IMPORTANT MANAGEMENT EFFECTS IN URBAN COPPICE FORESTS

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Abstract

Coppice was very common type of the management in the landscape in the past centuries. In these coppice forests were done only clear cuts in the end of the rotation periods. But during last twenty years renew interest in coppice forests has developed and a new trend was created, to do thinning in the coppice, due to higher resistance to climate change. It is known that coppice can be a suitable forest management how to mitigate drought issues in the forestry –and in the landscape. Furthermore, thinning is a good silvicultural treatment how to influence available water for trees in the landscape. Thinned coppice and low tree height can be attractive in urban settings, moreover visitors do not like unmanaged stands. Thinned coppice create different landscape structure. The effect of thinning in young oak-hornbeam coppice on diameter increment and soil water content was monitored in the Moravian part of the Czech Republic. It can be concluded that the diameter increment and soil moisture was significantly higher in thinned plots. Diameter increment of sessile oak was 59 % higher in thinned plots, for European hornbeam 61 %. Volumetric soil moisture content was 43 % higher in thinned plots. We can notice several advantages for visitors and forest owners.

Key words: thinning, soil moisture, coppicing, diameter increment, landscape

Introduction

Coppice forests provide shelter for invertebrates, birds, mammals and lots of plant species. So, it is a place of high biodiversity (Vild et al. 2013). Coppice is a renewable source of energy (McKenney et al. 2011). And coppice forests are more and more suggested for urban situations (Nielsen & Møller 2008).

Coppicing is the oldest silvicultural system which is used. Re-sprouting (the ability of the broadleaved trees to sprout from the stump) is used for establishment of new stands. Nowadays it seems reasonable to carry out thinning in coppice because of the global climate change and drought periods. It is a new approach in comparison to past times, where only clear cuts were done. It has been proved that soil moisture increases after thinning and that is why more water is available to remaining sprouts in stools. This topic has been mainly studied in the Mediterranean area and several papers published a positive impact of thinning on soil moisture (Cotillas et al. 2009; Rodríguez-Calcerrada et al. 2011). For the Central Europe does not exist lots of studies.

The study was focused on the effect of thinning on diameter increment and soil water content in young oak-hornbeam coppice.

Materials and methods

The study was located near Brno in Southeastern Moravia, Czech Republic (49º25´N, 16º68´E). The study area was located at an altitude of 328 m a.s.l.. This site is characterized by an annual mean temperature of 7.5°C, with annual mean precipitation of 550–650 mm. The soils are Cambisols. Studied forest stand is young oak-hornbeam coppice.

In 2008, a coppice stand was established by the clear-cut on the area of 40 x 125 meters according to the methodology of Kadavý et al. (2011).

Thinning was done on the half of the total area during the winter 2014/2015 with a hand saw at the ground level and 50% of basal area of each stool was reduced. One to five dominant sprouts were left.

Volumetric soil moisture content was monitored during the years 2015 and 2016 by using a PR2 Profile Probe (Delta-T Devices, Ltd., Cambridge, UK) and SM300 Soil Moisture Sensor with HH2 Moisture Meter – Readout Unit (Delta-T Devices, Ltd., Cambridge, UK). In each plot, three 40 cm long probes were permanently installed and soil moisture was measured every week at 5 cm depth with SM300 Soil Moisture Sensor and at 10, 20, 30 and 40 cm depths with PR2 Profile Probe.

Sprout diameters were measured at a height of 50 cm above the sprout base by calliper in millimeters. At one sprout two measurements perpendicular to each other were done. The diameters were measured in the growing season 2015 and 2016.

All data were analysed in STATISTICA 12 (StatSoft 2013).

Results

Volumetric soil moisture was higher at thinned plots (Fig. 1). Difference between soil moisture of thinned and unthinned plots was statistically significant during two years after thinning. Soil moisture of thinned plots was 43 % higher than that of unthinned plots in 2015 (Fedorová et al. 2016). In 2016, soil moisture was 26 % higher in thinned plots.

Thinning influenced the diameter increment of the studied species (Fig. 2). Difference between diameter increment of thinned and unthinned plots was statistically significant during two years after thinning. In 2015, diameter increment of Quercus petraea (Matt.) Liebl was 59 % higher in thinned plots and 61 % for Carpinus betulus L. respectively. In 2016, diameter increment of Q. petraea was 40 % higher in thinned plots and 28 % for C. betulus respectively.

Discussion

We can notice several advantages for visitors and forest owners when the thinning in coppice is done. Thinning in coppice have a good impact on aesthetic values and create place for children playgrounds. Another point is that thinning effects ecological values, especially soil moisture. In the future it will be the factor of drought more and more important. Thinning also influence the economic output from the coppice.

Thinned coppice and low tree height can be attractive in urban settings, moreover visitors does not like unmanaged stands (Rydberg 2000). Lots of visitors do not like logging residues, dead snags and decaying wood in forests (Tyrväinen et al. 2003). And this is not the case of coppice, where all sprouts are used for biomass and/or for firewood.

In urban areas coppice can be also recommended for vegetation filters to remove nutrients from municipal waste and surface water (Rydberg & Falc 2000).

Thinned coppice can be used for screening and sheltering from wind without blocking sunshine, enrich the environment for the urban wildlife (Rydberg 2000).

In the future coppice may ensure stability of forest landscape. Coppice is a suitable active urban forest, where the management is more ecologically-oriented. Coppice can make your neighbourhoods more green, coppice with trees and bushes of low tree height is a good forest management close to the gardens and houses (Rydberg & Falc 2000). Such silvicultural system is for example preferred in Finland by younger residents with a higher education and active urban forest users (Tyrväinen et al. 2003).

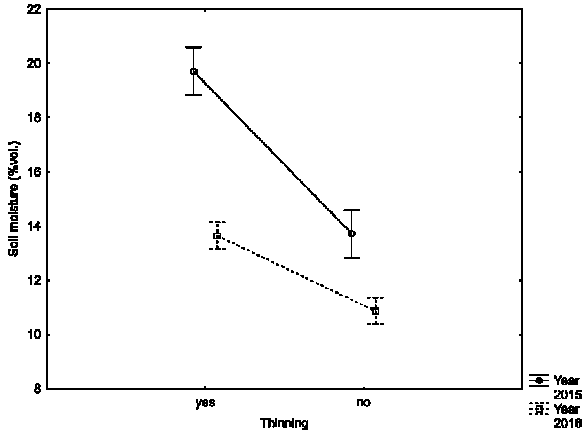

Fig. 1: Mean values of soil moisture (with 95% confidence interval) for thinned and unthinned plots in 2015 (Fedorová et al. 2016) and 2016

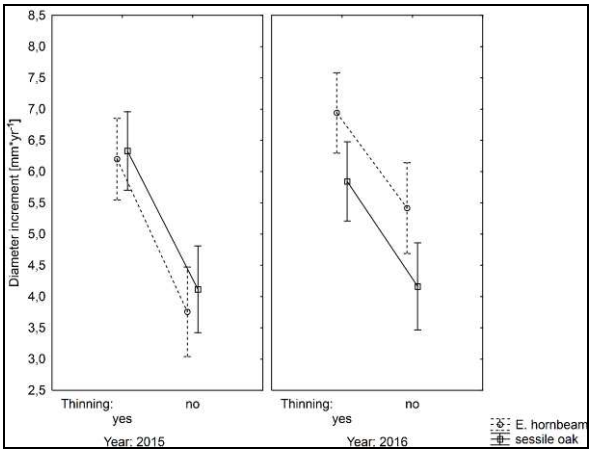

Fig. 2: Mean values of diameter increment (with 95% confidence interval) of sessile oak and European hornbeam for thinned and unthinned plots in 2015 (Fedorová et al. 2016) and 2016

Conclusion

In conclusion, thinning in coppice influence social, economical and ecological values and is recommended to do. Thinning in coppice brings advantages for the forest owners and visitors.

