monitoring location	Name	Surface	Width	User type distinction	Movement distinction (IN/OUT)
Forest road Kopaniny – Ressl's lodge	Resslova	(Type 1) unbound mixtures	4.0 m	no	yes

Results and Discussion

In the locality of Ressl road was in the whole monitored period the amount of 40,763 visits counted in the direction IN and OUT. Monthly average record was 8,153, the daily average calculated over all days was 266 and the average hourly was 11. Other important data can be seen in the table 2. The number of visitors going to Bilovice nas Svitavou was higher than t oBrno.

Between the months of July and August was recorded absolute and relative increase in the total number of users. In the coming months there has been a decline in visitors, while the highest decline was recorded in November. The reason for the decline is the end of the summer season and holidays. A similar conclusion can be applied to the individual directions. In the direction of Bílovice, the fall between October and November was 43%. The correlation between attendance Resslova locality and maximum daily temperature is 0.46, ie. the effect of temperature on daily attendance is not significant. Correlation between the visits and daily rainfall reaches - 0.18, ie. rainfall expected to have a negative impact on attendance.

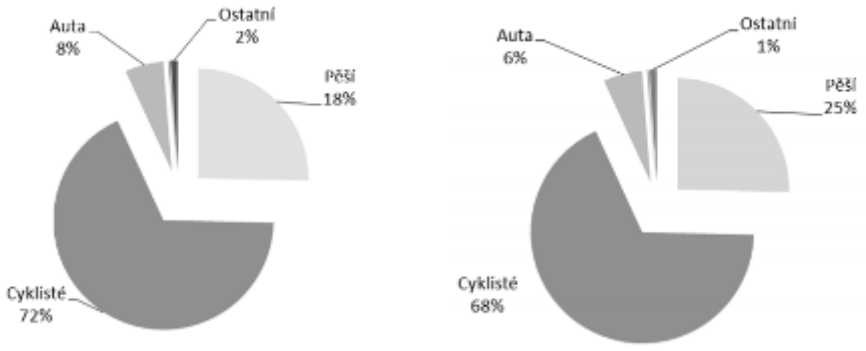

Fig. 2: The comparison of the users structure in the years 2013 a 2014 (%)
Pozn. Cyklisté – cyclists, Auta – cars, Ostatní – others, Pěší – pedestrians

Due to the fact that similar monitoring was conducted at the same location in 2013 (specifically, between the July 6th - November 30th 2013), data can be compared with measured values of 2014. For comparison, in both years selected period July 6th to November 30. Total attendance trails in Resslova has been higher in 2014 compared to 2013. Similarly, in the hourly and daily average.

Tab. 2: Comparison of visitors of selected forest hauling roads in the area of TFE, Bílovice nad Svitavou forest district in July 6–November 30, 2013 and in July 1-November 30, 2014 (selected indicators)

Selected indicators for user counts	Resslova - 2013	Resslova - 2014
Total	29,216	40,763
Daily maximum	Sunday July 14, 2013 (760)	Saturday September 28, 2014 (806)
Daily minimum	Thursday November 21, 2013 (42)	Tuesday July 18, 2014 (24)
The day with highest counts	Sunday	Sunday
Hourly mean	8	11
Daily mean	197	266
Monthly mean	5,843	8,153

The most significant differences between 2013 and 2014 can be by the monthly visits observed in August and October, when the number of visitors in 2014 exceeds that in 2013 more than 1000 entries. Busiest day in terms of attendance was between 2013 and 2014 Sunday. In 2013, followed by only a slight difference Saturday, in 2014, was also second in the order Saturday with about 4% lower attendance. In both years, around 45% of users visited the trail on the weekend. The least busy days in the two years were Monday and Friday.
The hourly distribution of traffic routes in 2013 and 2014 are similar. In both years we have seen the morning peak between 11th and 12th AM and a higher utilization in the afternoon, especially from 3rd to 6th PM. The structure of users in both years was detected within the calibration census. In both years showed similar results in 2014 were reported by 4% fewer cyclists, 7% more pedestrians and 2% fewer cars. In terms of directionality in 2013 significantly outweighs the number of users moving in the direction of IN to Bílovic over those who tend to Brno. This ratio is maintained in both working and non-working days. In 2014, the direction of movement more equalized, but still prevails in the direction Bílovic.

Conclusion
The evaluation resulted in both years is a basic overview of site traffic and traffic distribution in time, within months. It is important to always check the pressure of tourists to use sites and these results are important for the territory management - where to put financial resources and promote recreational attractiveness of the area, to eliminate the damage caused by excessive use of sites tourists.

References
Fialová, J. et al. (2014): Visitor monitoring of selected trails in ŠLP Křtiny. In Fialová, J., Pernicová, D. *Public recreation and landscape protection - with man hand in hand?.* 1. vyd. Brno: Vydavatelství Mendelovy univerzity v Brně, s. 340--343. ISBN 978-80-7375-952-0.
Galas, S. et al (2013):Environmental impact assessment process in the V4 countries in the field of recreation and tourism. In Fialová, J., Kubíčková, H. *Public Recreation and Landscape Protection - with man hand in hand.* 1. vyd. Brno: Mendelova univerzita v Brně, s. 45--50. ISBN 978-80-7375-746-5.
Navrátil, J., Knotek, J., Pícha, K., Fialová, J. (2014): *Šetrný cestovní ruch ve velkoplošně chráněných územích přírody: Jižní Čechy a Šumava.* 1. vyd. České Budějovice: Nakladatelství JIH. 143 s. 1. ISBN 978-80-86266-81-7.
Ondrejka Harbuľáková, V., Hronský, P. (2013a): Design of water ways for recreational purposes. In: Wybrane aspekty ochrony i kształtowania srodowiska w Polsce, we wschodniej Słowacji i zachodniej Ukrainie. - Brzozow : Muzeum regionalne im. Adama Fastnachta, 2013 P. 161-175. - ISBN 978-83-86801-78-7
Ondrejka Harbuľáková, V. et al. (2013b): Sporting and recreational functions of water streams. In: Public recreation and landscape protection - with man hand in hand... : Conference proceeding : 1st - 3rd May 2013, Brno. - Brno : Mendel University of Brno, 2013 P. 175-180. - ISBN 978-80-7375-746-5

Souhrn
Návštěvnost ŠLP ML Křtiny byla zjišťována v roce 2013 a v roce 2014 za pomocí automatického sčítače umístěného na lesní cestě vedoucí od Rozcestí Kopaniny přes Resslovu hájovnu do Bílovic nad Svitavou. Údaje z obou provedených sčítání byly porovnány a byl udělán popis staitstických rozdílů. Zajímavým zjištěním bylo, že celková návštěvnost v roce 2014 převyšovala tu z roku 2013 o 11547 (rok 2013 – 29 216 návštěvníků, 2014 – 40763 návštěvníků).

Contact:
Ing. Jitka Fialová, MSc, Ph.D.
Phone: +420 545 134 096, e-mail: jitka.fialova@mendelu.cz

TREAT RISK ASSESSMENT ON CULTURAL MONUMENTS NATURAL COMMUNITIES - EXAMPLES OF EVALUATION

Petr Kupec, Monika Veličková, Jaroslav Blahuta
Department of Landscape Management, Faculty of Forestry and Wood Technology, Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic

Abstract
The article presents the results which were obtained within the process of verification of the Methodology of assessment of the threat risk to the vegetation (natural communities) of cultural monuments, parks and gardens (Kupec, Deutscher, 2013). It has been designed as a part of the results obtained during the elaboration of a research task named „The identification and assessment of threat hazard on natural communities of cultural monuments" guaranteed by the Ministry of Culture CR. The methodology was applied for the treat risk assessment of the national culture monuments´ natural communities located in three regions of Czech republic (Jihomoravský, Zlínský and Vysočina Regions). Obtained results proved the original premise, that the status of natural communities of national cultural monuments in mentioned regions is thanks to optimal management approaches practically in all cases excellent.

Key words: risk assessment, natural communities of cultural monuments, potential development of natural communities

Introduction

Within the process of verification of the Methodology of assessment of the threat risk to the vegetation (natural communities) of cultural monuments, parks and gardens (Kupec, Deutscher, 2013) the natural communities of seven national cultural monuments situated within three regions of the Czech republic were assessed in 2013 a 2014. The methodology was elaborated in 2013 as a part of results of the project „The identification and assessment of threat hazard on natural communities of cultural monuments" guaranteed by the Ministry of Culture CR. The methodology represents simplified set of standard approaches to vegetation assessment e.g. Buček, Lacina, 1999; Kolektiv 2006 and 2007; Vyskot, I. et all., 2003 etc. adjusted for specific conditions of natural communities of cultural monuments. The article present the result obtained in 2013 (Kupec, Deutscher, 2013) and 2014 (Kupec et all., 2014).

Materials and methods

As was mentioned above in 2013 and 2014 seven national cultural monuments´ natural communities within three regions of the Czech republic were assessed by presented methodology in total. Specifically following national cultural monuments were evaluated:

Jihomoravský Region
- NCM Castle Valtice
- NCM Baroque castle Lysice
- NCM Slavonic fortified settlement Mikulčice

Vysočina Region
- NCM Jewish cemetery Třebíč
- NCM Church of St. Jan Nep. Žďár nad Sázavou

Zlínský Region
- NCM Castle Kroměříž
- NCM Castle Buchlovice

All these localities were evaluated by the field work, where the segmentation and natural communities assessment within defined segment was the main task. The status of natural communities was in all cases classified by assessment of parameters age structure, health status and the amount of tree individuals (species) on the border of their ecological optimum presented in table 1.
All the terrain data were processed in the ArcGIS working space where the orthophoto maps were used as a basic raster layer. The final values of assessment are calculated as weighted average from particular segment values, where as the weight the area of segments was taken.

Tab. 1: A simplified approach to the assessment and identification of threat hazard to natural communities of cultural monuments

Tree vegetation			
Degree	***A) Age structure of trees***	***B) Health status of trees***	***C) The amount of tree individuals (species) on the border of their ecological optimum***
1	Individuals with expected lifespan of 30 years and more are predominant	Healthy or individuals with first symptoms of damage are predominant	up to10%
2	Individuals with expected lifespan of 10 - 30 years are predominant	Individuals with little to medium symptoms of damage are predominant	11 - 30%
3	Individuals with expected lifespan under 10 years are predominant	Dying or individuals with severe symptoms of damage are predominant	30% and more

Shrub vegetation			
Degree	***D) Age structure of shrubs***	***E) Health status of shrubs***	***F) The amount of shrubs (species) on the border of their ecological optimum***
1	Individuals with expected lifespan of 30 years and more are predominant	Healthy or individuals with first symptoms of damage are predominant	up to 10%
2	Individuals with expected lifespan of 10 - 30 years are predominant	Individuals with little to medium symptoms of damage are predominant	11 - 30%
3	Individuals with expected lifespan under 10 years are predominant	Dying or individuals with severe symptoms of damage are predominant	30% and more

Degree	***Resulting classification of threat hazard to vegetation:***
1	Low (In 30 years the need for treatment should be expected)
2	Medium (In 10 years the need for treatment should be expected)
3	High (Treatment needed as soon as possible, maximum within 2 years)

Results

Following pictures (fig. 1 - 7) present reprints of maps with natural communities of national cultural monuments segmentation sorted according to regions.

Cumulated results of national cultural monuments´ natural communities are presented in following table (see tab. 2).

Table shows that practically in all parameters the treat hazard (risk) is low. As the only exception can be understood the health status o trees especially in solved national cultural monuments located in Zlínský Region. According to the final assessment of natural communities of natural cultural monuments in particular regions it can be stated that the treat hazard (risk) is low (in 30 years the need for treatment should be expected) in case of solved NCM in Jihomoravský and Vysočina Regions and medium (in 10 years the need for treatment should be expected) in NCM of Zlínský Region.

Jihomoravský Region

Fig. 1: NCM Castle Valtice

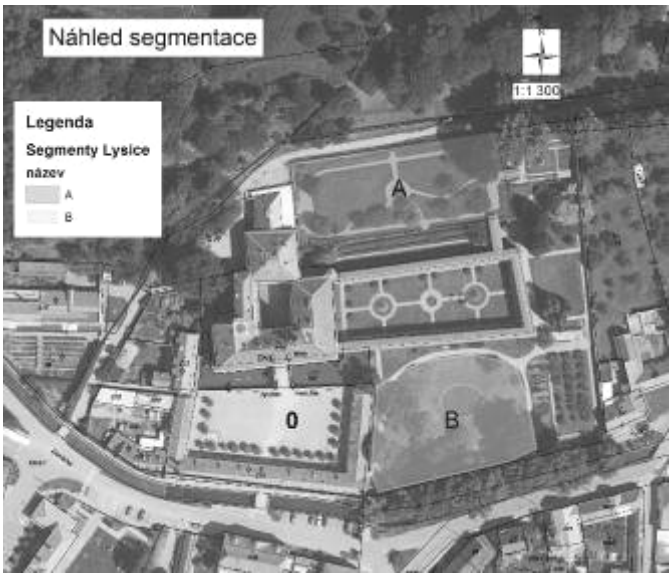

Fig. 2: NCM Baroque castle Lysice

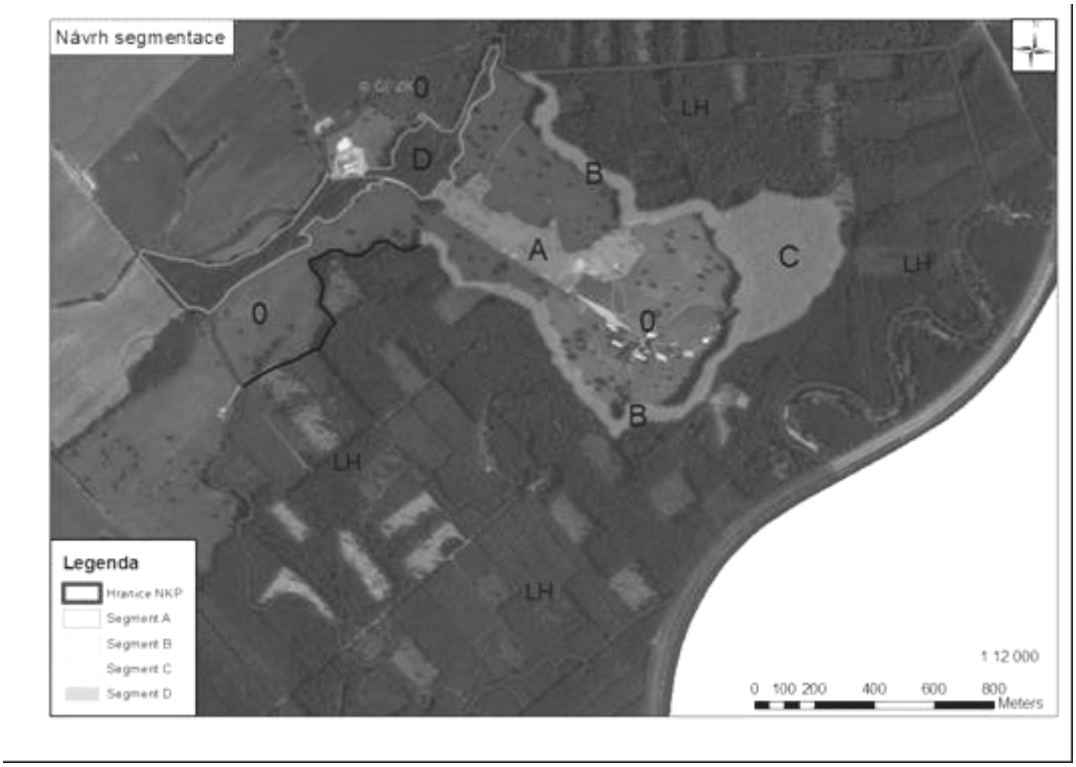

Fig. 3: NCM Slavonic fortified settlement Mikulčice

Notices: A,B,C,D,E assessed segments
0 areas excluded of assessment

Vysočina Region

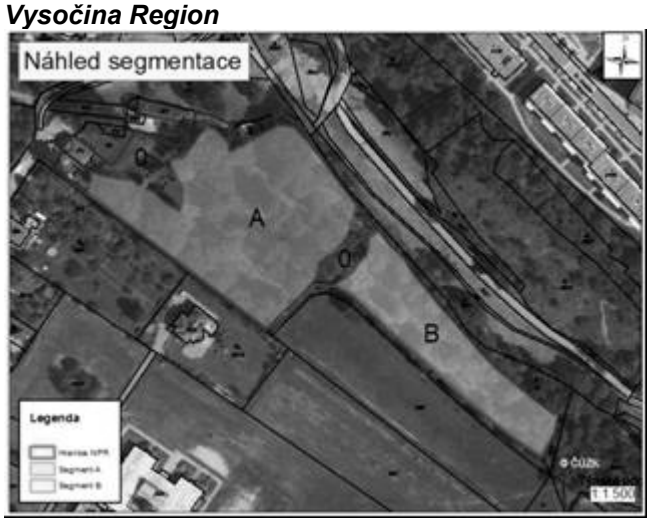

Fig. 4: NCM Jewish cemetery Třebíč

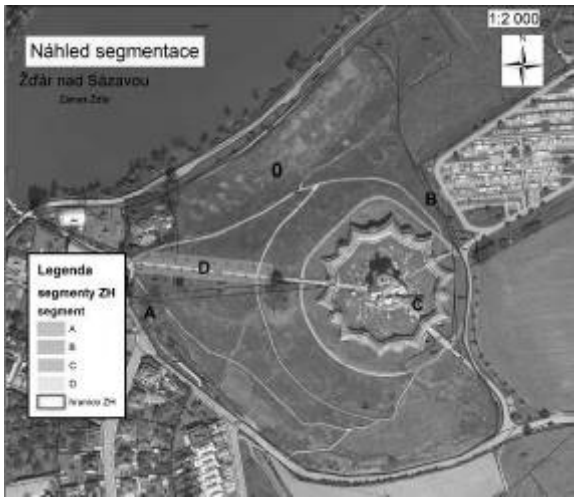

Fig. 5: NCM Church of St. Jan Nep. Žďár nad Sázavou

Zlínský Region

Fig. 6: NCM Castle Kroměříž

Fig. 7: NCM Castle Buchlovice

Notices: A,B,C,D,E assessed segments
0 areas excluded of assessment

Tab. 2: Cumulated results of national cultural monuments´ natural communities

	Jihomoravský Region			Vysočina Region		Zlínský Region	
	NCM Castle Valtice	NCM Slavonic fortified settlement Mikulčice	NCM Baroque castle Lysice	NCM Jewish cemetery Třebíč	NCM Church of St. Jan Nep. Žďár nad Sázavou	NCM Castle Kroměříž	NCM Castle Buchlovice
Age structure of trees	1	2	1	1	1	1	2
Health status of trees	3	1	1	1	1	3	3
The amount of tree individuals (species) on the border of their ecological optimum	1	1	1	2	1	2	2
Age structure of shrubs	1	1	1	1	-	-	-
Health status of shrubs	1	1	1	1	-	-	-
The amount of tree individuals (species) on the border of their ecological optimum	1	1	1	1	-	-	-
Final assess.	1	1	1	1	1	2	2