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Souhrn

Pařezina neboli les nízký byl velmi běžný typ hospodaření v krajině v minulých stoletích. Dříve bylo běžné těžit pařezinu pouze formou holé seče na konci produkčního cyklu (obmýtí) porostu. Ale během posledních dvaceti let, kdy se obnovil zájem o pařeziny, byl vytvořen nový trend realizovat těžební (resp. výchovné) zásahy ještě před koncem obmýtí z důvodu vyšší odolnosti vůči změně klimatu.
Je známo, že pařezina může být vhodným způsobem hospodaření jak zmírnit problémy sucha v lesnictví - krajině. Kromě toho probírky jsou vhodným pěstebním zásahem, jak ovlivnit dostupnost vody pro stromy v krajině.
Porost lesa nízkého, kde byla provedena probírka a jeho zpravidla menší výška může být atraktivní v příměstských lesích, navíc návštěvníci nemají rádi neobhospodařované porosty. Pařezina s provedeným těžebním zásahem přispívá k rozrůzněnosti struktury krajiny.

V mladé dubo-habrové pařezině v moravské části České republiky byl studován efekt probírky na tloušťkový přírůst a obsah půdní vody.
Z dosažených výsledků je možno učinit závěr, že tloušťkový přírůst a půdní vlhkost byla významně vyšší na těžených plochách pařeziny. Tloušťkový přírůst dubu zimního byl o 59 % vyšší v těžené části, u habru obecného o 61 %. Objemová vlhkost půdy byla o 43 % vyšší na těžených plochách pařeziny. Hospodaření - těžba v pařezinách i mimo jejich obmýtí tak návštěvníkům a vlastníkům skýtá nejednu z výše popsaných výhod.

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INFLUENCE OF IRRIGATION SYSTEMS TO DEVELOPMENT OF LANDSCAPE AROUND JEVÍČKO

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Abstract

This paper is aimed on development and change of the landscape around Jevíčko. In the first half of the 20th century occurred significant development of irrigation systems that affected the look and functions of the landscape in the area. There were carried out adjustments of the watercourse beds and for irrigation needs during droughts were built water reservoirs. During the second half of the 20th century was irrigation of the area ended and constructed irrigation objects started to crumble. There were also other significant changes of the landscape functions. Soil erosion was increased and the retention capacity of the landscape was reduced. By this were increased negative effects of floods and drought. There was development in the recreation at the same time when were built water reservoirs in the area. There were built recreational buildings and hiking trails. Therefore, the main function of reservoirs over the years has changed from water management to fish culture and recreation. Irrigation system components can perform another function and can be used or adapted for other uses.

Key words: Irrigation of soil, water retention in the landscape, recreational potential of the landscape, bike trails, educational trails

Historical development of the irrigation

The first irrigations were built in North Africa and in the areas around big rivers in southern and central Asia. Famous are the irrigation systems in ancient Egypt which were used before 2000 years BC. In Mesopotamia was irrigated in 2 or 3 millennium BC and across the country was constructed system of irrigation channels. Irrigation was a crucial factor in the case of ancient Syria, Palestine and Persia. In India was widespread basin irrigation from the 4th millennium BC. In ancient China was made adjustments of streams, reservoirs were built, swamps were drained and fertile valleys were irrigated. In Europe were irrigation built in Greece, Spain, in the Roman Empire. Irrigation were widespread in South America, where widespread in Bolivia and Peru in the VI. Century after Christ (Benetin 1979).

On the territory of our country has preserved records of irrigation from 1673. Meadows along Loučná near Osík (Litomyšl) were irrigated. Since 1841 were irrigation systems created in eastern Bohemia and since 1875 was built irrigation system in the valley of the river Úpa. Irrigation of meadows along the river Metuje were also built. The basin irrigation, drainage and flood irrigation were widespread. Significant development of irrigation occurred after World War II (Benetin 1979).

In the post-revolutionary period was widespread sprinkler irrigation on our territory. Sprinkler irrigation was considered as the most progressive and appropriate type of irrigation in the time of construction. In the future will be appropriate to rebuild sprinkler irrigation technology to technology with higher water savings and with a more precise dosing, such as micro irrigation, micro spraying and drip irrigation (Slavík 1998).

Methodics of the work

For the area of interest was chosen location near Jevíčko, which is very interesting for its historical development in using of irrigation systems. For purposes of contribution was made survey of historical materials that has preserved. Materials were provided by Povodí Moravy s.p. Zoning plan of Jevíčko and Velké Opatovice was also examined. The area of interest was surveyed in November 2016 and in March 2017. Current condition of the irrigation system parts in the area was observed during the survey. Data were processed by computing at the Department of Applied and Landscape Ecology. Photographs were compared between years 1933 (source: Coufal 1935), 1985 (source: Archive of Povodí Moravy s.p.) and 2016/17 (author of photos: Milan Jirout). Subsequently was assessed a condition of the system and the development of the area.

Definition of the area of interest

The area of interest is located in the south-eastern part of the Pardubice region, 39 km west of Olomouc and 49 km north of Brno. The area is defined by Malonínský stream floodplain from Bělá u Jevíčka to a confluence of Malonínský stream and Jevíčka. The focus is on the landscape in rural areas of Jevíčko. Malonínský stream basin (river basin area: 4517 ha) and the area of interest are shown in Figure 1. The area around of Jevíčko belongs to Malá Haná. Historically, there is evidence of settlement in this area already during the Roman period from the second half of the 1st century BC (Drojebar 2014).