Notice: - means that shrubs are not presented within the natural communities of specified national cultural monument

Conclusion

The article presents the results which were obtained within the process of verification of the Methodology of assessment of the threat risk to the vegetation (natural communities) of cultural monuments, parks and gardens (Kupec, Deutscher, 2013) which was developed on the Department of Landscape Management of Faculty of Forestry and Wood Technology at Mendel University in Brno. The methodology has been designed as a part of the results obtained during the elaboration of a research task named „The identification and assessment of threat hazard on natural communities of cultural monuments“ guaranteed by the Ministry of Culture CR. The methodology was applied for the treat risk assessment of the national culture monuments´ natural communities located in three regions of Czech republic (Jihomoravský, Zlínský and Vysočina Regions) in 2013 and 2014 years. Specifically, seven natural communities of seven national cultural monuments were assessed. These were divided into segments on which the following tree and shrubs layers assessment were carried out. On the base of the results it can be stated, that the level of threat risk of natural communities of solved national cultural monuments located in Jihomoravský and Vysočina Regions can be characterized as low in Zlinský Region as medium.

References

Buček, A., Lacina, J. (1999): Geobiocenologie II. Mendelova zemědělská a lesnická univerzita Brno, 249 s

Kolektiv: Monitoring zdravotního stavu lesa v České republice. Ročenka programu ICP Forests/Forest Focus 2006 a 2007). Výzkumný ústav lesního hospodářství a myslivosti, Strnady, 2007

Kupec, P., Deutscher J. (2013): Metodika hodnocení ohrožení vegetace památek, parků a zahrad. Průběžná zpráva úkolu MK ČR č. DF12P01OVV035 Hodnocení stavu a identifikace rizik přírodních společenstev kulturních památek za rok 2013. MENDELU v Brně.

Kupec, P., a kol. (2014): Metodika hodnocení ohrožení vegetace památek, parků a zahrad. Průběžná zpráva úkolu MK ČR č. DF12P01OVV035 Hodnocení stavu a identifikace rizik přírodních společenstev kulturních památek za rok 2014. MENDELU v Brně.
Vyskot, I. a kol. (2003): Kvantifikace a hodnocení funkcí lesů České republiky. [S.n.]: Nakladatelství 131 Margaret. 168 s. ISBN 80-900242-1-1

Acknowledgement
This contribution was supported by the project DF12P01OVV035 „Identification of significant areas with cultural and historical values threatened by natural and anthropogenic stresses “, 2012–2015, for Ministry of Culture of the Czech Republic.

Souhrn
Článek prezentuje výsledky verifikace metodiky Hodnocení stavu a identifikace rizik přírodních společenstev kulturních památek, která byla vytvořena na ÚTOK LDF MENDELU v Brně v rámci projektu Hodnocení stavu a identifikace rizik přírodních společenstev kulturních památek. Verifikace metodiky byla prováděna v letech 2013 a 2014 přírodních společenstvech národních kulturních památek ve Zlínském a Jihomoravském kraji a kraji Vysočina. Konkrétně bylo hodnoceno sedm národních kulturních památek. Tyto byly v souladu s postupem metodiky nejprve rozděleny na homogenní segmenty, na kterých bylo následně provedeno hodnocení parametrů stromového a keřového patra. Na základě šetření se ukázalo, že míra ohrožení přírodních společenstev šetřených národních kulturních památek v Jihomoravském kraji a kraji vysočina je nízká (s nutností zásahu 30 let), ve Zlínském kraji střední (s nutností zásahu 10 let). Jako parametr, který byl hodnocen jako parametr s vysokou mírou rizika (s nutností zásahu do dvou let) lze hodnotit zdravotní stav stromového patra v případě tří národních kulturních památek.

Contact:
Assoc. Prof. Ing. Petr Kupec, Ph.D.
Phone: +420 545 134 097, e-mail: petr.kupec@mendelu.cz

UTILIZATION OF DARK SKY PARKS IN NATURE TOURISM

Martin Labuda
Department of Landscape Ecology, Faculty of Natural Sciences, Comenius University, Mlynská dolina B2, 84215 Bratislava, Slovak Republic

Abstract
Nature tourism is one of environmental friendly forms of tourism. Dark Sky Parks are one of important measures to support nature tourism in the protected areas. The main scopes of astro tourism are to establish Dark Sky Park and the implementation of measures focused on dark sky protection, i.e. the elimination of light pollution over model area. The region of the Nature Park Nossentiner/Schwinzer Heide is characterised by low settlement density and large, continuous forest areas, which lead to low light pollution. It is very important from the view of ecology, e.g. by the protection of night animal species. On the other hand, these characteristics can be fully used in new tourism concept in that protected area.

Key words: light pollution, nature conservation, night sky brightness

Introduction

Nature tourism should be developed not only in protected areas, but also in other regions, where it is possible to apply this form of tourism. Dark Sky Parks are important, modern and fully applicable tool of nature tourism in praxis. Their number and importance increase progressively in many countries of the world. In this paper, we point out a possibility to establish Dark Sky Park on the model area of Nature Park Nossentiner/Schwinzer Heide. Another goal is to introduce astro-tourism as a tool for the conservation and the development of nature landscape, as well as the recovery of traditional cultural landscape ant its biodiversity. Dark Sky Park in the model area is proposed according to Dark Sky Park Poloniny.

Dark Sky Parks and the protection of dark sky

One of the most progressive environmental changes is the decrease of natural darkness caused by the excessive emission of artificial light. The study of global environmental change has to take into consideration this phenomenon of light pollution (Cinzano et al., 2001). The lack of darkness in night disturbs circadian rhythm, which has negative impacts on flora and fauna.

Duriscoe (2001) formulated optimistic appeal: „Unlike losing a species to extinction, topsoil to erosion, or virgin lands to development, the night sky is 100% recoverable".

There are only few areas in Europe, where night sky is not polluted by artificial light sources. Therefore, it is important to preserve the quality of dark sky in these areas and to improve it using various measures. One of them is the establishment of Dark Sky Park in such regions. The first condition for that is dark sky and the restriction of disturbing artificial light factors using effective measures (Held et al., 2013).

Areas with dark sky can be established as Dark Sky Park by several organisations:

- Royal Astronomical Society of Canada (RASC)
- International Dark Sky Association (IDA) establishes: Dark Sky Communitie, Dark Sky Reserves , Dark Sky Parks
- Starlight Initiative establishes: Star Parks**,** Starlight Reserves

Nature tourism

According to United Nations World Tourism Organisation (UNWTO) nature tourism is the form of tourism, by which the observation and enjoying of nature is the main motive of travelling (UNWTO, 2002).

Nature tourism is a responsible travel to natural areas, which conserves the environment. It is tourism based on the natural attractions of an area. Examples include birdwatching, photography, stargazing, hiking, fishing, and visiting parks (Nature Tourism Programme, 2014).

Materials and methods

Methodological progress can be characterised as integrated and logical flow of following steps: the reconnaissance of terrain, the study and the analysis of documents and scientific literature, the mapping of external lighting, the measurement of night sky brightness. The geographical location of model area is shown on Figure 1. At present, it is almost finished the proposal of Dark Sky Park Nossentiner/Schwinzer Heide. The selected aspects of this concept (night sky brightness measurements, involved persons and lighting plan) are introduced in this paper.

The measurements of night sky brightness were done in Nature Park Nossentiner/Schwinzer Heide (NP NSH) at many sites in months: January 2014, July 2014 and September 2014. The selection of suitable sites for measurements was done according to knowledge about region. Only sites, which allow the measurement of free sky without its covering or eclipse, were accepted. Another criterion was the spatial distribution of sites within NP NSH and the transport accessibility of each site.

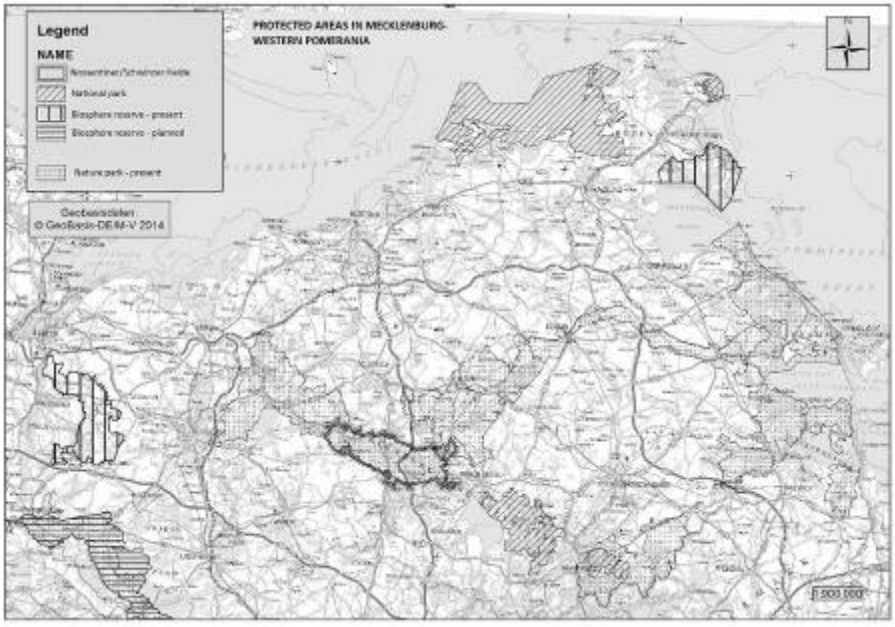

Fig. 1: Geographical location of study area

Sky Quality Meter L (SQM-L) by Canadian company Unihedron was used to measure night sky brightness in astronomic units magnitudes per square arcsecond (mag/arcsec^2). Scale is inverse, where high values mean dark sky:

21.7 truly dark sky, Milky way is visible up to horizon, black clouds
21.4 zodiacal light (in the evening in spring and in the morning in autumn) is well visible; Milky way is well visible; clouds above town are bright on horizon
20.5 Milky way is visible with low contrast, clouds are bright
19.5 Milky way is hardly discernible
18.5 few stars, very bright sky

The measurement of night sky brightness took important part in the concept preparing of new Dark Sky Park Nossentiner/Schwinzer Heide.

Results

The concept of Dark Sky Park NSH was prepared using knowledge and experiences from implemented project Dark Sky Park Poloniny in Slovakia (DSP P). DSP P is located within area of National Park Poloniny on the borders with Poland and Ukraine (Figure 2). It was established on the occasion of International year of biodiversity in 2010 as the first dark sky area in Slovakia and the 20th in the world with the total area of 48 519 ha. It is characterised by extraordinary low population density (9 inhabitants per 1 km^2). DSP P has the lowest light pollution in Slovakia. Average night sky brightness reaches 21.5 mag/arcsec^2. It is possible to observe objects and phenomena such as zodiacal light, or gegenschein (from German, established term in English).

Nature Park Nossentiner/Schwinzer Heide is one of the darkest places in Germany (Figure 3). This region has low population density (8.7 inhabitants per 1 km^2). This fact is of high ecological importance for night species protection and can be fully used for the development of offered nature tourism in the form of night sky park. In co-operation with villages, it is necessary to implement innovative external lighting, which reduces emitted light from settlements and contributes by climate protection.

The cooperation of several involved persons is needed during the establishment of DSP NSH (Figure 4). On the one side, it is important to gather knowledge and experiences within topic from various aspects. On the other side, scientists from existing Dark Sky Parks and other multipliers should spread information.

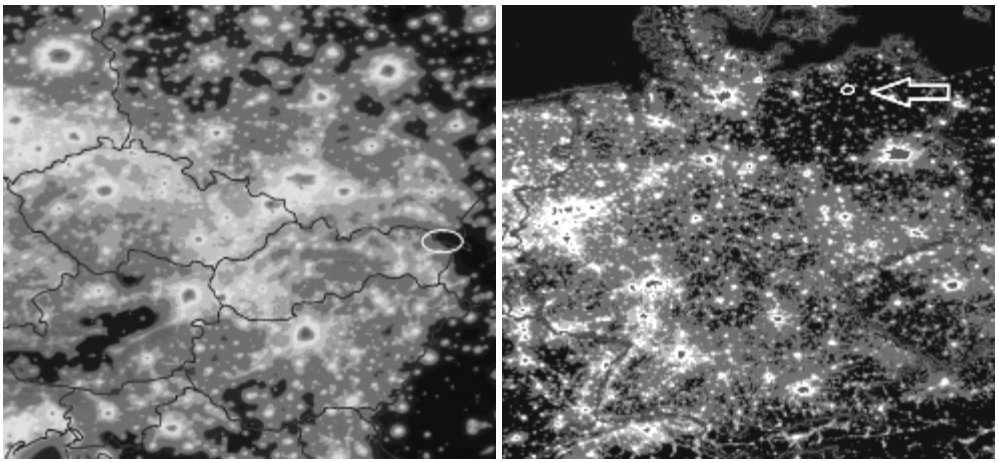

Fig. 2: Map of light pollution in Slovakia with the location of Dark Sky Park Poloniny (left). Source: **http://fjfi.cce.cz/astro/celp.jpg**

Fig. 3: Map of light pollution in Germany with the location of Nature Park Nossentiner/Schwinzer Heide (right). Source: www.lichtverschmutzung.de

Regional associations of tourism bear the highest responsibility for the marketing of concept through the creating and the support of attractive activities for visitors. Nature Park Service is the main coordinator in all processes. The participation of inhabitants is necessary to achieve acceptation. The building of network among those involved persons may achieve that dark sky park will be a tool for the support of economically weak regions.

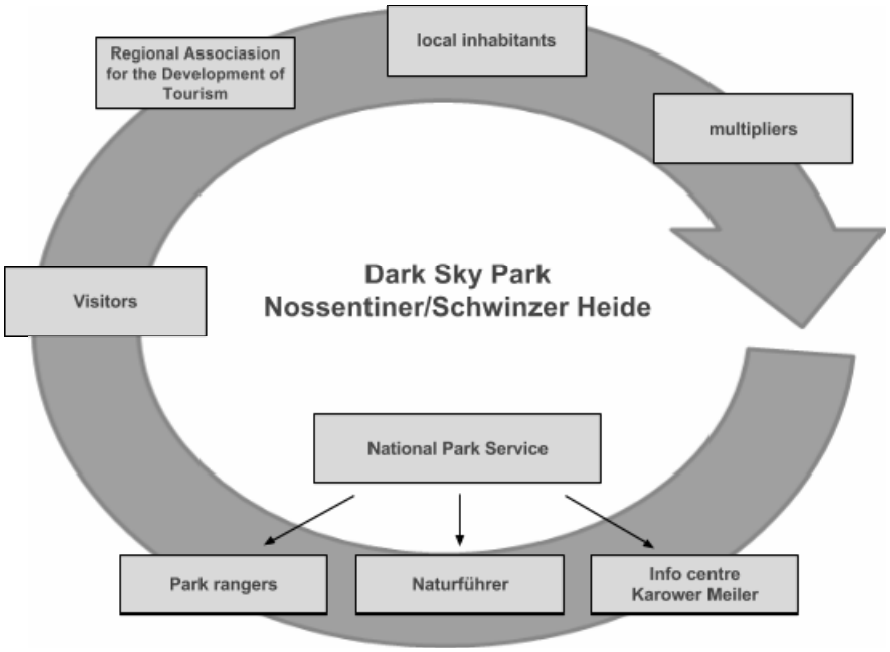

Fig. 4: Involved persons in Dark Sky Park Nossentiner/Schwinzer Heide

The important part of concept was the selection of sites, which are suitable for astronomical observations. Selected sites had to fulfil following criterion:

- no light pollution sources in visual field (360°), ideally near water level
- well transport accessibility – existing infrastructure (parking places, roads, tourist paths)
- suitability for tourism from species and area protection viewpoint (exclusion of sites, which are the part of NR and FFH)

Following table (No. 1) shows brief overview of night sky brightness measurements at selected sites in NP NSH

The sites, which belong to class 4 and 5, are the most important from the view of concept and realisation of Dark Sky Park NSH compare with Figure 5. They are ideal sites for astronomical observations as they reach values greater or equal to 21.40 mag/arcsec^2.

Tab. 1: Distribution of sites into categories

Class	Value (mag/arcsec^2)	Number of sites
Class 1	18.5-19.49	1
Class 2	19,50-20,49	2
Class 3	20,50-21,39	20
Class 4	21,40-21,69	33
Class 5	≥ 21,7	2

Lighting plan

The goal of lighting plan is to set stable rules and directives for external lighting in proposed Dark Sky Park NSH. Essentially, there should be no inappropriate external lighting in Nature Park NSH in the future. As Figure 6 shows, the best lights are those, which's the ratio of effectively used light is the highest (two most right lights in Figure 6). The example of such lights is shown in the Figure 7. Important parameter by the assessment of unused emitted light is Upward Light Ratio. It describes how many percent's of light are emitted into atmosphere in imaginary circle above lighting. Optimum value is equal to 0. In this way, it is one of criterion valid for Dark Sky Park (Luginbuhl et al. 2006).

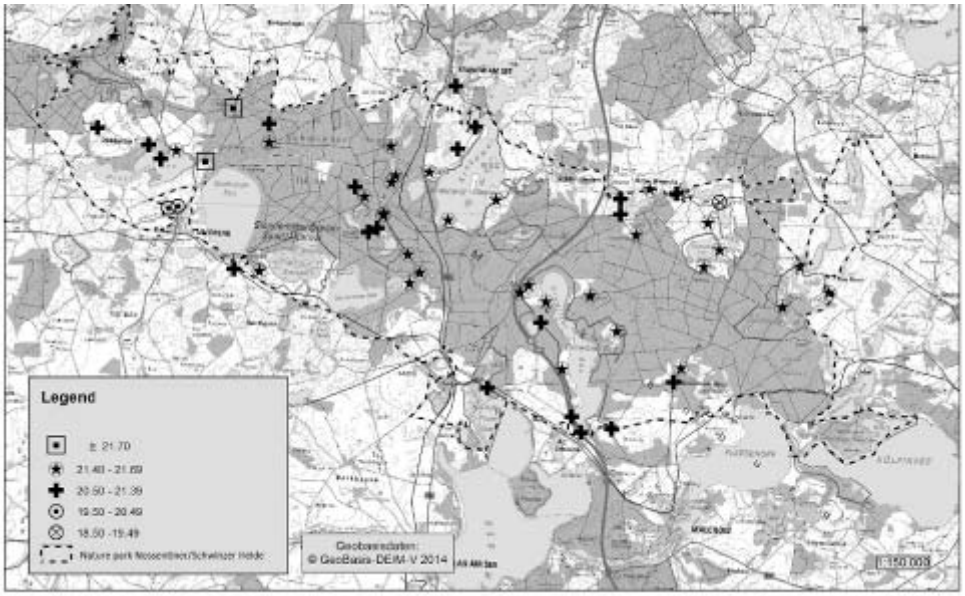

Fig. 5: Selected sites for night sky brightness measurements in Nature Park Nossentiner/Schwinzer Heide

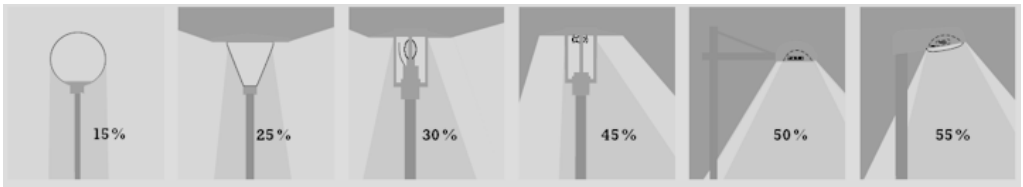

Fig. 6: Ratio of effectively used light by different lighting types (© S.A.F.E.)

Fig. 7: Examples of appropriate lighting in NP NSH (©Koch, 2014)

Discussion

The concept of Dark Sky Park Nossentiner/Schwinzer Heide is not the first planed dark sky park in Germany. Naturally dark sky is rare phenomenon in developed countries. Therefore, it is necessary to protect it. Naturally dark sky is the base condition for the establishment of Dark Sky Park, which is basis for the increase of area attractiveness from astro-tourism viewpoint.

The topic of dark sky parks was discussed by several authors (Kossack 2013, Held et al. 2013, Marín et al. 2010). E.g. Kossack (2013) lists the tourism advantages of such parks on the example of Nature Park Westhavelland. The author came to conclusion that this form of tourism is not only sustainable, but it also prolong tourist season and enlarge the attractiveness of Nature Park. The concept of dark sky park enables to enlarge added value of region and its economical utilization within sustainable development in margin regions.

Conclusions

Dark sky protection and light pollution elimination belong to important environmental problems in developed countries, i.e. Germany, too.

The establishment of Dark Sky Park is one of useful nature tourism tools, which is basis for astro-tourism. Measurements confirmed that Nature Park Nossentiner/Schwinzer Heide fulfil difficult requests for night sky quality, as well as other requests for the establishment of dark sky park. At the same time, the basis of regional partners was created, which will further develop concept. It is assumed that it will increase added value of this margin region and it will improve its position from the viewpoint of sustainable tourism implementation.

References

Cinzano, P., Falchi, F., Elvidge, C. D. (2001): The first World Atlas of the artificial night sky brightness. Padova: Universita` di Padova, Dipartimento di Astronomia, 707 pp.

Duriscoe, D. (2001): Dark-Sky Park Program In: Weickelt, H. (2010): Der Naturpark Westhavelland als Sternenpark? - Aspekte von Ökologie, Beleuchtung und Tourismus. Bachelorarbeit, HNE Eberswalde: Hochschule für nachhaltige Entwicklung, 68 pp.

Held, M., Hölker, F., Jessel, B. (2013): Schutz der Nacht – Lichtverschmutzung, Biodiversität und Nachtlandschaft. Bonn: Bundesamt für Naturschutz, 189 pp.

Kossack, S. (2013): Entwicklung von Erfolgsfaktoren für die touristische Nutzung von Sternenparks. Master Thesis, HNE Eberswalde, Hochschule für nachhaltige Entwicklung, 123 pp.

Luginbuhl C., Jones, R., Richman, A., Moore, C. (2006): Dark-Sky Program.- Version 1.31, Arizona

Marín, Cipriano, Wainscoat, Richard; Fayos-Solá, Eduardo, (2010): 'Windows to the Universe': Starlight, Dark Sky Areas, and Observatory Sites. Paris: International Secretariat of ICOMOS, 283 pp.

Nature Tourism Programme, (2014): What is nature tourism? Online: https://tpwd.texas.gov/landwater/land/programs/tourism/what_is/

UNWTO, (2002): Ecotourism and Protected areas. Online: http://sdt.unwto.org/en/content/ecotourism-and-protected-areas, 93 pp.

Acknowledgement

This article was supported by VEGA-Project No. 2/0133/14.

Souhrn

V posledních letech výrazně stoupá poptávka po nových, environmentálně vhodných formách turismu, ke kterým patří i přírodní turismus. Zejména v západních zemích jsou etablované různé aktivity, při kterých je pozorování přírody ústředním motivem samotného cestování (bird watching, astroturismus). Posledně jmenovaná aktivita je bezpochyby environmentálně vhodnou, mající minimální negativní dopad na složky ŽP, či krajinu. Základním předpokladem pro vyhlášení území za např. Park tmavé

oblohy je přirozeně tmavá obloha a minimální světelné znečištění, které zajišťují možnost pozorovat tmavou noční oblohu se všemi jejími specifiky. Astroturismus se stal efektivním nástrojem rozvoje rurálních oblastí již v několika zemích světa, aktuálně se etabluje v ekonomicky vyspělých zemích (Německo), kde jsou řídce osídlené oblasti, postupně vyhlašovány za Parky tmavé oblohy a tmavá noční obloha se stává předmětem ochrany ve smyslu mezinárodních pravidel. Jednou z těchto raritních oblastí je i Přírodní park Nossentiner / Schwinzer Heide, kde se dokončuje koncept Parku tmavé oblohy. Vybrané aspekty tohoto konceptu představujeme i v našem příspěvku.

Contact:
RNDr. Martin Labuda, PhD.
Phone: +421 260 296 589, e-mail: mlabuda@fns.uniba.sk

VISITORS' PERCEPTION OF CHOSEN SUBURBAN RECREATIONAL LOCALITIES OF BRATISLAVA CITY

Katarina Pavlickova, Viera Novanska Chrenscova
Department of Landscape Ecology, Faculty of Natural Sciences, Comenius University in Bratislava, Mlynska dolina B2, 842 15 Bratislava, Slovak Republic

Abstract
Suburban tourism is considered as a subsystem of recreational tourism. It is organized in appropriate leisure area near by cities, agricultural and residential agglomerations (Michalová, 2001). The target of its recreation-health function is focused to the regeneration of physical and mental power of people, the freshness and body amenity in their interrelationships. This is a theoretical basis of our research started in 2014 year.
The main target of our research are suburban recreational localities of Bratislava city. As the initial step the method of questionary with a goal to recognize visitors´view on main components of their satisfaction with the quality of provided services on attractive localities which are appropriate for trips, walks and whole day tourings was chosen. Questionary survey was realized in natural environment of Zelezna studnicka situated in the landscape protected area Small Carpathians and natural-cultural environment of Devin castle surrounded by various protected zones and elements.
The focus of our research is in a harmony with the National Tourism Development Strategy to 2020 year (MDVRR SR, 2014), concrete with the particular strategic aim: improved exploitation of natural, cultural and historical potentials of Slovakia in existing developed destinations.

Key words: survey, tourism, Zelezna Studnicka, Devin

Introduction

Cities possess a various degree of attractiveness for tourism. A good outlook for further growth can be found especially in cities with a well-preserved historical centre, which have been declared historical reserves, can boast a number of natural and cultural monuments, sufficient infrastructure and organize events attractive for tourists. Tourism in cities is quite a complex phenomenon, which has begun growing significantly in the past decade. The number of city tourists has been increasing, which results in the rise of tourism intensity. Tourism in cities is concentrated in specific areas, the so–called municipal tourist districts (Hayllar, Griffin, Edwards, 2008). These areas are noted for a high amount of tourist attractions, and, as a result, a high density of tourists and services related to tourism.
The expansion of urbanization is also connected to a growth in suburban tourism as well as suburban recreation. Suburban recreation is linked to natural environment, which through its quality makes it possible to enjoy one´s physical well being and mental relief. It is an asset to an activization of this area and its tourism branches, too. Recreation can take place within the site itself or in its close vicinity. Suburban recreation usually has a short-term character. Often it is only a half a day´s, one day´s or a weekend´s long recreation combined with staying overnight. Its typice feature is a small distance between a place of residence and recreation site. (Gúčik, 2010).
Recreation area, where suburban recreation can take place, has a diverse character depending on what ways people spend their spare time. It is, in a broader sense of the word, constituted by places offering an oportunity to recognize arts, historical and cultural monuments, nature as well as places assigned to sport and leisure.
It is important for human health and well-being to balance the growing uniformity of the environment, frequent dreariness of a job, overall hasty and overtechnized consumer way of life with beauty, uniqueness, art and closeness to nature. (Kvasničková et al., 2002).
Visit rate of a recreation place depends on a quality and attractivity of environment, important is also a level of services offered as well as an accesibilty to the location. The needs of visitors are quite diverse, and can be divided into target and facilitating. In order to satisfy them there is the product of tourism, with services being its major part. The ability to satisfy the needs and fulfill visitors´ expectations is dependent on the quality of services, which reflects a sum of their usefulness attributes. Useful characteristics of services are marks of their quality (Orieška, 2011). Quality expresses a sum of usefulness attributes and characteristics of services (commodities), which give it the ability to satisfy customers´ needs and expectations. Quality does not have to be understood as the highest level, as the best and most expensive, though, as a guest may expect. As a service satisfies a customer´s needs, he understands quality as a balance of his expectations about the service (commodity) with reality. In tourism, quality is considered as one of the decisive factors in customers´ satisfaction. Characteristics of a service or offering a service may be quantitative

(measurable) or qualitative (comparable). Decisive in evaluating the quality of service is an assessment by a customer, whose needs and expectations are fulfilled by their usefulness attributes. That is why it is necessary to emphasize the importance of the customer´s perception of quality. (Gučík, 2001).
The translated article brings partial results of a study conducted in the area of Bratislava from the point of view of torurism growth.

Aim and methods of survey
The major aim of exploring the city of Bratislava was, by means of a questionnaire research, to assess the perception of suburban recreation localities of the city of Bratsialava by its visitors as well as their views on main constituents of satisfaction with the quality of offered services. The explored areas of interest were locations of Zelezna studnicka and Devin, which are areas suitable for trips, walks and day-long hiking. 202 respondents were addressed. The filled-out questionnaires were received from all of the addressed respondents (100 % return).
The questions in the questionnaire were answered by 102 respondents from Devin locality and 100 respondents from the locality of Zelezna studnicka. The staticstical body therefore comprised 202 respondents (n = 202). 46 % of males and 54 % of females participated in the study, with the population rating from 16 to 45 years of age being the major part. Out of all the participating, represented were respondents with university education (63 %), secondary education with school-leaving exam (31 %), secondary education without school-leaving exam (2 %) and elementary education (4 %).
For the purposes of the study an interrogative method was chosen – a questionnaire suitable especially in cumulative collecting of information, but also in gaining opinions and attitudes to issues froma higher number of respondents (Halašová, 2001). The questionnaire consisted of open, scaled and semi-closed questions/items, which offered a possibility of selecting a single or multiple answers. Collecting data took place in 2014 year. Respondents were addressed in person and asked to fill in the questionnaire.

Characterization of affected area
Bratislava is the largest city in Slovakia with its area of 367,58 km². In terms of geomorphological structuring, the area of the city incorporates three gemorphological bodies. All the southern and eastern part of the area is taken by Podunajska flatland, and Podunajska lowland, respectively. In the central part of this area altitude rises due to Small Carpathians mountain range, which splits into Devin Carpathians and Pezinok Carpathians. The area of the city is touched by the southern bulge of Zahorska lowland known as Borska lowland range. Several water courses flow through the area of Bratislava. Out of these, river Danube, together with its tributary river Morava, stands for the most important and commercially used.
The area of the city was in 2011 year inhabited by the population of 415 589, out of which 194 279 were males and 221 310 were females. More than 75 % of its inhabitansts work in service sector, made up primarily of commerce, banking, informatic technologies, telecommunications, tourism etc.
The city can be considered as one of the most signifiant Slovak tourism centers. The central part of the Old City is a historical monument zone, while the historical core together with Bratislava castle and Podhradie is a historical reserve. Moreover, Bratislava boatsts lemure zones, parks and facilities with abudance of natural features, which allow for lemure and sport opportunities as a part of suburban recreation.
Zelezna studnicka belongs among the most frequently visited recreation sites of Bratislava. It´s one of the Male Karpaty forest park locations in Bratislava as well as a popular recreation and sports natural resorts in Bratislava. The Vydrica stream flows through it, which supplies four ponds in its middle with water. In the vicinity of the prime stream there are springs, wells and wetplands. A peculiarity of Zelezna Studnicka is the harmony of technical purpose buildings (mills, flumes, ponds, forest and fishing industry installations) with buildings popular with Bratislava population of all generations. Zelezna Studnicka was settled by millers, who built mills there, centuries ago. Water mills, which were first noted as soon as 1455 year, vanished and have been used as sight-seeing restaurants. They used to be the target destination of an excursion path in past. Out of these mills, the 9th one – Suchy mly, has been preserved. Klepac, originally the 7th mill, disappeared before 1970 year and is but a ruin today. A notable technical monument is the system of four lakes built in 1846 year serving as a propeller of nine Vydrica mills. Lakes are nowadays used for fishing. The city intends to use them perspectively for rowing. The instructional path Cerveny most – Zelezna Studienka – Kamzík – leads through Zelezna Studienka. The path leads through locations which are not only interesting from the point of view of recognizing historical and natural values, but also attractive for tourism.

Devin is deemed to be one of the most beautiful locations in Bratislava. Its vicinity provides exquisite natural sceneries, interesting cycling routes, touristic paths, proximity to Small Carpathians. Among tourist attractions belongs Devin castle, too. At present Devin castle and his nearest proximity count as the most popular short hike paths out of the capital. Apart from the chance to visit the castle itself, it offers opportunities for walks on the riverside of the Danube under the castle rock, beside Morava and across adjacent streets of Devin (local part of Bratislava). The increased interest of tourists is reflected and adjusted in the offers of refreshment and restaurant services near the entrance to the castle premises as well as on the Danube riverside.
Both localities and their environment are wellknown also by their natural beauties full of protected areas (see table 1). Zelezna studnicka is situated on the boundaries of Protected Landscape Area Small Carpathians as well as close mountains toward Devin castle.