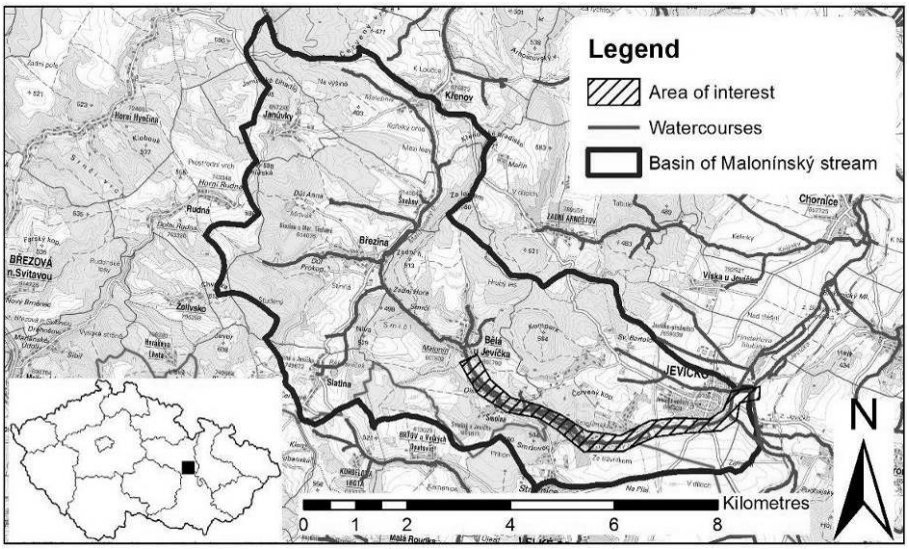

Fig. 1: Basin of Malonínského stream with highlighted area of interest. Basic map: Czech Office for Surveying

Development of irrigation on the area of interest

In the first half of the 20th century was spread cattle breeding on the territory around Jevíčko. It was necessary to provide enough of good and quality food for cattle and was necessary to drain some of wet areas. During construction in the 20s and 30s of the 20th century irrigation channels, technical objects and regulation channels were built. To provide the necessary amount of water in the dry season water reservoirs

were built. The largest of reservoirs was Smolenská reservoir on Malonínský stream (Coufal 1935).
Irrigation was abandoned in the area during the second half of the 20th century. Meadows and irrigation channels in the area are the still evident from the aerial photography from the 50s. From that time parts of irrigation has been breaking up. Maintenance and repairs only occur on water reservoirs and their neighbourhood.

Components of the irrigation system in the selected area

Smolenská reservoir and Žlíbka reservoir

Smolenská reservoir was built together with the entire irrigation system and was completed in the early 30s. The main purpose of the reservoir was retention of sufficient amount of water in case of drier summer period (Coufal 1935). Photos of the reservoir from 1933 is shown in Figure 2.
In the 90s Státní meliorační správa (SMS) built sedimentation reservoir above Smolenská reservoir to capture sediment. SMS also built small pond here to improve biodiversity in the area. Between 2008–2009 was carried out reconstruction of safety overflow, drain and was adjusted dam of the reservoir (aquasys-vhs.cz 2017). Photos of the reservoir from 2016 is shown in Figure 3. Figure 4 shows a sediment in the reservoir which comes from an area above the reservoir and reduces a capacity of the reservoir.
Reservoir Žlíbka (Figure 5) is situated on the periphery of Jevíčko. Reservoir Žlíbka is smaller than Smolenská reservoir and were constructed also for summer irrigation systems of meadows. The reservoir was built between years 1930–1931 (Coufal 1935). The reservoir was divided into two smaller by dam after World War II. Smaller part on the inflow currently serves as sedimentation reservoir and following reservoir serves as a swimming pool named Tyršova plovárna and is part of the sport and recreational areal.

Other components of the irrigation system

An important part of the system were regulations of riverbeds. Riverbeds are also fortified. In the 20s and 30s were used mainly natural materials when the regulations were built. In the 70s of the 20th century was built regulation of Malonínský stream between Bělá u Jevíčka near Smolenská reservoir. Concrete panels were used and this regulation wasn't part of the irrigation system. In Figure 6 and 7 is shown Malonínský stream near Jevíčko in front of the body of the unfinished highway.
For a consuption of water and control of the water amount drained from watercourses served floodgates on Malonínském stream on the road bridges across the river bed. (Coufal 1935). Road bridge on Malonínský stream near Jevíčko is shown in Figure 8, 9 to 10.
The irrigation millraces transferred water from the consumption objects directly on irrigated meadows. They formed a system of river beds. Water flowed from the millraces to irrigated meadows by using flood irrigation. For increasing of level in millraces served simple floodgate (Figure 12 and 13) (Coufal 1935).
Aqueducts (Figure 11) were used to passing the millraces over the other streams.

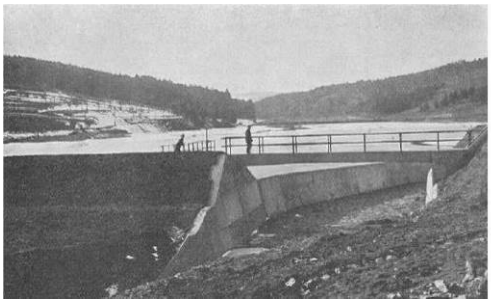


Fig. 2,3: Smolenská reservoir in years 1933 (left side) and 2016 (right side)


Fig. 4,5: Smolenská reservoir in 2017 (left side) and Žlíbka in 2016 (right side)


Fig. 6,7: regulated riverbed of Malonínský stream in 1985 (left side) and 2017 (right side)

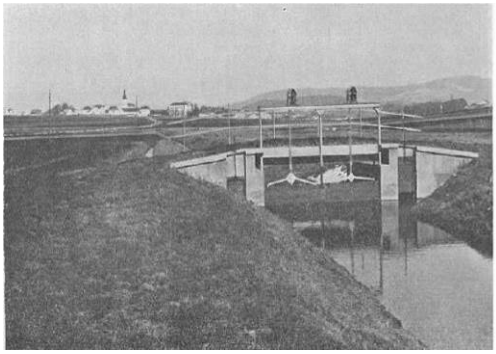


Fig. 8,9: A bridge with a floodgate at Malonínský stream in 1933 (left side) and 1985 (right side)


Fig. 10,11: A bridge with a floodgate at Malonínský stream in 2017 (left side) and Remnant of an aqueduct over a nameless watercourse in 2017 (right side)


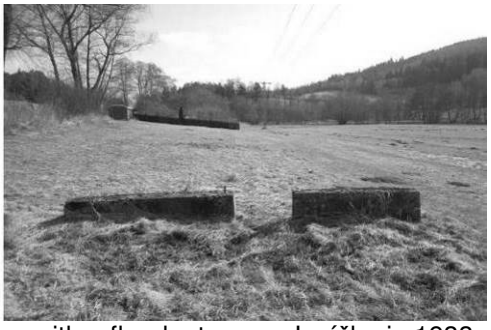

Fig. 12, 13: Example of an irrigation millrace with a floodgate near Jevíčko in 1933 (left side) and example of a floodgate near Bělá u Jevíčka in 2017 (right side)

Recreation and attractions around Jevíčko

Recreation around Smolenská water reservoir expanded in the period after World War II. On the hills in the surrounding forests were built a number of recreational buildings. Buildings are set among greenery and do not disturb the landscape. Recreational buildings in the reservoir neighbourhood are shown in Figure 15, 16 and 17.

The red hiking trail is carried directly along the dam of the reservoir (Figure 18). Around the reservoir is also carried out the cycling route which leads from Velké Opatovice to Jevíčko. In the woods near the reservoir is Jevíčko sanatorium, a monument of the lost aviators and a monument to the victims of the Napoleonic wars who were treated from their wounds and did not survive (belaujev.net 2017).

Other technical curiosity, which affected the look and functioning of the landscape, is unfinished highway Wroclaw–Vienna. Construction of Highway ended in 1942. Ředitelství silnic a dálnic plans in the future to use unfinished highway to build highway from Brno to Moravská Třebová (rychlostni-silnice-r43.cz 2017).

The new bicycle path is planned across the area that will be more direct and safer route for cyclists from Velké Opatovice to Jevíčko. For carrying of the path over Malonínský stream will be used the existing bridge. The path will be located along the backfilled irrigation millrace (Zoning plan of Jevíčko).

As part of the building of the bicycle path would be appropriate at the same time to create an educational route that reveals the history of the landscape development to visitors. The educational boards could illuminate visitors the meaning of each preserved object of historical irrigation system in the landscape. The boards could

easily explain which parts of adjustments of the landscape will help to reduce the negative effects of droughts and floods.
The bicycle path will be built near orchard near Velké Opatovice where could be placed an educational board about currently used modern types of irrigation. For example drip irrigation which is more water saving and it is more precise in the dosage of water to the individual subjects of crops.
Map showing photographing locations, tourist route, existing bicycle route and planned bicycle path between Jevíčko and Velké Opatovice is showed in Figure 14.

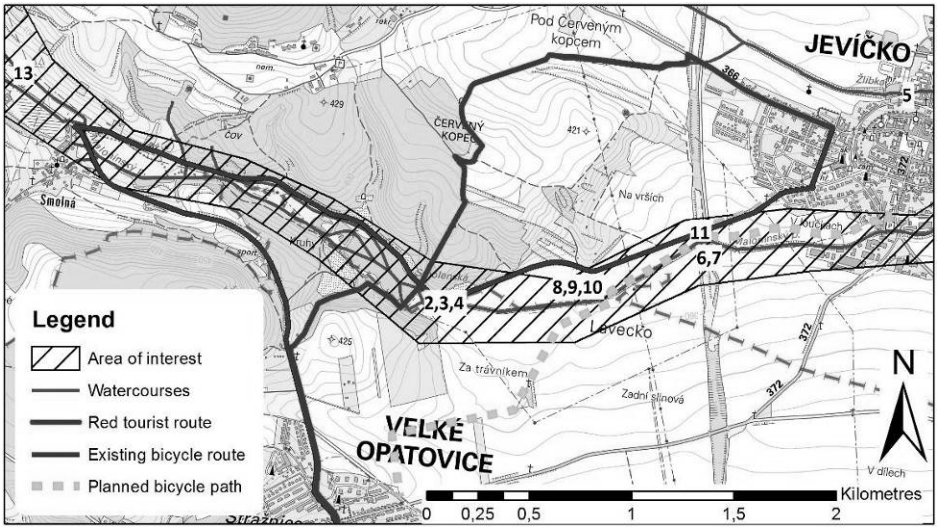

Fig. 14: Map showing photographing locations, tourist route, existing bicycle route and planned bicycle path between Jevíčko and Velké Opatovice. Basic map: Czech Office for Surveying



Fig. 15,16: Recreational building on the left bank of Smolenská reservoir in 2017 (left side) and recreational buildings on the right bank of Smolenská reservoir in 2016 (right side)


Fig. 17,18: Recreational buildings on the right bank of Smolenská reservoir in 2017 (left side) and the sign of a red tourist route near Smolenská reservoir in 2016 (right side)

Conclusion

Irrigation system at Malá Haná changed the landscape. Some parts of the system were destructed and others have been preserved and are working with a different purpose. This happened at Smolenská reservoir and reservoir Žlíbka. Their main function was changed over the years from water supply to fish breeding and recreation. Currently, they are not only an important aesthetic element, but also they increase the amount of water retained in the landscape. In case of drought they can help to maintain residual flows in streams below the reservoirs. Also other parts of the irrigation system may perform functions other than those for which they were originally intended. They can carry tourist trails over watercourses or they can serve as dirt road bridges for possible renewed dirt roads after the land consolidation. It is appropriate to add information boards to hiking trails which will illuminate to visitors the meaning and principle of functioning of the landscape and landscape history. This could increase the sense of belonging of human with the landscape. Because only someone who feels chained to the landscape emotionally does not need to use the landscape carelessly.

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Souhrn
Tento příspěvek se zaměřuje na vývoj a změnu krajiny v okolí města Jevíčko. V první polovině 20. století došlo na území k významnému rozvoji závlahových systémů, které ovlivnilo vzhled a fungování krajiny. Byly prováděny úpravy koryt vodních toků a pro potřeby závlahy v obdobích sucha byly vystavěny vodní nádrže. V průběhu 2. poloviny 20. století se od zavlažování území upustilo a započalo chátrání vybudovaných objektů. Došlo také k dalším výrazným změnám ve fungování krajiny, došlo ke zvýšení eroze půdy a snížení retenční schopnosti krajiny. Tím byly zvýšeny negativní účinky povodní a sucha. Při budování vodních nádrží na území zároveň docházelo k rozvoji rekreace v tomto území. Byly budovány rekreační objekty a turistické trasy. Proto se hlavní funkce nádrží v průběhu let změnila z hospodářské na rybochovnou a rekreační. Prvky závlahových systémů proto mohou plnit i další funkce a mohou být využívány, popřípadě upraveny i pro další způsoby využití.

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INFLUENCE OF RECREATION ON INHERITED AND RENEWED NATURE OF THE MORAVIAN-SILESIAN REGION

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Abstract
The change in post-industrial society, together with period of transformation in the Czech Republic after 1989, there is a change of the ways of work and related transformation of requirements for leisure activities beyond the everyday life. Tourism, infrastructure and services have a multiplier influence on land use.
Recreation aiming to natural and cultural heritage, on the one hand, potentially threatens the natural environment its components and its economic and social structure of the visited regions, while the situation in Moravian-Silesian region shows effect of recovery in areas affected by underground mining.
The natural succession in the Ostrava basin offers the opportunity to new habitats which can contribute to the newly acquired biodiversity and this may gradually be reflected in economic benefits in the form of preserving or restoring, and their relation to the use of ecosystem services. Invertebrates (e.g. crustaceans, butterflies, beetles and spiders) and vertebrates (fish, amphibians, reptiles and birds) find their shelter at post-mining landscape. Recovery of degraded landscapes offers wildlife observatory or important objects of a specific landscape and thereby attractive targets for human relaxation and recreation