Tab. 1: Protected areas of Zelezna Studnicka and Devin (SOP SR, 2015)

Type	Name	Landscape Protected Area	Expanse (ha)	Year of declaration (revision)	Level of protection
Devin					
NPP	Devinska hradna skala	-	1,7000	1985	4
NPR	Devinska Kobyla	Small Carpathians	101,1157	1964, 1986	4
PP	Devinska lesostep	-	5,0966	1992	4
CHA	Devinske aluvium Moravy	-	253,1600	1999	4
PR	Slovansky ostrov	-	34,3772 (protected zone 2,5562)	2009	5
CHKP	Vapenicky potok	-	2,5161	2007	4
PR	Fialkova dolina	Small Carpathians	20,5879	1993	5
Zelezna Studnicka					
PP	Rosslerov lom	-	2,3828	1990	4

Notes: NPP – National Natural Monument, PP – Natural Monument, NPR – National Natural Reservation, PR – Natural Reservation, CHA – Protected Area, CHKP – Protected Cultural Monument

Instead of that Zelezna studnicka locality is intersected by SCI (SKUEV0388 Vydrica) and close to Devin castle is located as SCI (SKUEV0280 Devinska Kobyla) so SPA (Dunajske luhy).
From the poit of view of wetlands close Devin castle locality is located the internationally important wetland Morava River floodplain.

Analysis and interpretation of results
Obtained data from 202 questionnaires were qualitatively evaluated. Tables showed results in quantity rates (%). At the beginning were respondents asked for „What was a main reason for visiting the locality?“ The evalutaion is representing by the table 2.

Tab. 2: Main reason for visiting the locality

Type of Reason	Devin (%)	Zelezna studnicka (%)
Relaxant	64	56
Nature beauties	54	37
Culture and history	39	4
Šport	19	34
Other: visiting the playground and/or sportground	0	9
Other: to take a dog out for a walk	2	0
Other: friends´ meeting	3	2
Other: health walk	0	1

As we can see visitors of Devin locality came there mainly for a leisure (64 %), nature recognition (54 %), culture and history (39 %). Zelezna studnicka area was mainly visited for the purpose of leisure (56 %), nature recognition (37 %) and sport (34 %).
To the locality of Devin came 38 % respondents by city public transport, 33 % respondents by the car, 18 % by the bicycle and 11 % by walking. To the locality Zelezna studnicka came 55 % respondents by the car, 31 % by city public transport, 9 % by the bicycle a 5 % by walking.
Respondents were also invited to evaluate their satisfaction with services quality offered at the locality. The results overview is showed in the table 3.

Tab. 3: Services evaluation

Services	Devin (%)				Zelezna studnicka (%)			
	1	2	3	4	1	2	3	4
Traffic and parking	62	19	19	0	63	22	15	0
Existing information system – tourism marking, informatio tables	49	23	22	6	53	13	34	0
Tourism information centers	19	11	42	28	26	8	54	12
Feeding and refreshment	53	10	35	2	47	25	26	2
Participation in cultural activities and entertainment	51	11	28	10	55	12	31	2
Enjoyment of sport, relaxation	56	8	26	10	92	3	5	0
Tourism services level	32	30	24	14	41	28	30	1
Level of services prices	48	41	11	0	39	37	24	0
Other services (shops, municipal services, health services, banks, post office)	22	9	60	9	30	11	59	0

Notes: 1-satisfied, 2-unsatisfied 3–unused, 4-missing

Respondents of both localities used mainly traffic, feeding, sport-recreational, cultural and information services. Respondents of Devin locality were mainly satisfied with traffic and parking (62 %), possibilities for sport/leisure enjoyment (56 %) and feeding and refreshment possibilities (53 %). Unsatisfied were with the level of services prices (41 %), tourism services level (30 %) and existing information system (23 %). Respondents of Zelezna studnicka were satisfied mainly with possibilities

for sport/leisure enjoyment (92 %), traffic (63 %) and possibilities for cultural/entertainment possibillities (55 %). On the contrary they were unsatisfied with the level of services prices (37 %), %), tourism services level (28 %) and with feeding and refreshment possibilities (25 %).
At both localities respondents point out missing tourism information centres (28 % Devin, 12 % Zelezna studnicka).
Finally visitors were asked about 2 open questions „What did you not like at the locality (what did you negatively amaze)?“ and on the opposite „What did you like at the locality (what did you positively amaze)?“ Resulting from answers visitors consider few parking places (16 %), weak social facilities (13 %), waste contamination (8 %), absence of waste baskets (8 %) and unsatisfied information system (1 %) as main problems. Respondents were also unsatisfied with the level of feeding facilities. At the locality Devin respondents consider weak quality of feeding facilities (14 %), absence of waste baskets (9 %), weak information system (8 %), weak social facilities (7 %), waste contamination (3 %), weak maintenance of traffic (3 %) and weak possibilities for sporting (2 %) as main gaps.
Respondents of Zelezna studnicka indicated the locality as ideal for leisure and relaxation for families with children, young people and doglikers (8 %). They liked nature (32 %), playgrounds and sporting possibilities (17 %), lot of attractions (14 %), boating possibilities (6 %), reconstructed amphitheatre (5 %), tourism trails (1 %) and existing of eduactional tables (1 %). At the locality Devin were visitors fascinated with beauties of surrounding nature (52 %), activities organised on the castle Devin (11 %), cultural actions (6 %), tourism trails (4 %) and educational tables (2 %). Some of them were satisfied with services (3 %) and traffic (2 %).

Conclusion

Within the acitivities of suburban recreation the influence of the age was very important. At localities mainly young people were overweigted. It could be concidered as a favorable trend, but at the other hand it must be increased sevices development for different age categories, too.
Visitors mainly critically refered unsatisfied quality and sortiment of feeding/social facilities, parking and problems with waste contamination. Positively were accepted mainly nature beauties and the fact that both localities could be considered as ideal places for leisure and relaxation.
To maintain the aim of the national tourism strategy, the sortiment and quality of services including traffic and parking must be increased in future. As both localities and their environment are full of natural protected areas also many restrictions are need to be maintain, especially creation of new trails at Zelezna Studnicka locality (SKUEV Vydrica), walking out-off official trails at Devin locality (SKUEV Devinska Kobyla) and using of light and sound effects on both localities.

References

Gučík, M. (2001): Cestovný ruch. Bratislava : Media Trade, 105 s. ISBN 80-08-03071-2.
Gučík, M. 2010. Cestovný ruch. Úvod do štúdia. Banská Bystrica : Univerzita Mateja Bela, Ekonomická fakulta, 73 - 74 s. ISBN 978-80-89090-80-8.
Halašová, M. (2001): Výskumné metódy v environmentálnej výchove. Spoločenskovedná časť. Banská Bystrica : Fakulta prírodných vied Univerzity Mateja Bela, 55 s. ISBN 80-8055-488-9.
Hayllar, B.; Griffin, T.; Edwards, D. (2008): City Spaces – Tourist Places: Urban Tourism Precincts. 1st ed. Oxford, (UK): Elsevier Ltd. 374 s. ISSN 978-0-7506-8195-7.
Kvasničková, D. et al., 2002. Životné prostredie. Bratislava : Slovenské pedagogické nakladateľstvo, 160 s. ISBN 80-08-03341-X.
Michalová, V. et al., (2001): Služby a cestovný ruch : súvislosti, špecifiká, cesta rozvoja. Bratislava : Sprint vfra, 524 s. ISBN 80-88848-78-4.
MDVRR SR (Ministry of Transport, Construction and Regional Development of the Slovak Republic), 2014: The strategy of the tourism development to 2020 year. Dostupné na: www.telecom.gov.sk
Orieška, J., (2011): Služby v cestovnom ruchu. I časť. Banská Bystrica : Univerzita Mateja Bela, Ekonomická fakulta, s. 17- 18. ISBN 978-80-89090-93-8.
Štátna ochrana prírody Slovenskej republiky, 2015. Dostupné na: www.sopsr.sk
Štatistický úrad SR, (2012): Mestská a obecná štatistika. [online] január 2015. [cit. január 2015] Dostupné na: http://app.statistics.sk/mosmis/sk/run.html.
Štatistický úrad SR, (2011): Základné údaje zo Sčítania obyvateľov, domov a bytov 2011. Dostupné na: www.scitanie2011.sk alebo www.statistics.sk.

Acknowledgement

The contribution is prepared under the project VEGA 2/0133/14 „The ecological model of tourism development based on the feasibility and assumptions localization and realization of the landscape“.

Souhrn
Příměstský cestovní ruch je subsystémem rekreačního cestovního ruchu. Je to rekreace, která se pořádá ve vhodném rekreačním prostoru v blízkosti měst, průmyslových a sídelních aglomerací (Michalová, 2001). Jeho funkce je rekreačně-zdravotní, která se zaměřuje na regeneraci fyzických a duševních sil člověka, zdatnost, svěžest a tělesnou pohodu v jejich vzájemném propojení. Tato teze je základem našeho výzkumu. Hlavním cílem zkoumání je příměstský cestovní ruch ve městě Bratislava, kde jsme si na začátek zvolili prostřednictvím dotazníkového výzkumu zjistit pohled návštěvníky na hlavní komponenty spokojenosti s kvalitou poskytovaných služeb na lokalitách, které jsou vhodným místem pro výlety, procházky a celodenní turistiku. Dotazníkový výzkum byl proveden v přírodním prostředí Železné studánky a v přírodně-kulturním prostředí lokality hradu Děvín. Zaměření výzkumu je v souladu se Strategií České republiky rozvoje cestovního ruchu do roku 2020, která si jako jeden ze svých 3 cílů zvolila lépe využívat přírodní a kulturně-historický potenciál Slovenska podporou cílových míst, kde již existuje stabilizovaný poptávka klíčových trhů, tzn. nepodporovat nová cílová místa s nestabilními segmenty trhu, které nepřinesou dostatečný synergický efekt.
Z výsledků vyplývá, že návštěvníci na lokalitu Děvín přišli zejména za účelem odpočinku, poznávání přírody, kultury a historie. Areál Železné studánky navštívili návštěvníci za účelem odpočinku, poznávání krás přírody a sportu. Naopak návštěvníci kritizovali zejména nedostatečnou kvalitu stravovacích zařízení a malou pestrost nabízených služeb. Vše ale třeba zlepšovat v souladu s ochranou přírody a krajiny nakolik jsou obě lokality zajímavé i z tohoto hlediska.

Contact:
Assoc. Prof. Katarina Pavlickova
Phone: +421-2-602 96 579, e-mail: pavlickova60@gmail

WATER QUALITY AND RECREATION FUNCTIONS IN THE PROCESS OF ABANDONED SMALL WATER RESERVOIRS AND PONDS RESTORATION AND MANAGEMENT PROPOSAL

Miloš Rozkošný, Hana Hudcová, Pavel Sedláček, Miriam Dzuráková
T. G. Masaryk Water Research Institute, Brno Branch Office, Mojmírovo náměstí 16, 612 00 Brno, Czech Republic

Abstract
Small water reservoirs are one of the principal elements of agricultural landscape in the Central European context with different functions including fishing, angling, recreation activities. In the Czech Republic, small water reservoirs have a long historical tradition, related in particular with fish farming and construction of ponds. Relation between functions of selected small water reservoirs and water quality was studied at four localities. Ecosystems of monitored SWR with constructed wetland areas (littoral zones) significantly eliminated the pollution brought by the inflows (streams). It was confirmed that the character of outflow water quality changes is fundamentally influenced by the inflow water quality and recreation fish stock management.

Key words: small water reservoir; pond; water quality; angling; pond restoration

Introduction

Small water reservoirs are one of the principal elements of agricultural landscape in the Central European context (Juszcak, Kędziora 2003). They represent one of the most valuable natural components of the cultural landscape, otherwise entirely transformed by intense human activities (Waldon 2012). In the landscape, small water reservoirs fulfil a number of important roles. From the environmental point of view, they are significant local biocentres increasing the biodiversity of the landscape. In addition, small water reservoirs influence the microclimate. From the point of view of the water management, they retain water within the river basin and affect its further distribution; they influence the groundwater level and the soil moisture (Kosturkiewicz, Fiedler 1996). If the retention area is handled correctly, they are able to transform the flood waves.

Small water reservoir, including ponds, may also contribute to the improvement of water quality, if the principles of their correct management are observed (Rozkošný et al. 2011, Všetičková et al., 2012, 2013). Despite their irreplaceability in the landscape, small water reservoirs are among the European endangered ecosystems and they are under incessant anthropogenic pressure. The water reservoirs near large settlements and those located in intensive farming landscapes are the most sensitive ones, facing the risk of pollution by sewage, the eutrophication caused by artificial fertilisers, the drainage of littoral marshlands, etc. (Waldon 2012).

In the Czech Republic, small water reservoirs have a long historical tradition, related in particular with fish farming and construction of ponds (Vrána 2004). The first ponds were established in this territory as early as in the 10th century. However, the boom of their construction dates back to the 15th and 16th centuries, connected with the flourishing and economically profitable fish farming run by leading aristocratic families. The scope of this construction activities is reflected in the estimates of the total number of ponds in the Czech Lands at the end of the 16th century, mentioning from 75,000 to 78,000 ponds with an area over 180,000 ha. However, it is not possible to identify the final scope of this phenomenon, since most ponds were suppressed at the end of the 18th century and in course of the 19th century as a consequence of the introduction of crop rotation farming, the abolition of serfdom, unprofitability of fish farming and the sugar beet growing. The ponds became new arable land, meadows and woods. Nowadays, there are around 22,000 ponds in the territory of the Czech Republic.

Thus, more than two thirds of small water reservoirs were cancelled during the two centuries. The research of these defunct pond systems and their precise localisation is important for: proving or disproving the general hypotheses concerning the extinction of ponds in individual regions or confirmation of the grounds for their suppression; getting to know the local historical hydrological conditions; identification of the current use of former pond areas and their comparison with the surrounding non-pond areas (e.g. from the point of view of soil value); identification of the localities for a possible renewal of ponds, e.g. within National Programmes, such as the Programme of Revitalisation of River Systems or the current Landscape Care Programme, with a focus on the selected functions in the landscape

These functions include, apart from the fish farming management, biodiversity enhancement, flood events protection, protection again arable land erosion and surface water pollution decreasing above all.

Materials and methods

The research project QJ1220233 has as a main task a determination of areas of abandoned ponds within the Czech Republic, assessment of current land-use of these areas and draft of potential restoration of ponds, not only for fish farming management, but also for other reasons including flood event protection and surface water pollution decreasing with a focus on phosphorus and nitrogen retention and removal.

For the solution of these problems, it is necessary to create a spatial database mapping the areas of the historical ponds, their current use and to prepare in this way the basis for further analyses (Pavelková et al., 2012).

The database of the historical ponds which was made with using of the Ist Military Survey from 1764–1783 and the IInd Military Survey from 1836–1852, as well as the maps of the Stabile Cadastre from 1824–1843, was further analysed in the GIS environment. First of all, the current land-use in the locality of the historical pond was identified. Modified and aggregated layers of the ZABAGED vector database were used for this purpose (Pavelková et al., 2012; Havlíček et al., 2014).

As a second step, we prepared information about retention capacity of different types of the small water reservoirs and about their retention of nutrients. We used information from ponds and wetlands monitored by the Water Research Institute, p.r.i. in the period 2000 – 2015. For the detailed monitoring, there were selected these localities of small multi-purpose water reservoirs, representing agriculturally managed landscape:

1. Small water reservoir - village Želeč - 49.3472344N, 17.1273514E / main functions – water retention, biodiversity support in the agriculturally managed watershed (almost 90 % of land-use – arable land)
2. Small water reservoir - village Dražovice - 49.1990025N, 16.9417000E / main functions – sporting angling, recreation
3. Small water reservoir - village Němčice - 49.4342464N, 16.7091728E / main functions – flood protection, retention reservoir, biodiversity support
4. Small water reservoir - village Velký Rybník - 49.4860272N, 15.3088683E / main functions– flood protection, retention reservoir, biodiversity support

A monitoring of water quality, including suspended solids (TSS), parameters of organic pollution (BOD, COD, TOC, DOC), nutrient balance (anorganic forms of nitrogen, total nitrogen - TN, phosphates, total phosphorus - TP) and microbial contamination parameters (Enterococci, Feacal coliform bacteria), together with a monitoring of phytoplankton was taken in the period 2013 – 2015 in selected periods of the year with regards to climatic conditions and biological processes based on previous experience (Všetičková et al., 2012). Monitoring was focused on inlet and outlet of each reservoir and on the water body of the reservoir. Water temperature, dissolved oxygen concentration, oxygen saturation, pH value and electrical conductivity were measured by HACH Lange HQ40d portable meter, in the case of a water body in different depths.

Results

In this section of the article, there are presented results from two localities – Dražovice SWR and Želeč SWR. Both of the reservoirs are used for recreation activities, mainly angling. The localities are situated in catchment with dominance of arable land as a land-use. In the next tables Table 1 and Table 2, there are presented average values of water quality parameters analysed from the samples taken in the inflow and outflow profiles located at the selected retention basins.

The results from Dražovice were divided into two different groups, first for the period without fish introduction into the water body at the beginning (first year) of operation. The second period represents monitoring after delivery of fish to the reservoir. Presence of fish and angling activities means changes in water quality at the outflow profile – an increasing of water turbidity (concentration of suspended solids and lower removal of phosphorus. The treatment efficiency of the Želeč SWR was high for microbial pollutants, forms of nitrogen and total phosphorus. Similarly to the Dražovice SWR, average treatment efficiency for BOD, COD and suspended solids was negative, but it is affected by biological processes occurring in the water body during vegetation periods. Organic pollution originated in the Želeč village sewer system is highly reduced with the result of primary production growing.

Tab. 1: Average values of the water quality parameters at the inflow (In) and the outflow (Out) profiles of the Dražovice small water reservoir during the two periods in the years 2013-2015. First period (A) – the reservoir without fish, second period (B) – the reservoir with fish, sport angling

Profile	BOD5	TOC	TSS	TN	TP
	mg/l	mg/l	mg/l	mg/l	mg/l
DR-A-In	1,48	7,0	6,6	0,83	0,06
DR-A-Out	1,67	6,85	7,3	0,64	0
DR-B-In	4,09	12,85	20,9	4,33	0,11
DR-B-Out	3,78	12,85	44,3	3,28	0,07
Treatment efficiency (period A)	- 13 %	2 %	- 12 %	22 %	100 %
Treatment efficiency (period B)	8 %	0 %	- 112 %	24 %	37 %

Tab. 2: Average values of the water quality parameters at the inflow (In) and the outflow (Out) profiles of the Želeč small water reservoir during the the years 2013-2015.

Profile	BOD5	TOC	TSS	Enterococci	Feacal coliform bacteria
	mg/l	mg/l	mg/l	CFU/1 ml	CFU/1 ml
ZEL In	6.38	7.60	10.1	29	50
ZEL Out	14.87	24.75	60.0	2	1
Treatment efficiency	- 133 %	- 225 %	- 494 %	92 %	98 %
Profile	$N\text{-}NH_4^+$	$N\text{-}NO_3^-$	$N\text{-}NO_2^-$	TN	TP
	mg/l	mg/l	mg/l	mg/l	mg/l
ZEL In	3.72	4.01	0.41	8.66	0.81
ZEL Out	0.49	1.12	0.08	5.07	0.46
Treatment efficiency	87 %	72 %	79 %	42 %	43 %

Discussion

The extensive and semi-intensive management systems typical for Czech pond aquaculture include complex production methods with numerous important links within the pond environment itself, to other connected ponds, and to the surrounding ecosystem (Pechar, 2000). In consequence, watershed management upstream of fish ponds can significantly affect their functioning by either enhancing or reducing productivity. Further, fish pond management can substantially modify the hydrological regime and ecological quality of receiving waters (usually rivers, canals, and ponds downstream in an interconnected system), again with potentially positive or negative impacts on watershed functioning (Všetičková et al., 2012). Depending on the management measures used to improve and/or control productivity, therefore, fish ponds can either discharge harmful waste water into downstream water systems, or act as water bodies in which beneficial ecological processes, including natural self-purification (biodegradation of organic matter, nutrient retention, etc.), can take place.

Conclusion

Monitored localities have a positive impact on the nitrogen and phosphorus retention and uptake from polluted surface waters and diluted wastewaters produced by settlements. Also the reduction of microbial contamination was significant by the monitored ponds and reservoirs. Ecosystems of monitored SWR with littoral zones significantly eliminated the pollution brought by the inflows (streams). It was confirmed that the character of outflow water quality changes is fundamentally influenced by the inflow water quality and recreation fish stock management.

References

Havlíček, M., Pavelková, R., Frajer, J., Skokanová, H. (2014): The long-term development of water bodies in the context of land use: The case of the Kyjovka and Trkmanka River Basins (Czech Republic). Moravian Geographical Reports, Vol. 22, No. 4, p. 39–50. DOI: 10.1515/mgr-2014-0022.

Juszcak, R., Kędziora, A. (2003): Threats to and Deterioration of Small Water Reservoirs Located within Wyskoć Catchment. Polish Journal of Environmental Studies 12 (5), 567-573.
Pavelková, R., Frajer, J., Pavka, P, Dzuráková, M., Adámek, P. (2012): Identification and Analysis of Areas of Historical Ponds (Chrudimka River Basin). Acta Universitatis Palackianae Olomucensis, Facultas Rerum Naturalium, Geographica, Vol. 43, No. 2. ISSN 1212-2157.
Pechar L. (2000): Impacts of long-term changes in fishery management on the trophic level water quality in Czech fish ponds. Fisheries Management and Ecology 7 (1–2): 23–31.
Rozkošný, M., Adámek, Z., Heteša, J., Všetičková, L., Marvan, P., Sedláček, P. (2011): Vliv rybníků na vodní ekosystémy recipientů jižní Moravy (Impact of ponds on the recipients water ecosystems of the South Moravia Region). VTEI 53 (1), 18-21.
Vrána, K. (2004): Malé vodní nádrže – součást revitalizace krajiny. In Koncepce řešení malých vodních nádrží a mokřadů. Česká společnost krajinných inženýrů při ČSSI, Česká zemědělská univerzita v Praze, České vysoké učení technické v Praze, 4-14
Všetičková, L., Adámek, Z., Rozkošný, M., Sedláček, P. (2012): Effects of semi-intensive carp pond farming on discharged water quality. ACTA ICHTHYOLOGICA ET PISCATORIA, roč. 42, č. 3, s. 223—231. ISSN 1734-1515.
Všetičková, L., Adámek, Z., Rozkošný, M., Sedláček, P. (2013): Environmental Impacts of Carp Pond Farming on Discharged Water Quality. World Aquaculture, roč. 44, č. 4, s. 46—49. ISSN 1041-5602.
Waldon, B. (2012): The conservation of small water reservoirs in the Krajeńskie Lakeland (North-West Poland). Limnologica 42, 320-327.

Acknowledgement
This work has been supported by the research project QJ1220233 NAZV Ministry of Agriculture of the Czech Republic „Assessment of agricultural land in the areas of abandoned fishpond systems with the aim of supporting sustainable management of water and soil resources in the Czech Republic“.

Souhrn
Malé vodní nádrže jsou jedním z hlavních prvků zemědělské krajiny ve středoevropském kontextu s různými funkcemi, včetně rybaření a rekreačních aktivit. V České republice mají malé vodní nádrže dlouhou historickou tradici, zejména v souvislosti s chovem ryb a stavbou rybníků. Vztah mezi funkcemi vybraných malých vodních nádrží a kvality vody byl studován na čtyřech lokalitách. Ekosystémy sledovaných nádrží s mokřadními pobřežními zónami byly schopny významně eliminovat znečištění transportované přítoky. Bylo potvrzeno, že charakter změn kvality vody v odtoku je zásadně ovlivněn kvalitou přítokové vody a vlivem rekreačního chovu ryb a sportovním rybolovem.

Contact:
Ing. Miloš Rozkošný, Ph.D.
Phone: +420 541 126 318, e-mail: milos_rozkosny@vuv.cz

WATER QUALITY EVALUATION OF SELECTED WELLS AROUND BRNO RESERVOIR

Petra Oppeltová, Věra Hubačíková, Sabina Valešová
Department of Applied and Landscape Ecology, Faculty of Agronomy, Mendel University in Brno, Zemědělská 1, 613 00 Brno, Czech Republic

Abstract
Wells had always an important function in landscape, which, however, changed over time. Hunting wells formed first, then agrotechnical ones used during land cultivation. Later, they began to perform the pilgrimage and tourist function. Monitoring of several wells around Brno reservoir was the aim of this study. The actual condition of chosen wells – Slešťůvka, Veveří, Betelná, Rozdrojovická, Soví and U tří křížů - was assessed and monitoring of chosen water quality indicators was conducted. Selected physical, chemical and microbiological indicators were evaluated. The results were compared with the limits for drinking water according to Decree No. 252/2004 Sb., as amended. From the results it can be concluded that water quality in wells depends on their location in the field – there were shown effect of agriculture, transportation and settlements (wastewater discharge). Direct consumption of water is not recommended either from one of the wells.

Key words: water pollution, monitoring, microbiological analysis

Introduction
Spring is a place, where the underground water rises in the surface. The well is a spring, which is modified by the human activity, e. g. walled, roofed, with drain. The wells are among the most vulnerable sources of drinkable water, because their water quality subjects to very rapid changes. They serve primarily as natural waterholes for wild animals before the human started to exploit them.

Materials and methods
The labour is focused on the monitoring of water quality in selected wells around Brno reservoir. First, the detailed field survey was done and individual wells were chosen and charted. Subsequently the chosen indicators were determined right on the site together with water sampling for each of the wells. The water samples were determined in the lab of DALE (Mendel University in Brno).
Water sampling of six wells (Fig. No. 1) was realized four times, 2013/03/17, 2013/09/06, 2013/02/10 and 2013/12/20.
Right in the site pH, dissolved oxygen (mg/l), conductivity (μS/cm) and water temperature were determined. These parameters were measured by a multimeter HQ 30d flexi by HACH LANGE. Subsequently the concentrations of nitrate, nitrite, iron, chloride, sulphates and COD were determined in the lab of DALE (Mendel University in Brno) on the spectrophotometer DR/4000 by HACH LANGE as well. The analysis of microbiological indicators was made in the lab of the Department of Microbiology (2013/11/21) – total colony at 22°C and total colony at 36°C, coliforms and entercocoos.
The last sampling from the well Veveří was not realized because of the shortage of the water. Missing chemicals for the determining of chloride were the next problem.
The results of these analyses were compared with the hygienic limits for drinkable water listed in Annex No. 1 of Decree No. 252/2004 Sb. as amended (Porál veřejné zprávy). Subsequently, information boards for chosen wells were designed.

Characteristics of the wells
Slešťůvka
The spring is located in a small biocorridore among farmland close to the south edge of Veverská Bítýška. The well is preserved spring at which there stands the chapel of the Virgin Mary. The chapel was built in 1896 by Jan Dvořák gratitude for recovery from a serious illness. (Estudánky, 2013)
Delivery tube is richly covered with moss and red cold-algae. The spring is surrounded by farmland. Coverage of the wells fluctuated during the year consequently involves a change in water quality. The well is influenced by its surrounding, which is agriculturally used. Previously, this water was considered sufficiently good quality even for infants.

Veveří
There is a brick fountain east of the road under the castle Veveří close to the footbridge. This well was built in 1934. It is situated close to the bay, just above the water level of the dam. Previously, the fountain was an entrance to a secret supply corridor of the castle Veveří. Water comes largely from a

single source of Veverka stream, which discharges in these places into the Brno dam (Drápalová et al.)
The spring is very shallowly captured. Coverage varies widely, mainly during dry summer, and in winter, when there the water level of Brno dam is reduced.

Betelná
This spring is located close to the bus station Rakovec-rozcestí, on the beginning of Kočičí žleb before the entrance to the Podkomorské lesy. The well is close to the unmarked forest path and it has two outflows. It is used mainly by gardeners from surrounding lodges. In previous years, the water in the well slightly exceeded the quality of infant waters. Negative affect of the surrounding facilities is reflected on the water quality in the spring.

Rozdrojovice well
Above Rozdrojovice on the red-marked hiking trail Rozdrojovice spring rises. The access road and surrounding of the springs are in contrast to wells maintained. Coverage varies widely depending on precipitation.
The well has a relatively low yield year-round, except a period during the spring thaw. Water has an average quality. Fountain is mainly used by cottagers.

Sova well
This discrete spring is located on the yellow tourist trail linking the village Rozdrojovice with the left bank of the Brno dam. The well is on the slope of a forested hill Trnůvka, under the bike trail. Spring itself is made up of stone blocks with a statue depicting an owl. From this block water flows through a stainless steel tube and falls into the hole in the stone under which the drain is located. The spring is relatively abundant.

U tří křížů
The well, so called U kamene, is located on the south side of the village Chudčice, approximately in the middle of the Calvary. Calvary was built in 1856 consisting of 14 chapels. At the point, where there was the chapel of The Saint Cross in 1784, three wooden crosses were later erected. This pilgrimage place received its present name (at Tree Crosses) because of this. (Estudánky, 2013)
The spring flows from the concrete terraces, which lies beneath the chapel of St. Mary Help of Christians. It was built as a gratitude to God for such precious and healing water. Chapel was built by Josef Kotovic.
Spreading of a well varies widely in the dry season.

Results and discussion
The water temperatures in all wells correspond to the temperature of the air, because the wells do not seepage of deep groundwater.
The limit for electrolytic conductivity according to Decree no. 252/2004, as amended, is 125 mS/m (Porál veřejné zprávy). None of the measured values do exceed this limit. Overall the highest conductivity was observed in wells Slešťůvka and Betelná (about 80 mS/m).
The pH of drinking water is determined in the range from 6.5 to 9.5 (Porál veřejné zprávy), the measured values for all wells ranged in this limit.
Elevated nitrate concentrations (Fig. no.2) were measured regularly at wells Slešťůvka and Betelná when the highest value exceeds the limit for drinking water of 50 mg/l. This is probably caused by runoff from the surrounding farmed land. Values above 50 mg/l were also affected by higher precipitation totals for the last 14 days prior to sampling.
During the monitoring of water quality nitrite value was not measured higher than the limit for drinking waters according to Decree 252/2004 Coll. is (0.05 mg/l).
COD can be viewed as a problematic indicator (Fig. no.3). The limit for drinking water of 3.0 mg/l was exceeded in almost all sampling in all wells. This is probably the organic pollution from wastewater. The concentration of sulphates at all analyzes were below the set limit of 250 mg/l.

The total iron generally ranged below the limit of 0.2 mg/l, only wells Betelná and Soví in June were found higher values (around 0.4 mg/l). A sudden increase in the concentration of iron could be caused by corrosion of pipes, where spring flows from both wells. Increased iron content is hygienically insignificant, but affects the organoleptic properties of water.

Extremely high concentrations of chlorides (Fig. no.4) were found in a well at the castle Veveří, where the values varied between 400-500 mg/l, while the limit for drinking water according to Decree no. 252/2004 as amended, is 100 mg / l.
Because high values in the different zones are consistent, it is unlikely that the cause of this phenomenon was only salinization of the road several meters from the well. Then you should see greater seasonal fluctuations. The high chloride content could be associated with contamination with sewage. In this case, the only possible source of applicable Veveří castle itself. According to the castle administration wastewater is collected in a sump and regularly siphoned off from it. But we failed to confirm or refute the fact that the contamination came from this source. To determine the exact source of contamination would need more long-term measurements, or perform analyzes at other locations nearby.
The concentrations of chlorides in the other wells are below the limit for drinking water. Exposed is a fountain Betelná in which there the concentration of chlorides slightly approach the limit (Fig. no.4). The lowest concentrations are in forest wells: The Three Crosses, Soví and Rozdrojovice. Chlorides are hygienically safe for drinking water, but at higher concentrations they may affect the taste of water.

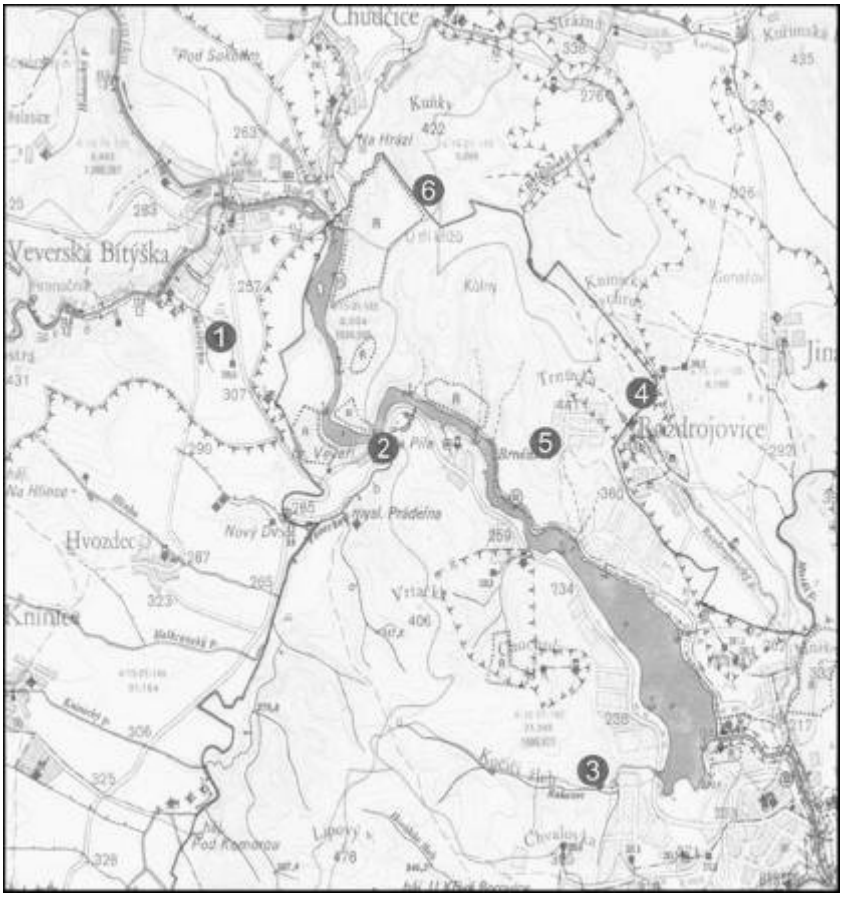

Fig. 1: Map of chosen wells (www.mapy.cz)
1. Slešťůvka; 2. Veveří; 3. Betelná; 4. Rozdrojovická well; 5. Soví well; 6. U Tří Křížů

Table no. 1 shows the results of microbiological analyzes of November 2013. Coliform bacteria are one of the indicators of faecal pollution from human and animal faeces. Intestinal Enterococci bacteria are referred to as indicators of dangerous pollution characteristic for sewage water and animal faecal wastes. The presence of Organotrophic bacteria (viable organisms at temperatures of 22 ° C and 36 ° C) represent data on the total microbial contamination. They are used to determine the ecological water quality assessments. (Ambrožová, 2004)
Neither of the monitored wells did comply with the limits under applicable legislation. This is probably a long-term organic pollution caused by runoff from agricultural lands and especially from wastewater.