Key words: fragmentation of the landscape, subsidence troughs as refuges, spoil heaps as refuges, recreational land use

Modern society, coupled with the development of information and communication technologies, the ageing population, the shift of employees to the service sector and changes in organisational structures, is a time of significant transformation and is also changing the way in which we work. This transformation is also altering society's leisure needs; on the one hand, we still need to relax in a peaceful and harmonious environment, yet on the other hand we also want to make more of our time spent discovering, intensively experiencing and learning new things, and thus on self-enrichment (Tourism Policy, 2013). The growing demand for recreation has led to a boom in so-called sustainable tourism activities. The term *sustainable tourism* is defined by UNWTO (World Tourism Organization) as a situation, where *sustainable tourism development meets the needs of present tourists and host regions while protecting and enhancing opportunity for the future. It is envisaged as leading to the management of all resources in such a way that economic, social, and aesthetic needs can be fulfilled while maintaining cultural integrity, essential ecological processes, biological diversity, and life support systems*. (Study of Recreation in the Jeseníky, 2012). Tourism activities can be sited in a specific area and developed based on the characteristics of that area, or on localisation conditions that show recreational potential. These conditions are expressed by the local landscape, natural and cultural places of value and their appeal. Tourism

requirements, amongst other things, also create the need for technical and transport infrastructure in the area, as well as widespread demand to change how the area is used in order to enable the construction of tourist service facilities. However, the downside of such activities is that they pose the risk of damage to valuable places in the area, i.e. tourist destinations, as well as attracting numerous temporary visitors and reducing the standard of living for the local residents. This incompatibility could be summed up in the term “seeking a balance”, specifically a balance between sustainable development, not only of tourism, but also of the area, i.e. environmental protection, the benefits to human society, and economic development.

One of the principal areas in the Moravian-Silesian region with the greatest recreational potential is the Beskydy Protected Landscape Area. As this area has long been used for recreational purposes, it may serve as an example of some of the consequences of this use, or overuse, of the landscape.

Besides its unique natural riches, the Moravian-Silesian Beskydy (Beskydy) area particularly offers original stands of virgin forest, home to rare Carpathian animal and plant species, species-rich meadow communities, and unique surface and underground pseudo-karst phenomena. Its landscape structures, which originated when man first began to coexist with this area, are of exceptional aesthetic value. However, the region is significantly affected by its proximity and ease of transport access from the heart of the Ostrava conurbation, which is home to more than 700 thousand inhabitants. Although this short distance provides opportunities for temporary and daily recreation, it also places the Beskydy under pressure of urbanisation. Good transport access makes the Beskydy an attractive place not only for family recreation, but also increasingly as a place for families to live. It is not possible to statistically differentiate between how buildings that serve a residential purpose, for family recreation or as a second home are used, as essentially no difference has been defined (Decree No. 268/2009). However, as these built-up areas expand, they are fundamentally broadening the boundaries of the developed area.

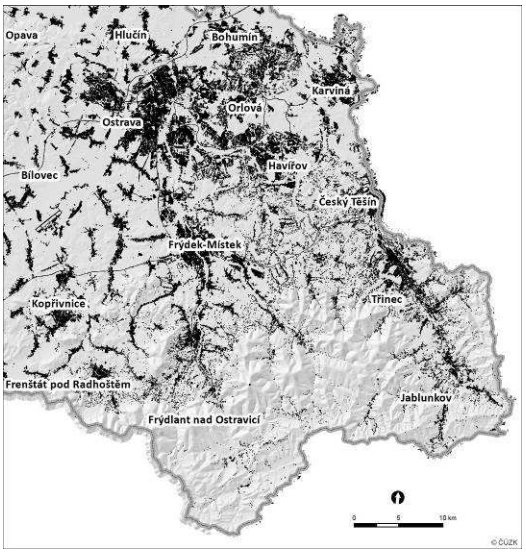

Fig. 1: Built-up area in the Beskydy Mountain 2015

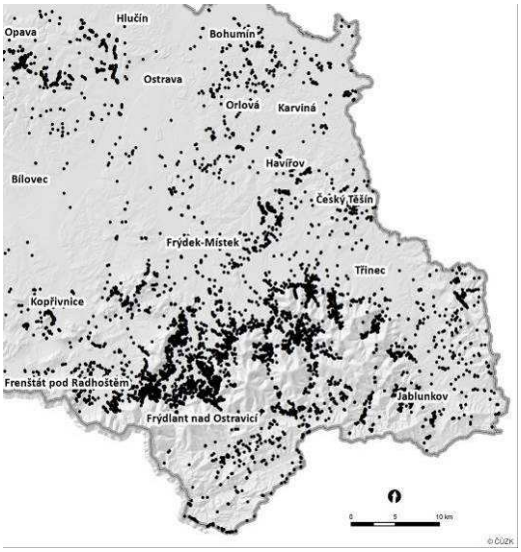

Fig. 2: Recreational buildings in the Beskydy Mountains 2016

The Beskydy and Podbeskydí region are a good example of how the growth in built-up areas can cause the coalescence of residential areas and lead to congestion. Suburbanisation (the outgrowth of suburbs) is caused by inhabitants, their activities and certain functions shifting from the core city to the hinterlands (Ouředníček, 2002). This is a process typical of the expansion of a city, the fundamental prerequisites for which are a naturally attractive or less disrupted environment and short driving distance to the city centre, as mentioned above. The construction of residential structures and fenced-off areas in the open countryside presents is of the primary migration barriers that increases the fragmentation of the landscape, which previously had automatically served as a connecting link between different populations (Anděl et al., 2010). Measures to preserve the permeability of the landscape include conditions laid down in land use planning documentation and strict protection of agricultural land resources.

In addition to the example of the urbanisation of the overburdened Beskydy, the heterogeneity of the Moravian-Silesian region enables new qualities of the area to emerge. These qualities include the biological restoration of reclaimed areas affected by industry associated with coal mining. Redevelopment and reclamation work has been under way in the Ostrava-Karvina mining district since 1954, when an extensive redevelopment and reclamation programme was prepared for areas devastated by underground mining. The programme particularly involved the removal, landscaping and greening of spoil heaps and eliminating spontaneous combustion and fires on them. Water conditions were changed and selected areas became forested, a process that included landscaping modifications (Ševčík et al., 2010). The gradual degradation of the environment also caused people to move away from populated areas and villages to become defunct.