Tab. 1: Microbiological analysis

WELL	TOTAL COLONY NO. AT 22°C	TOTAL COLONY NO. AT 36°C	ENTEROCOCCUS	COLIFORMS
LIMIT	**100NMH - 200MH**	**20 NMH**	**0**	**0**
U tří křížů	19216	2162	0	11
Rozdrojovická	231747	246162	1	49
Soví	88297	0	0	9
Betelná	243	279	1	78
Veveří	14486	351	0	547
Slešťůvka	overgrown	overgrown	3	540

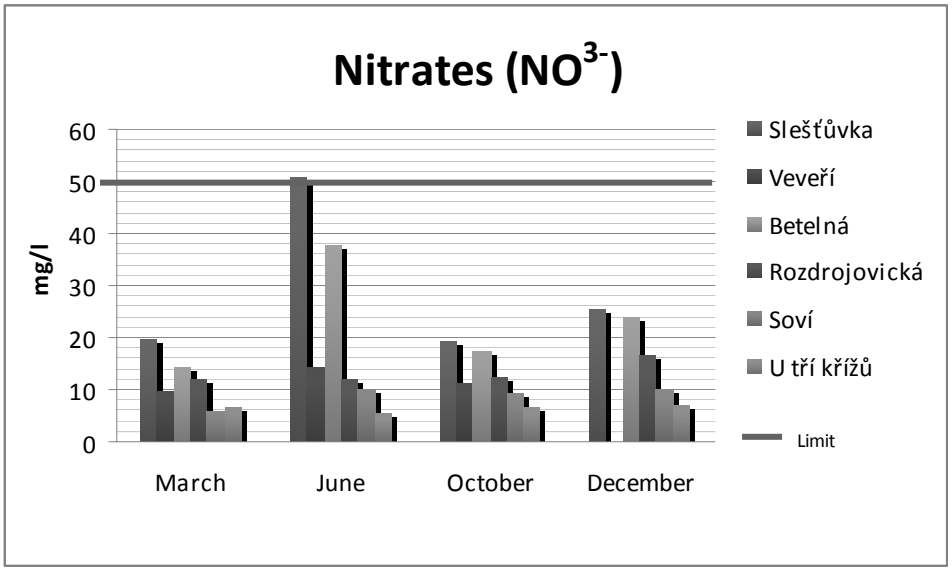

Fig. 2: Nitrates concentration

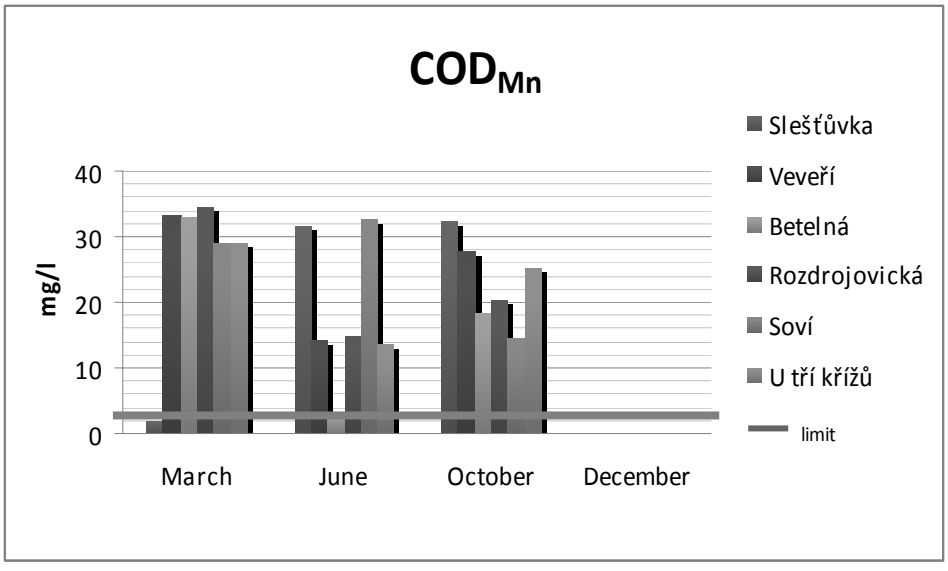

Fig. 3: COD values

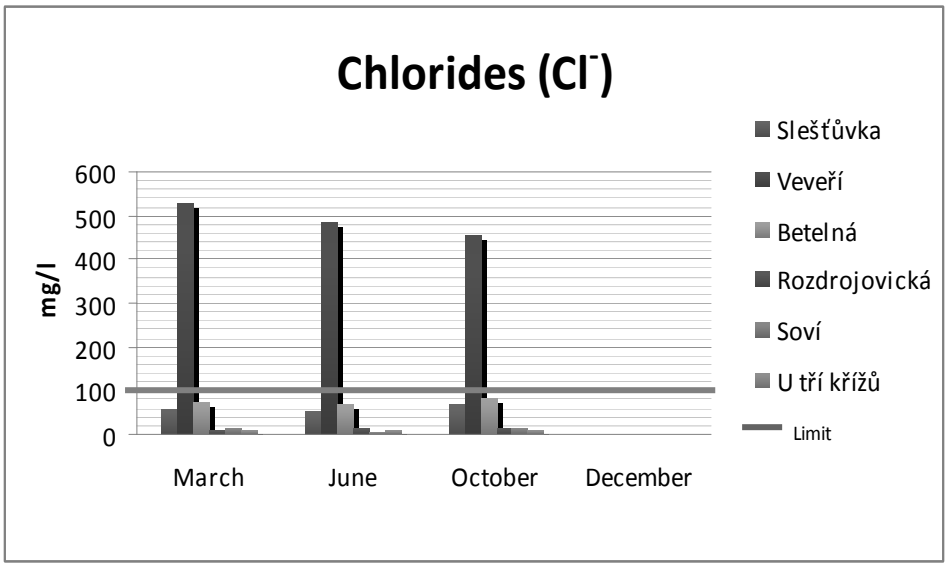

Fig.4: Chlorides concentration

Conclusion

The results show that the water quality in wells depends on their location. Fountain Slešťůvka is located in a narrow biocorridor surrounded by fields. In this well was recorded higher nitrate content, which may be caused by fertilizer runoff from farm land. Wells Veveří and Betelná are other typical examples. Both wells are located near the road, and therefore disability signalled higher chloride content, which is probably due to winter maintenance (salting) of roads and wells Veveří also likely seepage of wastewater. Only three wells - at Three Crosses, Rozdrojovice and Soví - are the source with the appropriate content of chemicals. For these sources there is recorded exceeding the limit of measured chemical and physical parameters. These wells are located in the forest, and therefore not directly affected by anthropogenic activities.

After microbiological site any of the wells has not complied with and direct consumption of water of which can not in any case be recommended.

Design for public information boards at the wells, which are frequently used (Soví and The Three Crosses) was another part of the thesis.

References

Estudánky [online]. [cit. 2013-11-18]. Dostupné na: http://www.estudanky.cz

Drápalová, J., Skácelová, O., Hříb, J. Studánky Brna a okolí. Brno: Český svaz ochránců přírody, Moravské zemské muzeum

Ambrožová, J. (2004): Mikrobiologie v technologii vod. Vyd. 1., přeprac. Praha: Vydavatelství VŠCHT, 252 s. ISBN 80-7080-534-X.

Portál veřejné správy, vyhláška č. 252/2004 Sb. [online]. [cit. 2014-02-10]. Dostupné na: http://portal.gov.cz/app/zakony/zakonPar.jsp?page=0&idBiblio=57875&recShow=0&fulltext=252~2F2004&nr=&part=&name=&rpp=15#parCnt

Souhrn

Cílem práce bylo provést monitoring několika studánek v okolí Brněnské přehrady. Byl zhodnocen současný stav studánek – Slešťůvka, Veveří, Betelná, Rozdrojovická, Soví a U tří křížů a proveden monitoring vybraných ukazatelů jakosti vody. Hodnoceny byly ukazatele fyzikální, chemické i mikrobiologické. Monitoring a odběr vzorků vody proběhl v březnu, červnu, říjnu a prosinci 2013. V terénu byla měřena konduktivita, pH, teplota a obsah rozpuštěného kyslíku, v laboratoři UAKE byly hodnoceny následující ukazatele: dusičnany, dusitany, železo, chloridy a CHSK. V laboratoři na Ústavu mikrobiologie MENDELU byla v listopadu 2013 provedena analýza vybraných mikrobiologických ukazatelů - koliformní bakterie, enterokoky a celkový počet kolonií při 22°C a 36°C. Výsledky byly porovnány s mezními hodnotami pro pitnou vodu dle vyhlášky č. 252/2004 Sb., v platném znění.

Z výsledků vyplývá, že kvalita vody ve studánkách závisí na jejich umístění. Studánka Slešťůvka je umístěna v úzkém biokoridoru obklopeném poli. U této studánky byl zaznamenán vyšší obsah dusičnanů, což může byt způsobeno splachem hnojiv ze zemědělsky obhospodařovaných pozemků. Dalším typickým příkladem jsou např. studánky Veveří a Betelná. Obě studánky se nachází v blízkosti

komunikace, a proto je postižení signalizováno vyšším obsahem chloridů, které je pravděpodobně způsobeno zimní údržbou (zasolováním) silnic a u studánky Veveří také pravděpodobně průsakem odpadních vod. Pouze tři studánky – U Tří křížů, Rozdrojovická a Soví – jsou zdroje s přiměřeným obsahem chemických látek. U těchto zdrojů není zaznamenáno překročení limitu u sledovaných chemických a fyzikálních ukazatelů. Tyto studánky jsou umístěny v lese, a proto nejsou přímo ovlivněny antropogenní činností.
Po mikrobiologické stránce nevyhověla žádná ze studánek a přímou konzumaci vody z nich nelze v žádném případě doporučit.
Další součástí práce byl návrh informačních tabulí pro veřejnost u studánek, které jsou nejčastěji využívány Soví a U Tří křížů.

Contact:
Ing. Petra Oppeltová, Ph.D.
E-mail: oppeltova@mendelu.cz

WIND FACTOR IN A PROCESS OF SHORE ABRASION IN RECREATIONAL AREA OSADA – BRNO DAM RESERVOIR

Lenka Gernešová, Petr Pelikán
Department of Landscape Management, Faculty of Forestry and Wood Technology, Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic

Abstract
The paper deals with long term problem of bank erosion observed along the shoreline of Brno dam backwater zone – recreational area Osada. Usually, the abrasion process is evoked by various factors however the factor of waves scouring bank toe is considered as the most significant. The permanent water table motion (wave action) and its parameters are closely related to the local wind characteristics and horizontal projection of water reservoir. The objective of research is determination of unfavourable combination of wind direction, wind speed and fetch facilitating the abrasion process in considered locality. Wind data were gained from numerical weather model GFS for the purposes of statistical processing.

Key words: bank erosion, numerical weather model, wind characteristics, wind-driven waves

Introduction

The energy transferred to the water level by wind generates a range of wave heights and periods that increase as the waves travel across the available fetch length (CERC, 1973, 1977, 1984). The fetch represents the length within which the wind blows over the water table from the opposite side of reservoir to the point of interest. Wave growth is closely related to the fetch length (Pelikán, 2013). Wind with constant speed and direction causes the waves which reach its steady state limited by fetch length. Wave height becomes statistically constant in time but it differs along the fetch.

The primary research of wind-water interactions and wave mechanics had been accomplished in coastal areas along the shores of world oceans and seas because a basic understanding of coastal meteorology is an important component in coastal and offshore design and planning (USACE 2002–2011). Consequently the similar principles of water wave mechanics started to be considered in conditions of inland water bodies.

The problem of wind-driven waves was investigated worldwide by many specialists, e.g. Phillips and Miles (1957), Hsu (1988) the sea conditions and Lukáč (1972, 1980) Resio and Vincent (1977), Kratochvil (1987), Šlezingr (2004, 2007, 2010), Ozeren and Wren (2009) in the conditions of water reservoirs.

Experimental shoreline section is situated along the left bank of Brno Reservoir with southwest exposition. The locality is one of the most affected by abrasion in the Czech Republic, moreover there is possible to constantly monitor shoreline retreat very well. The Brno suburban area is much-frequented by tourists, plenty of vacation properties and technical and transport infrastructure is situated in the close vicinity of shorelines liable to abrasion (Šlezingr, 2007, Hrůza, 2013).

Materials and methods

The available measured and archived long-term wind data do not exist for the locality of Brno Reservoir. The data of wind direction frequencies were provided by numerical model GFS (Global Forecast System). GFS is operated by the American organization NCEP (National Centers for Environmental Prediction), which is part of NOAA (National Oceanic and Atmospheric Administration), NWS (National Weather Service), USA. Global model is run four times a day (at 00:00, 6:00, 12:00, 18:00 universal time) and an updated prediction time is up to 384 hours. The model has a horizontal resolution of 0.5 degrees, which represent approximately 50 km.

The data of horizontal projection of water reservoir are necessary to calculate the fetch related to a given wind direction. Vector data were undertaken from digital water management data base (VÚV TGM).

The problem of determination of unfavourable combination of wind direction, wind speed and fetch length was solved by geospatial computational methods with the aid of software ArcGIS 10.1 (ESRI) and AutoCAD Civil 3D 2015 (Autodesk, 2009).

Results

The wind data statistical processing was accomplished from GFS model archive database for period 2004 – 2013. The time step of three hours gained approximately 26 000 valid data records. Wind rose graphically represents the results of statistical analysis for the locality of Brno Reservoir (Fig. 1). Prevailing wind directions and the observed maximum wind speed for evaluated period are depicted. The values of wind speed are related to the 10m reference level above the ground.

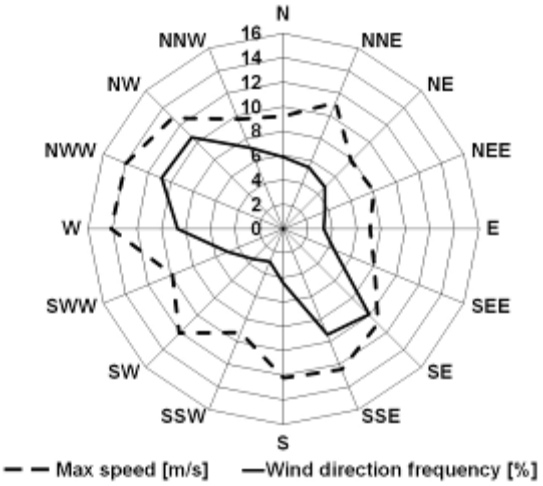

Fig. 1: Wind characteristics for locality of Brno Reservoir

Investigated shoreline section is situated along the left bank of reservoir with southwest exposition. Consequent calculations considered only part of all wind directions from NWW to SEE with respect to the horizontal projection of water reservoir. The winds from other directions, wind-driven waves respectively, do not affect shoreline due to the wave shade (Fig. 2).

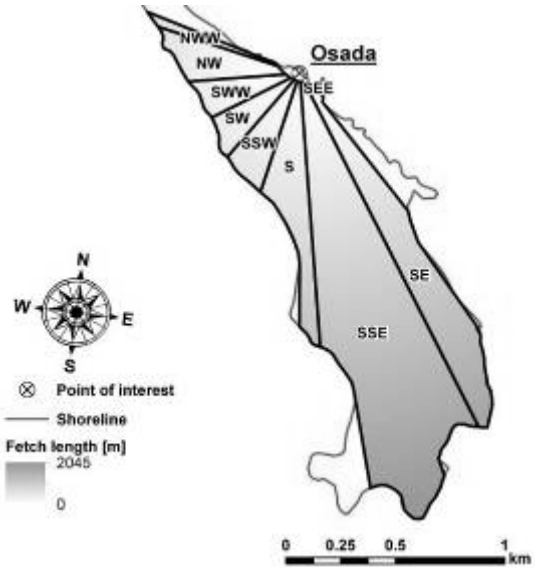

Fig. 2: Potential fetch variety for the point of interest – Osada

The abovementioned winds cause serious problem for the banks of Osada because these are built-up by sedimentary rock prone to be scoured by wind generated waves. The most occurring wind directions are NWW and SE.

The fetch lengths related to the given wind directions were examined with the aid of ArcMap tool *Euclidean Distance* (Spatial Analyst, Distance). The results show the most unfavourable SSE direction as the fetch length overreaches 2 kilometers (Fig. 2).

The final analysis consisted in combination of factor of wind direction frequency and fetch length (Fig. 3). The task was accomplished with the aid of *Raster Calculator* (Spatial Analyst, Map Algebra).

The results confirmed the most unfavourable SSE wind which blows relatively frequently along very long fetch over water table. Furthermore SSE wind speeds reach also relatively high values (Fig. 1).

However the NWW wind occur the most frequently, the fetch is shorter. Thus we can assume lower risk for the shoreline.

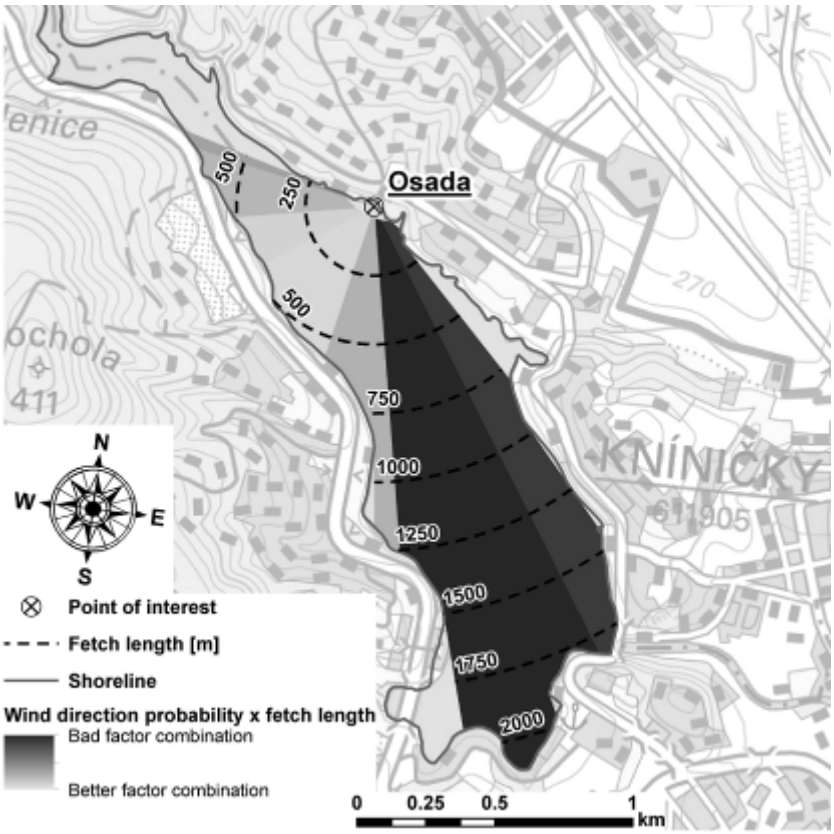

Fig. 3: Combination of the factor of wind direction probability and factor of fetch

Discussion

The problem of shore abrasion is very complex due to many factors causing and facilitating the process. The wind is one of the most important factor because evokes wave origination and growth causing bank scouring on the point of interaction with water table (WMO, 1998).

The presented model with relatively simple inputs is able to determine the most unfavourable combination of critical wind factors facilitating shore abrasion for any point of interest on any water reservoir. The gained results could be directly used for consequent modelling of wave parameters (e.g. height and period) and shore protection measures.

However there is one specific anthropogenic factor inducing significant waving of water table, namely shipping, which is not taken into account in the model. The next problem is supposing the different effect of waves reaching the shore under different angle. The highest energy of waves is assumed in the case of perpendicular inclination to the bank, again oblique inclination causes the bank is milling by waves. The model does not contain such matters but it could be the subject of future research.

Conclusion

Shoreline retreat in investigated recreational area Osada makes problem for properties and technical and transport infrastructure situated in the close vicinity of shorelines liable to abrasion. Wind characteristics play essential role in the abrasion process because their direct relation to the wave parameters. The objective of research was to determine unfavourable combination of wind direction, wind speed and fetch for investigated locality. The task was accomplished by method of computational geospatial processing of simple inputs – archive wind data and horizontal projection of water reservoir. The results confirmed the most unfavourable SSE wind which blows relatively frequently along very long fetch over water table.

References
AUTODESK, Inc., (2009): AutoCAD Civil 3D – User Guide, 2296 p.
Cerc, 1973, 1977, 1984. Shore Protection Manual. Waterways Experiment Station, U.S. Army Corps of Engineers, Washington, D.C.
Hrůza, P., (2013): Ecological criterion effect on the forest road network longitudinal gradient. Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, Volume 61, Issue 6, 2013, pp 1715–1723. ISSN 1211-8516.
HSU S.A., (1988): Coastal Meteorology. Academic Press, New York.
Kratochvíl, S., (1970): Stanovení parametrů větrových vln gravitačních vln v hlubokých přehradních nádržích a jezerech. Vodohospodársky časopis, ročník XVIII, č. 3.
Lukáč, M., (1972): Vlnenie na nádrži a jeho účinky na brehy nádrže. Bratislava, MS Katedra Geotechniky SVŠT.
Lukáč, M., Abaffy, D., (1980): Vlnenie na nádržiach, jeho účinky a protiabrázne opatrenia. Ministerstvo lesného a vodného hospodárstva SSR, Bratislava.
Miles, J. W. (1957): On the Generation of Surface Waves by Shear Flows. Journal of Fluid Mechanics, Vol. 3. pp 185-204.
Ozeren, Y., Wren, D. G., (2009): Predicting Wind-driven Waves in Small Reservoirs. American Society of Agricultural and Biological Engineers, Vol. 52(4). pp 1213-1221. ISSN 0001-2351.
Pelikán, P., 2013. Přetváření břehů vodních nádrží vlivem břehové abraze. Dizertační práce, Mendelova univerzita v Brně, 147 s.
Pelikán, P., Šlezingr, M., Marková, J., Pilařová, P., (2014): Wind Parameters Related to the Wind Driven Waves on Water Reservoirs. In *IV Międzynarodowa Konferencja Naukowo-Techniczna INFRAEKO 2014.* Rzeszów. Oficyna Wydawnicza Politechniki Rzeszowskiej, p. 235--241.
Phillips, O. M., (1957): On the Generation of Waves by a Turbulent Wind. Journal of Fluid Mechanics, pp 417–445.
Resio, D. T., Vincent, C. L., (1977): Estimation of Winds over the Great Lakes. J. Waterways Harbors and Coastal Div., American Society of Civil Engineers, Vol. 102. pp 263-282.
Šlezingr, M., (2004): Břehová abraze. CERM, Brno, pp 160. ISBN 80-7204-342-0.
Šlezingr, M., (2007): Stabilisation of Reservoir Banks Using an “Armoured Earth Structure”. Journal of Hydrology and Hydromechanics, Volume. 55, Issue. 1, pp 64-69. ISSN 0042-790X.
U.S. ARMY CORPS OF ENGINEERS, 2002–2011. Coastal Engineering Manual. Engineer Manual 1110□2□1100, Vol. I-VI, Washington, D.C., pp 2923.
Votruba, L., Kratochvíl, S., (1987): ČSN 75 0255 Calculation of wave effects on waterworks. Vydavatelství Úřadu pro normalizaci a měření, Praha.
WMO, (1998): Guide to Wave Analysis and Forecasting. 2nd edition, WMO No. 702, Geneva, Switzerland, pp 168, ISBN 92-63-12702-6.

Acknowledgement
The article contains partial results of research project “Active anti-abrasion structures”, reg. no. LDF_VT_2015011, funded by IGA FFWT MENDELU Brno.

Souhrn
Předkládaný článek se zabýval problematikou břehové eroze v konkrétních podmínkách vodního díla Brno, rekreační oblasti Osada. Proces eroze je vyvolán různými faktory. Nejvýznamnějším faktorem je vlnění vodní hladiny, způsobené zejména větrem. V článku je graficky znázorněno statistické zpracování směru a intenzity větru ve formě větrné růžice. Dalším významným a řešeným faktorem je délka rozběhu větru. Oba tyto faktory byly zahrnuty do výpočtu, který vyhodnotil pro oblast Osada jako nejnepříznivější směr působení větru jiho-jihovýchodní s délkou rozběhu větru přes 2 km. Tento vítr fouká velmi často a má velkou délku rozběhu větru – model tak potvrzuje nebezpečnost takového větru ve vztahu k břehové erozi.

Contact:
Ing. Lenka Gernešová
Phone: +420 545 134 082, e-mail: xgerneso@mendelu.cz

WINTER RECREATION AND AVALANCHE DANGER IN THE WESTERN TATRAS

Matúš Jakubis
Department of Forest Harvesting, Logistics and Soil/Land Ameliorations, Technical University in Zvolen, T. G. Masaryka 24, 960 53 Zvolen, Slovak Republic

Abstract
In the Slovak Republic, as in many other countries, are the winter recreation and various winter sports increasingly more polular. In addition of the High Tatras, are the Western Tatras one of the most popular areas for winter recreation in the Slovak Republic. In this area is fewer visitors than in the High Tatras and therefore is there more comfort with unique ambience. In the Western Tatras are the largest areas of avalanche paths in the Slovak Republic (8173.1 ha). In winter are the avalanches for the visitors in the mountain areas of Western Tatras very dangerous. The article deals with analysis of fatal accidents caused by various reasons (including avalanches) according to the records which are taken from the data of the Mountain Rescue Service Headquarters in Horný Smokovec. From 1911 to 2011 were in the Western Tatras 147 fatal accidents which are analyzed in the article from different aspects.

Key words: tourism, mountain areas, disasters, fatal accidents

Introduction

The issue of avalanches has been known from ancient history. Avalanches were first mentioned in writing as the cause of death of Hannibal's (*247 BC - †183 BC) soldiers during passage through the Alps (218 BC) in the Second Punic War (218 BC to 201 BC). These historical records about avalanches are known from the works of several authors - Cornelius Nepos (Roman biographer, *about 100 BC - †between 27 – 24 BC), Titus Livius (Roman historian, * 59 BC – †17 AD), Silius Italicus (Roman poet, *25 or 26 AD – †101 AD), Polybios (Greek historian, *about 203 – 200 BC – †about 120 – 118 BC), Plutarchos (Greek historian and writer, *about 45 AD – †about 125 AD). In the Alpine countries are avalanche disasters mentioned in the literature for centuries. These disasters have been often recorded at the historical paintings, too (Fig. 1). Nevertheless, avalanches are remain one of the greatest dangers for visitors in the high mountains in winter. In the Slovak Republic, as in many other countries, the winter recreation and various winter sports are increasingly more polular. In addition of the High Tatras, the Western Tatras are one of the most popular areas for winter recreation. In this area is fewer visitors than in the High Tatras and therefore is there more comfort with the unique ambience and many opportunities for winter recreation. Overview of the number and size of avalanche paths in the mountains of Slovakia are given in Tab. 1. In the Western Tatras occurs 755 of avalanche paths with an area of 8173.1 ha. The largest avalanche in the Western Tatras is considered the enormous avalanche, which fell in March 25, 2009 in Žiarska valley. The length of tear line of this avalanche was estimated at 1500 - 2000 m, avalanche area was 28 ha and snow deposition masses in the valley accounted for more than 20 m, the volume of the compacted snow in the avalanche was 1.89 million m^3, the total amount of snow in an avalanche was estimated at 2.5 million m^3. Avalanches often threaten the ski and snowboarding slopes, trails for cross-country skiing, hiking trails, roads in the valleys (Fig. 2), mountain huts. Avalanches also devastate forest ecosystems over large areas (Fig. 3). Many authors in Slovakia and abroad addressed the issue of avalanches and their dangers for the mountain visitors (KŇAZOVICKÝ 1984, ATKINS 2000, HARVEY ET AL. 2002, McCLUNG, SCHAERER 2006, STATHAM 2008, LIZUCH 2009, TECHEL, ZWEIFEL 2013 etc.).

Materials and methods

The article deals with analysis of fatal accidents caused by various reasons (including avalanches) according to the records which are taken from the data of the Mountain Rescue Service Headquarters in Horný Smokovec (available at http://www.hzs.sk/horska-zachranna-sluzba/smrtelne-nehody-zapadne-tatry/). From 1911 to 2011 were in the Western Tatras 147 fatal accidents which are analyzed in the article from different aspects. The fatalities were evaluated by months of the year, causes of accidents, days in the week, nationality of the visitors, and decades, too.

Tab. 1: Avalanche paths in the Slovak Republic (MILAN, 2006)

Mountain range	Number of avalanche paths	Area of avalanche paths (ha)
Tatras	2664	11 899.7
thereof: Western	755	8 173.1
High	1749	3 121.4
Belianske	160	605.2
Nízke Tatray	656	5 704.9
Veľká Fatra	158	1 412.8
Malá Fatra	201	1 300.1
Chočské vrchy	17	43.0
Oravská Magura	1	14.2
Total:	3697	20374.7

Fig. 1: Painting from around 1740 showing avalanche disaster (Composite authors 1989)

Fig. 2: The face of an avalanche struck the road and walking trail in the valley (Photo: Author archive)

Fig. 3: Avalanches devastate forest ecosystems over large areas
(Photo: Author archive)