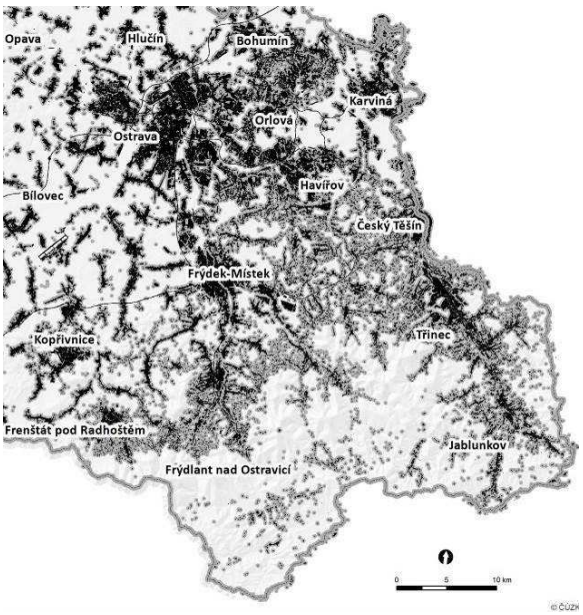

Fig. 3: Coalescence of residential areas in the Podbeskydí region (buffer 200m from the built-up area)

Historical development of Doubrava

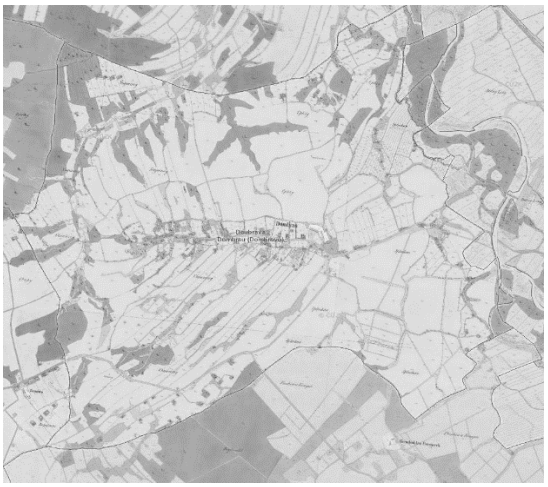

Fig. 4: Doubrava- Imperial Imprint of Stable Cadastre (about 1830)

Over 40 spoil heaps covering an area of more than 500 hectares were created in the geomorphological unit of the Ostrava Basin, in the area now occupied by the municipalities with extended powers Bohumín, Orlová, Karviná, Havířov and Český Těšín. The biggest spoil heaps were in Karvina-Doly, Orlová, Doubrava, and Louky nad Olší. These have had a long-term impact on the structure of the landscape.

Fig. 5: Doubrava - Orthophoto 1955

Fig. 6: Doubrava - Orthophoto 2016

Until recently, biotechnological reclamation procedures were mostly used; reclaimed areas were used as forest land and agricultural land – arable land, meadows, vineyards and orchards, ponds. Topsoil was added and legume plants, grass mixtures and trees were planted to provide nutrients. Biotechnological reclamation destroys ecosystem stability and heterogeneity. Fiercely competitive plant species often grow from the topsoil, and invasive species of plants (*Reynoutria* spp.) spread through the area, endangering the original vegetation. Topsoil that is rich in nutrients (nitrogen and phosphorus) promotes strong competitive ruderal species such as bushgrass *(Calamagrostis epigejos*) and mugwort *(Artemisia vulgaris)*, at the expense of species that are gradually developing on the bare substrate of the spoil heaps (Zaoralová, 2015).

The earlier landscape, made up predominantly of agricultural land, comprised more than 70 % of the Ostrava Basin until the mid-19th century. Now, only 4 % of the region around Karviná is agricultural land, with permanent grassland and meadows covering roughly a quarter of that area. The amount of forest land has not changed

significantly. Forest stands cover an area of around 800 hectares. Former mining sites and spoil heaps have become home to spontaneous vegetation, which occurs across a third of the area (Matuszková, 2016). Recently abandoned post-industrial habitats are in the early stages of succession development. However, extreme environmental conditions prevent completion of the succession, e.g. the growth of continuous forest. This situation is made worse by moving substrate, an extreme microclimate, warming up, drying out, lack of nutrients or an excess of certain elements (Tropek, 2011). Steppe species of insects and species of open habitats bound to the early stages of succession retreat from spoil heaps over time. In the first phase of the reclamation cycle spoil heap habitats are very poor in cenotic terms. These biotopes have a scarcity of nitrogen and phosphorus, and serve as alternative habitats for many organisms that have disappeared from the surrounding eutrophicated landscape. It has recently been discovered that spontaneous succession is just as fast as biotechnological reclamation and guarantees a wider range of plants and a greater diversity of endangered species (Stalmachová, 1998).
Invertebrates comprise the basic component of this ecosystem, and it is invertebrates, such as pollinators, that play the decisive role as regards the permanent existence and external eco-stabilisation effect of that ecosystem (Míchal, 1994). Post-industrial habitats become refuges for butterflies, wasps, beetles and spiders, amphibians and birds. The height and age of the vegetation are also important factors (Chuman et al., 2015). Butterflies in particular respond rapidly to changes in the microclimate, water system and the environment; this is proof of their abilities as bioindicators. They quickly colonise new biotopes. They respond to changes in the vegetation in terms of larvae's need for host plants and adult specimens' need for nectar (Matuszková, 2016). This is why the Red List of Endangered Species of the Czech Republic - Invertebrates (Farkáč et al., 2005) has become one of the main indicators of biodiversity on the regional scale; this list was created in response to the European Red List of Butterflies (Van Sway et al., 2010).
Depending on the morphology of the terrain, dips spread in the form of subsidence waves that extend away from the centre in all directions. Bodies of water formed by soil subsidence in the vicinity of mines, as well as subsidence troughs, are particularly characterised by the fact that they are regular in shape, have gently sloping banks, are shallow and have a flat bottom. Subsidence troughs that form on flat land, especially in alluvial river floodplains, are generally waterlogged or flooded. Wetlands can be considered an effective form of redevelopment for a wide range of polluted waters, which has also long been used for secondary and tertiary cleaning. Flooded subsidence troughs enhance the ecological value of the landscape, as they increase species diversity in the area. The banks of flooded subsidence basins are home to wetland plant species and rare invertebrates (Mikulková, Popelková, 2010). We see a rise in the number of communities of wetland or marsh vegetation able to tolerate high levels of organic nutrients. Their rich underground organs (i.e. roots and rhizomes) provide substrate for bacteria and oxygenation from areas adjacent to roots and rhizomes. They need to have a large amount of biomass above ground to provide winter insulation in cold and temperate regions, provide habitats for wild animals and also clean the waters that run through them. Newly-formed biotopes can thus serve as refuges for fauna and flora.