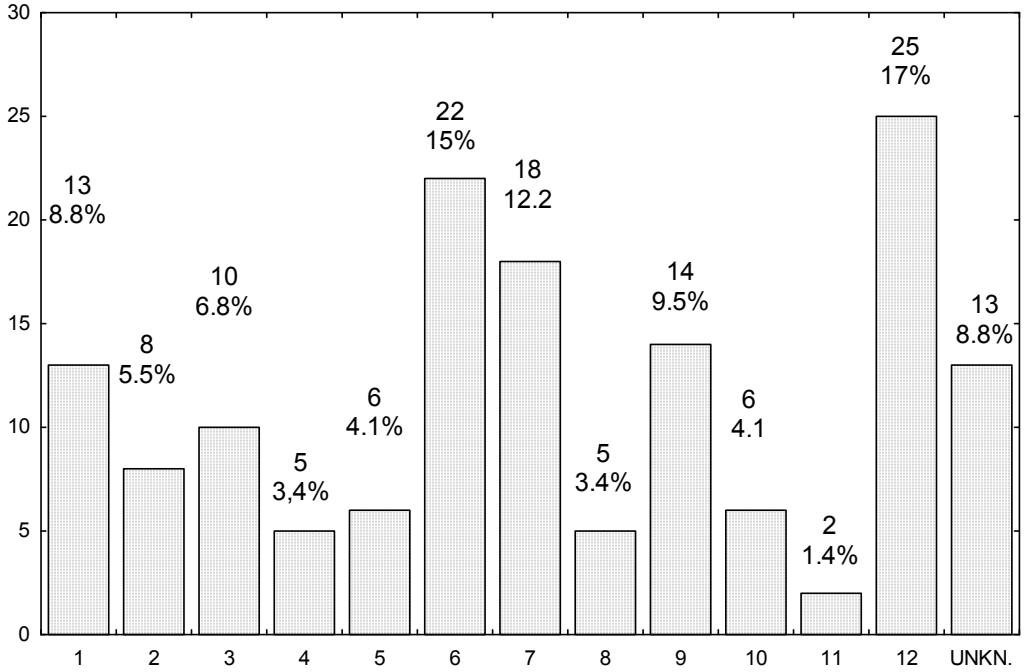

Fig. 4: Fatal accidents by month

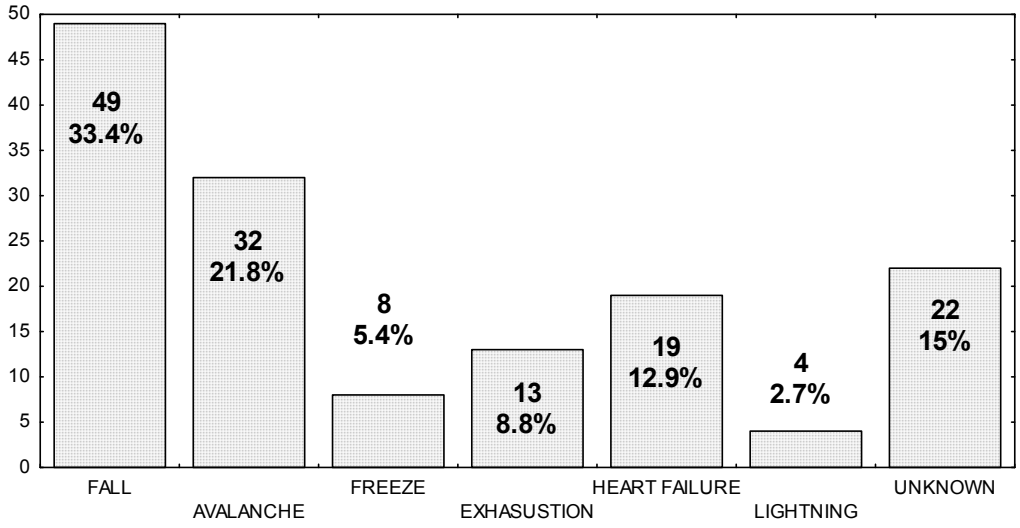

Fig. 5: Fatal accidents by cause

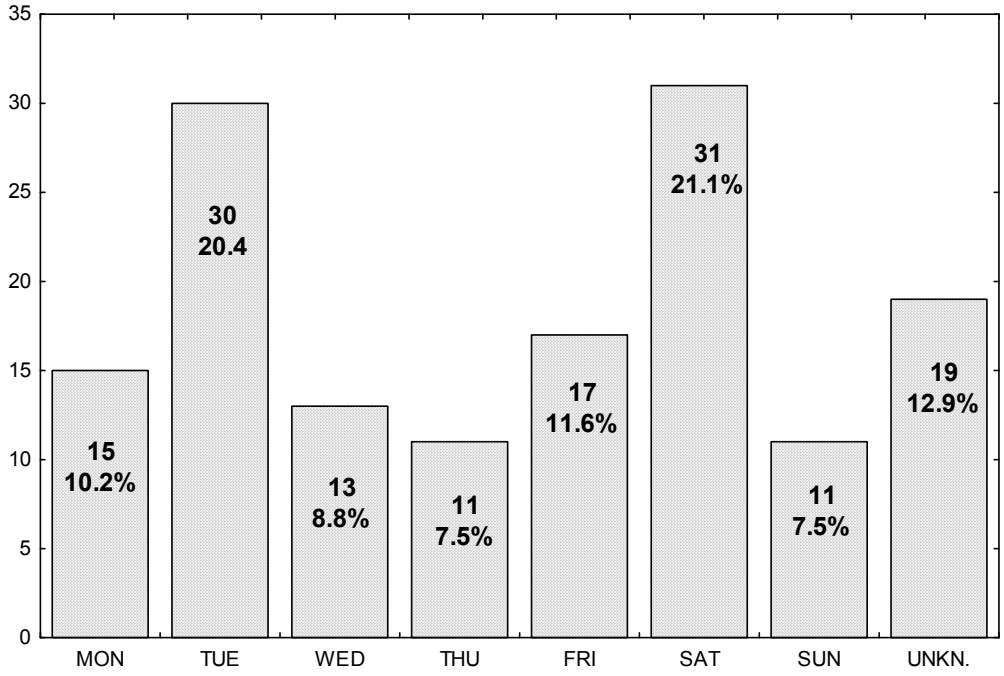

Fig. 6: Fatal accidents by days of the week

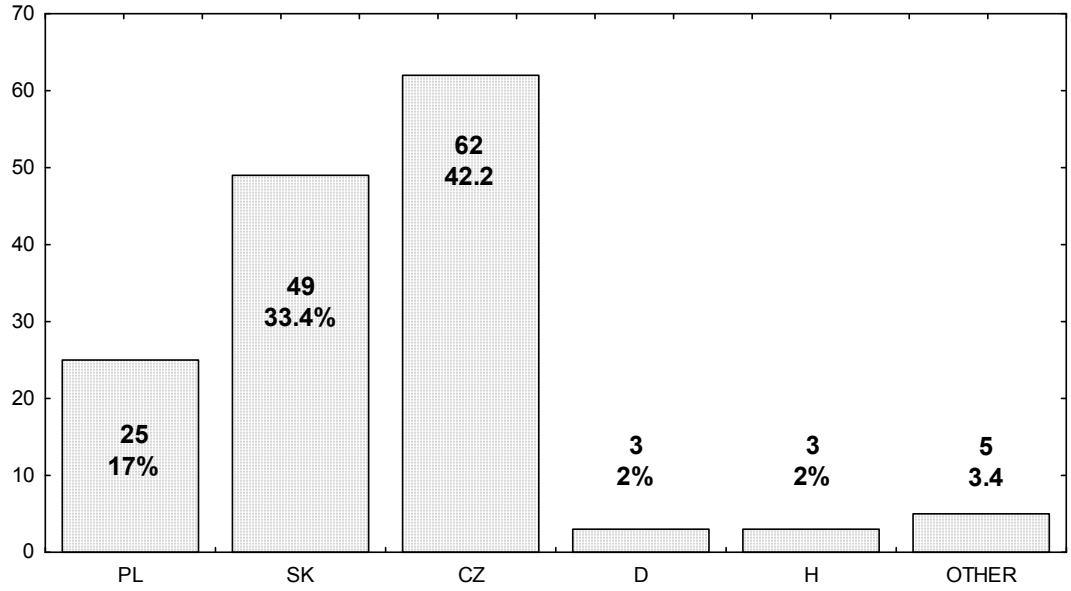

Fig. 7: Fatal accidents by nationality of visitors

Results

Evaluation of fatal accidents by months of the year shows Fig. 4. Most fatal accidents happened in December (25, i. e. 17 %) and June (23, i. e. 15 %). At least accidents happened in November (2, i. e. 1.4 %), April (5, i. e. 3.4 %) and August (5, i. e. 3.4 %). Evaluation by causes of accident (Fig. 5) confirms that most fatal accidents are caused by falls from hight (49, i. e. 33.4 %). Avalanches are the second leading cause of death (32 fatal accidents i. e. 21.8 %). The results of the analysis showed that greatest number of accidents by days of week (Fig. 6) has become a Saturday (31, i. e. 21.1 %) and Tuesday (30, i. e. 20.4 %) and the smallest number of accidents has become in the Thursday and Sunday (11, i. e. 7.5 %). Evaluation of the accidents by nationality of the visitors (Fig. 7) has shown that most fatalities suffered by visitors from Czech Republic (62, i. e. 42.2 %) and from Slovak Republic (43, i. e. 33.4 %). Evaluation by decades (Fig. 8) shows that most fatal accidents happened in last five decades (from 1961-1970 with 8 fatalities to 2001-2010 with 40 fatalities).

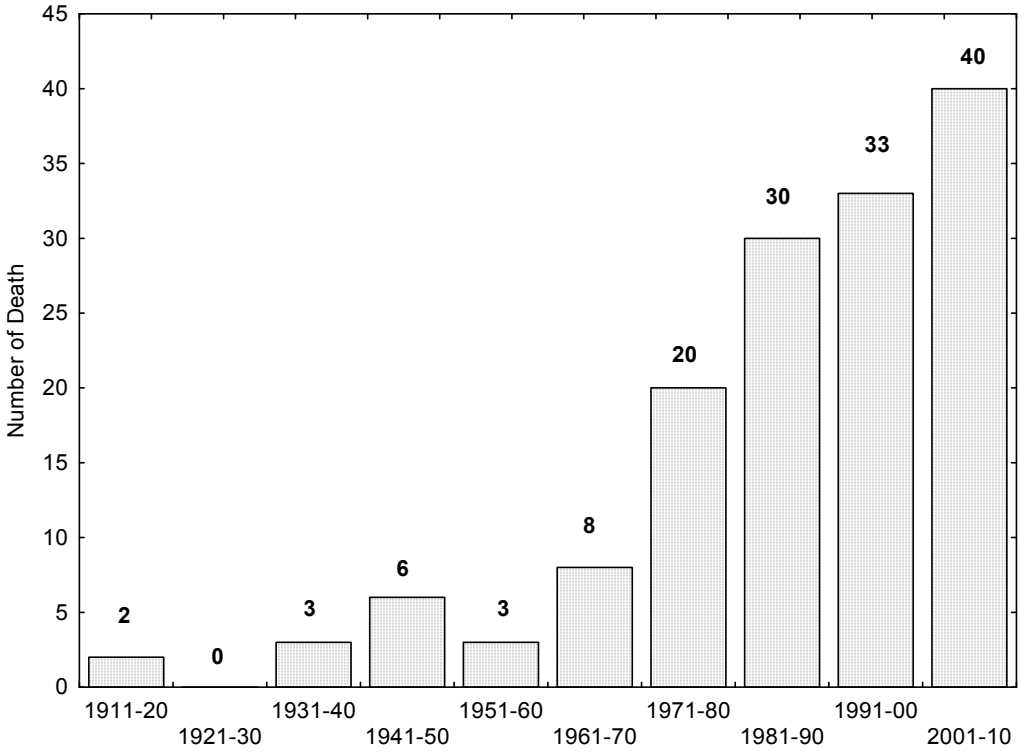

Fig. 8: Fatal accidents by decades

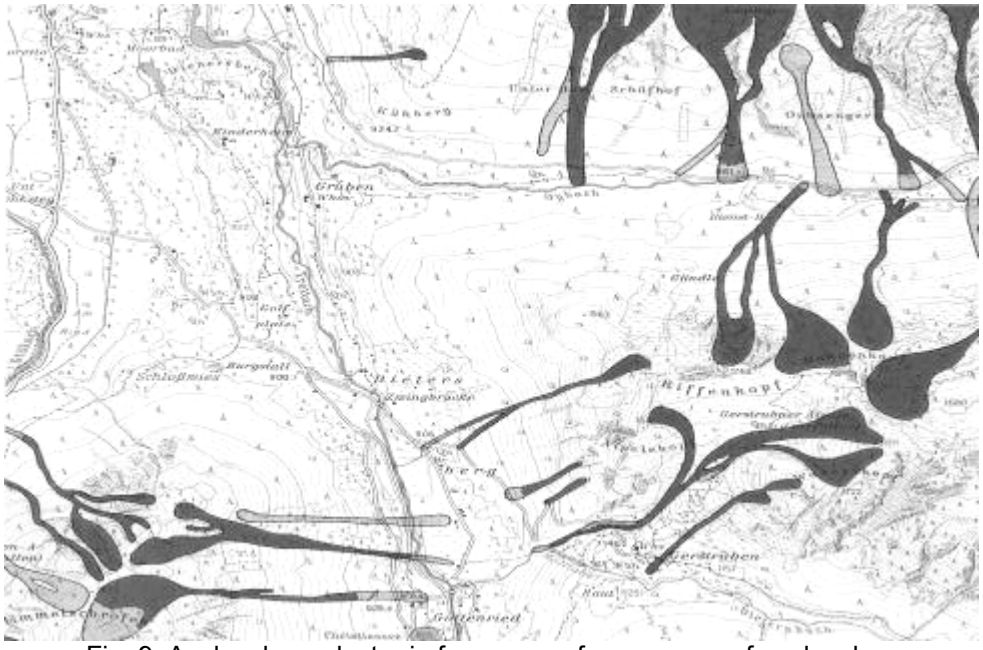

Fig. 9: Avalanche cadastre in frequency of occurrence of avalanches
(Composite authors 1984)

Conclusion

With the increase of winter recreation in the mountains, increases the risk of avalanche accidents. Currently, the avalanche paths in many countries are at present processed and recorded in the maps of avalanches which showing their occurrence, frequency (repetition) and the potential impact (Fig. 9). Knowledge and respect of these avalanche maps, actual information and instructions of mountain rescue services can significantly contribute to the reduction of fatalities caused by avalanches in mountain areas during winter recreational activities.

References
Atkins, D. (2000): Human factors in avalanche accidents. Boulder, CO: Colorado Avalanche Information Center, p. 46 – 51.
Casale, R., Margottini, C. (eds.) (2004): Natural Disasters and Sustainable Development. Berlin Heidelberg: Springer – Verlag, 397 p.
Composite authors (1984): 100 Jahre Wildbachverbauung in Österreich. Wien: Bundesministerium fűr Land und Forstwirtschaft, 282 p.
Composite authors (1989): Wildbäche und Lawinen. Gefahren erkennen. Vorsorge treffen. Műnchen: Oberste Baubehorne im Bayerischen Staatsministerium des Innern, 88 p.
Harvey, S., Signorell, CH., Genswein, M. (2002): Avalanche accidents in back country terrain of the Swis Alps: New investigation of a 30 year database. British Columbia, Penticon: International Snow Science Workshop – Rescue and Survival, p. 449 – 455.
Jakubis, M. (2006): Lesníci, lesy a protilavínová ochrana krajiny. Lesník, 2006, 3, s. 4-8.
Kňažovický, L. (1984): Nebezpečenstvo hôr. Bratislava: ČZTV, 126 p.
Lizuch, M. (2009): ABC Lavín. Vysoké Tatry: Horský internetový klub, 79 s.
McClung, D., Schaerer, P. A. (2006): The Avalanche Handbook. Seatle, WA: The Mountaineer Books, 288 p.
Milan, L. (1981): Spracovanie katastra lavínových terénov a ich topografickej charakteristiky v horstvách Slovenska. Geografický časopis, 33 (2), s. 145-166.
Milan, L. (2006): Lavíny v horstvách Slovenska. Bratislava: Veda, vydavateľstvo SAV, 152 s.
Statham, G. (2008): Avalanche hazard, danger and risk – a practical explanation. Whistler: Snow Science Workshop, p. 224-227.
Techel, F., Zweifel, B. (2013): Recreational avalanche accidents in Switzerland: Trends and patterns with an emphasis on burial, rescue methods and avalanche danger. Grenoble – Chamonix Mont–Blanc: International Snow Science Workshop, p. 1106 – 1112.
http://www.hzs.sk/horska-zachranna-sluzba/smrtelne-nehody-zapadne-tatry/

Souhrn
V Slovenské republice, tak jako v mnoha jiných zemích Evropy a světa, jsou zimní rekreace a různé zimní sporty stále více populární. Po Vysokých Tatrách jsou v rámci Slovenské republiky Západní Tatry jednou z nejatraktivnějších a zároveň nejvyhledávanějších oblastí pro zimní rekreaci. V této oblasti je podstatně méně návštěvníků než ve Vysokých Tatrách a je tu větší klid na odpočinek. Pohoří je známé množstvím různorodých příležitostí na zimní rekreaci a zimní sporty, ale i jedinečnou přírodou. V zimním období mohou být návštěvníci Západních Tater na více místech ohrožováni významným nebezpečím - lavinami. V Západních Tatrách se nacházejí největší plochy lavinových území ze všech horstev Slovenské republiky (8173,1 ha). Článek se zabývá statistickou analýzou smrtelných nehod způsobených několika příčinami, včetně lavin, podle údajů, které zveřejnilo Ředitelství horské záchranné služby se sídlem v Horním Smokovci. Od roku 1911 do roku 2011 bylo v horských oblastech Západních Tater 147 smrtelných nehod, které jsou v článku analyzovány z několika hledisek. Nejvíce fatálních neštěstí se stalo v měsíci prosinci (25, tj. 17%) a červen (22, tj. 15%). Z uvedeného počtu nehod zapříčinili laviny 32 úmrtí (21,1%), nejčastější příčinou smrtelných úrazů byl pád z výšky (49 úmrtí, tj. 33,4%). Podle dní v týdnu se nejvíce smrtelných nehod stalo v sobotu (31 úmrtí, tj. 21,1%) a v úterý (30 úmrtí, tj. 20,4%). Podle národností zahynulo nejvíce návštěvníků z České republiky (62, tj. 42,2%) a Slovenské republiky (49, tj. 17%). Na základě analýzy smrtelných nehod podle dekád od roku 1911 do roku 2010 jsme zaznamenali výrazně stoupající trend zejména po roce 1961. Největší počet smrtelných nehod v rámci sledovaného období se vyskytl v poslední dekádě (2001-2010), v níž bylo zaznamenáno až 40 úmrtí.

Contact:
Prof. Ing. Matúš Jakubis, PhD.
Phone: +421 45 5206 272, e-mail: jakubis@tuzvo.sk

Sponsors:

PROJEKTOVÁNÍ EKOLOGICKÝCH STAVEB 3E EKOLOGIE EKONOMIKA ESTETIKA

PROXIMA

Paměť krajiny, s.r.o. je společnost, důvodem jejíhož vzniku je společná láska a úcta k české venkovské krajině, tak typické svojí rozmanitostí a členitostí. Znovuoživení krajiny se snažíme dosáhnout vytvářením a obnovou starých alejí, extensivních sadů, výsadbou remízků a dalších krajinných prvků, které z české krajiny vlivem hospodaření minulého režimu takřka vymizely. Společnost je uskupením tří krajinných inženýrů, kteří mají víceleté zkušenosti, jak s prací projekční, tak realizační činnosti v terénu. Naším cílem je zkrášlovat českou krajinu, která je svojí podobou jedinečná na světě, a která pro nás vždy bude krajinou, kterou nazýváme domovem.

Projekční činnost ve volné krajině. Naše společnost nabízí komplexní služby týkající se přípravy projektů pro široké spektrum výsadeb zeleně ve volné krajině a současně i výběr dotačního titulu a zpracování žádosti o dotaci. Můžeme se pochlubit velmi vysokou úspěšností podaných žádostí o dotace.

Realizační činnost ve volné krajině. Celistvost a hlavní filosofie služeb nabízených naší firmou spočívá v unikátním přístupu k celé problematice. Přestože nabízíme možnost oddělené projekční činnosti a následné realizace návrhu dalším zhotovitelem, preferujeme možnost podílet se na celém procesu od samotné myšlenky návrhu výsadby, přes projekci, podání žádosti až po samotnou realizaci projektů. Fakt, že máme zkušenosti jak s projekcí, tak s vlastní realizací výrazně zvyšuje kvalitu dodávaných služeb. Také nám to umožňuje chápat problémy realizačního rázu lépe, než firmám specializovaným pouze na projekci. Neboť, jak známo z mnoha odvětví lidských činností, rozdíl mezi teoretickým návrhem a realitou v terénu bývá mnohdy enormní.

Paměť krajiny, s.r.o.
Mánesova 55/9
612 00 Brno
IČO: 293 06 922
DIČ: CZ29306922
www.pamet-krajiny.cz

Zastoupení firmy
Ing. Petr Sedlák - **kraj Vysočina**
e-mail: sedlak@pamet-krajiny.cz
tel.: +420 723 331 461
Ing. Jan Deutscher - **Jihomoravský kraj**
e-mail: deutscher@pamet-krajiny.cz
tel.: 420 777 594 967
Ing. Tomáš Vávra - **Zlínský kraj**
e-mail: vavra@pamet-krajiny.cz
tel.: 420 777 656 983

Title: **Public recreation and landscape protection – with man hand in hand!**
Editors of the proceeding: Ing. Jitka Fialová, MSc., Ph.D.; Dana Pernicová
Publisher: Mendel University in Brno, Zemědělská 1, 613 00 Brno
Print: ASTRON studio CZ, a.s.; Veselská 699; 199 00 Praha 9
Edition: 1st Edition, 2015
No. of pages: 314 No. of copies: 120
ISBN 978-80-7509-251-9
ISBN 978-80-7509-249-6 (Online)
ISSN 2336-6311 (Print)
ISSN 2336-632X (Online)