Tab. 1: Flora of anthropogenically affected areas of the Ostrava region

Flora of anthropogenically affected areas of the Ostrava region	
Cornus mas	*Chamaenerion palustre*
Centaurium erythraea	*Echium vulgare*
Dactylorhiza majalis	*Typha angustifolia*
Oenothera biennis	Typha latifolia
Reseda luteola	*Phragmites australis*

Tab. 2: Fauna of anthropogenically affected areas of the Ostrava region

Fauna of anthropogenically affected areas of the Ostrava region (Polášek, 2011 in Zaoralová, 2015)	
Proserpinus proserpina	*Rana arvalis*
Pyrgus armoricanus	*Rana esculenta*
Hipparchia semele	*Bombina variegata*
Ozyptila claveata	*Lacerta agilis*
Drassyllus praeficus	Ixobrychus minutus
Titanoeca quadriguttata	*Locustella luscinioides*
Ballus chalybeius	*Rallus aquaticus*
Xerolycosa miniata	*Anas strepera*
Pardosa alacris	*Accipiter nisus*
Cicindela campestris	*Corvus corax*
Pyrrhosoma nymphula)	*Alcedo atthis*
Anaciaeschna isosceles	*Accipiter nisus*
Anax parthenope	*Muscicapa striata*
Aeshna grandis	*Apus apus*
Sympetrum danae	*Hirundo rustica*
Triturus vulgaris	*Oriolus oriolus*
Triturus cristatus	*Mergus merganser*
Bombina variegata	*Circus aeruginosus*
Bufo bufo	*Podiceps cristatus*
Hyla arborea	*Acrocephalus arundinaceus*
Rana temporaria	

Subsidence troughs have become integral features of the landscape in the Ostrava region. The mining landscape often shows greater geodiversity in comparison with the area around it and with how it was before mining started. Spoil heaps and subsidence troughs play an important biological role. New biotopes forming in stagnant waters created as the result of anthropogenic activities cannot be compared with aquatic and wetland biotopes which are the result of natural

processes, as they have less microbiotope diversity and less fauna and flora species diversity. However, they may serve as refuges for organisms that have been forced out of their original habitats by man. Natural development controlled by the process of biotic succession, which occurs after mining has ceased, is able to populate even extreme anthropogenic habitats and create there ecologically valuable ecosystems that are important in terms of the natural sciences (Lipský, 2010). Compared to conventional farmland, a landscape that has been degraded by mining has a far more diverse structure and greater biodiversity. This is a benefit gained as a consequence of mining, in this respect. Interest in learning more about the natural processes of the post-mining landscape is becoming popular not only with eco-tourism, which does not disrupt the natural environment, but understands nature and does a great deal to protect it. A landscape abandoned by man becomes a refuge for plants, fungi and animals that formerly lived in the open countryside, now mostly in the post-mining landscape, which is not rich in nutrients, and so it becomes a habitat for competitively weak species that are rare in or disappearing from the surrounding countryside. An observatory of nature (fauna and flora) forced out from urbanised areas into the wetlands of subsidence basins forms the counterpart of the landscape used for farming. Water reservoirs are able to produce fish and offer forms of recreation and relaxation, such as fishing. Less useful fragments of the post-mining landscape have the potential to be used for tourism-related services (e.g. car parks, cycling trails) in order to ease pressure on valuable territories. These areas have found uses that appeal to tourists, e.g. as a dinopark (Doubrava), geopark, archaeopark (Chotěbuz), biking trails (Karviná-Fryštát), horse-riding trails, golf courses (Karviná – Fryštát), motorcycle routes (Lazy).

Tourism is always associated with a range of activities and increased values of the area in question; these values also include the succession of renewed territory. In 2016 the Moravian-Silesian region was visited by 50 thousand more people than in the previous year. Tourists continue to be attracted by the traditional destinations, not only in the Beskydy. The post-mining landscape has considerable recreational potential, which opens up new options for tourists who can relax there in the newly emerging countryside. This could ease pressure on places traditionally frequented by tourists, where the development of tourism has transformed into the development of urbanisation; the main risk for these places is the irreversible landscape barriers that are formed, resulting in fragmentation, and preserving the open landscape and keeping it permeable, including migratory connectivity, is becoming a growing problem.

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Souhrn
Změna v postindustriální společnosti spolu s obdobím transformace v České republice po roce 1989, kdy došlo ke změně způsobu práce a s tím související proměně požadavků na trávení volného času každodenního života. Cestovní ruch, infrastruktura a služby mají vliv na celkové využívání krajiny.
Rekreace orientovaná na přírodní a kulturní dědictví může potenciálně ohrožovat dané životní prostředí, ale na druhé straně může přispět k obnově v oblastech zasažených hlubinnou těžbou, jako tomu bylo v Moravskoslezském kraji. Přirozená sukcese v Ostravské pánvi nabízí mnoho nových stanovišť, která zde vznikla, a navíc zde došlo k rozvoji biologické rozmanitosti, což se může stát novým cílem zájmu. V potěžební krajině našla úkryt celá řada bezobratlých (například korýši, motýli, brouci a pavouci) a obratlovců (ryby, obojživelníci, plazi a ptáci). Obnovená degradovaná krajina může posloužit jako observatoř pro pozorování divoké zvěře nebo zde mohou být různé atraktivní lokality, které se mohou stát cílem pro relaxaci a odpočinek.

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IT HAS A SMALL VILLAGE A CHANCE FOR THE DEVELOPMENT OF THE RECREATION?

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Abstract
The village Suchohrad is a village on the very west of Zahorie – located on Moravia river, by the most western village of Slovakia - Zahorska Ves. It is small village, with a handful of the population, which currently stands 646 inhabitans. Its relative proximity to the capital city of the Slovak republic, to Bratislava city, and to district town Malacky as well, has the possibility to become one of the recreational background for its inhabitants. This also contributes to its beautiful nature, as evidenced by the presence of protected areas. The whole territory of the village is situated in the Protected Landscape Area Zahorie and the SPA Zahorske Pomoravie (SKCHVU016), includes also Sites of Community Importance. The question is therefore whether it can attract visitors who may visit it, even using the bike trails Moravian cycle route which runs directly through the center of the village. On this question we try to answer by using the evaluation of its recreational potential (protected areas, cultural and historical potential, recreational infrastructure, environmental infrastructure).

Key words: tourism, development, assumptions, marginal area

Introduction

The scale and type of tourism development in rural areas will differ according to variables such as natural and cultural resource endowment, location, competition, entrepreneurial activity, and institutional arrangements. For some rural communities, tourism is one element in a diversified economy. For others, tourism is the primary economic endeavour which dominates community life and upon which the local area dependent. (Gill, A., 1997).

Rural tourism is by definition located in regions with scattered settlements, which means that these types of mainly small - scale tourism activities take place within, or very close to, natural areas. Rural tourism is founded on the natural or human resource base of rural communities and exists predominantly in a symbiotic relationship with other local economic activities. In peripheral and economically marginal areas, rural tourism may contribute to vigorous developments in local communities. (Haukeland, J.V., Lindberg, K., 2001)

The development of tourism is always connected with its impacts on the environment. Currently a great number of methods are being used to determine impacts on the environment. For instance, Zvijakova et al. (2014) presents qualitative models (also indicated as conceptual or institutional) which are primarily focused on the identification of core components of a system, a qualitative identification of system structures, and the construction of a developmental diagram of a system. Models of ecological effectiveness stem from the philosophy of social ecological prognostication of the potential impact of an artifact on its surroundings. This evaluation is based on landscape and ecological knowledge using the fundamental methodical approaches of predicting and evaluating environmental

impacts (e.g. Pavlickova et al., 2009, Morris, Therivel, 2009). Those impacts have to be connected with the evaluation of recreational potential.
In recent years, recreational potential has become increasingly significant from the perspective of both local and regional development opportunities. Therefore the evaluation of recreational or tourism potential has turned out to be an essential technique for considering background conditions of particular landscape and for selecting recreational activities that are most suitable. Until now, several methodologies for recreational potential evaluation have been developer. (Pavlickova, Vyskupova, Igondova, 2014).
There are two basic approaches how to evaluate recreational potential (Zvara, 2011). Local natural and anthropogenic characteristics can be assessed to find out either the most proper areas for recreation and tourism or the most suitable activities specific for the whole area, alternatively their combination.
The given article is based on the second approach; the evaluation of recreational potential covers the selection of specific recreational activities that are most appropriate in terms of tourist demands and local conditions in the Suchohrad municipality.

Materials and methods
Chosen methodology has the structure built on the methodology of the evaluation of recreational landscape potential by authors Andel, Balej, Suchevic (2008) modified by Pavlickova and Molitoris (2011). It is based on a creation of indicators set and their evaluation carried out under the method of the scaling. We've been modified this methodology according characteristics of chosen area. These indicators have been chosen:

- ✓ protected areas
- ✓ culture-historical potential
- ✓ recreational infrastructure
- ✓ environmental infrastructure.

Every indicator is individually affecting each recreational activity. That is why we had separated recreational activities into several types: hiking, cycle, rural tourism, hunting, water recreation and fish hunting, non specified tourism (e.g. horseback riding, alternative sports).

A. Protected areas and culture-historical potential
In first step we set up 2 categories. Each category is divided into 4 parts with the ascending point values from 1 to 4:
A1 Protected areas (PA) – categories P1 to P4 are specified by number of the units of PA in cadastre: PA 1 (1 protected area, PA 2 (2), PA 3 (3), PA 4 (≥ 4)
A2 Culture-historical sites (CH) - categories CH1 to CH4 are evaluate according urban and municipal statistics (UMS); specified by the number of the culture-historical sites: CH1 (0-1 sites), CH2 (2-4), CH3 (5-6), CH4 (≥7)

B. Recreational and environmental infrastructure
In the second step we have been dealing with indicators of recreational and environmental infrastructure. Because in the research area both infrastructures are represented poor, we did not differentiate categories, but we grant each allocated single unit with one point.
Analyzed units of the recreational and environmental infrastructure:
B1 accommodation – source data of the UMS, B2 information centre - source data of the UMS, B3 cycle route - evaluated according existing maps, B4 hiking trails –

evaluated according touristic topographic map, B5 sport facilities - source data of the UMS, B6 cultural facilities - source data of the UMS, B7 public water-supply - source data of the UMS, B8 sewage and disposal plant - source data of the UMS, B9 communal waste disposal - source data of the UMS.

C. Indicator importance
In the third step we have been added the importance, in the range of values from 1 to 4. Used indicators had those values:

- ✓ hiking – for protected areas 4, for culture-historical potential 3
- ✓ cycle - for protected areas 4, for culture-historical potential 4
- ✓ rural tourism - for protected areas 2, for culture-historical potential 2
- ✓ hunting - for protected areas 1, for culture-historical potential 1
- ✓ water recreation and fish hunting - for protected areas 4, for culture-historical potential 1
- ✓ non specified tourism - for protected areas 1, for culture-historical potential 1

In terms of recreation and environmental indicators, we worked with a unit weight of first.

D. The resulting numerical values
The resulting numerical values for the various recreational activities in each category indicator (forest areas, lakes etc.) we achieved the following formula:
$K_I \times V_I$, where
K_I is a category indicator to the appropriate point value 1-4.
V_I is the scale of the indicator with the corresponding point value of 1 to 4.
The total sum of the point values of each category indicator represents the final point value individual recreational activities.
The total sum of the point values of various recreational activities in all categories indicator represents the total point value for the recreational potential of the cadastre.
The higher the point value, the cadastre has the greater potential for the development of recreation.

Results and discussion
The village Suchohrad is a village on the very west of Zahorie – located on Moravia river, by the most western village of Slovakia - Zahorska Ves (Fig 1). It is small village, with a handful of the population, which currently stands 646 inhabitans, but with beautiful nature, as evidenced also by the presence of protected areas. The whole territory of the village is situated in the Protected Landscape Area Zahorie and the SPA Zahorske Pomoravie (SKCHVU016), includes also Sites of Community Importance (SKUEV0124 Bogdalicky vrch, SKUEV0177 Smolzie, SKUEV0161 Suchohradske aluvium Moravy, SKUEV 0314 Niva Moravy). On the other hand the evidence of culture-historical potential is poor typical for small villages.

Fig. 1: The Suchohrad municipality
Source: www.google.sk/maps/place/Suchohrad

Concerning our chosen methodology those results could be declared:

A. Protected areas and culture-historical potential
The evaluation based on the presence of protected areas and culture-historical potential is declared in the table 1.

Tab. 1: The value of recreational activities

		Recreational activities - value					
	category	**hiking**	**cycle**	**rural tourism**	**hunting**	**water recreation and fish hunting**	**non specified tourism**
A1 Protected areas	PA 4	16	16	8	4	16	4
A2 Culture-historical sites	CH1	3	4	2	1	1	1
Total		**19**	**20**	10	5	**17**	5

B. Recreational and environmental infrastructure
Analyzed units of the recreational and environmental infrastructure:
B1 accommodation – 0
B2 information centre – 0
B3 cycle route - 1
B4 hiking trails – 2
B5 sport facilities – 2
B6 cultural facilities - 1
B7 public water-supply – 1
B8 sewage and disposal plant – 0
B9 communal waste disposal - 0.

As can be seen from the Suchohrad results, there is much difference between the natural capabilities and infrastructure that can offer the community. The village does not use its location on the river Morava in direct contact with Austria. The only real possibility as recreational facilities for tourists is the Moravian cycle route. But if a community does not build up its infrastructure for tourists staying, still Suchohrad municipality remains a forgotten village. The community, however, is well aware of when developing activities to increase recreational opportunities in the municipality. It is prepared as through a Plan of economic and social development of the municipality (2015) as well as through the establishment of Educational trail (2016) linking the natural richnesses. But even that will not go without the collaboration with other municipalities and among them especially with the municipality Jakubov, with which it is associated mainly by natural conditions and wealth of wetlands. This way can filles recreational potential of the Suchohrad municipality suitable for recreational activities as hiking, cycle and water recreation are.

Conclusion

Among the variables thought to be of importance in determining the impacts of tourism are (Ryan, C., 2003):

- the numbers of tourists
- the nature of activities in which tourists partake
- the infrastructure provied by tourist planners at the site
- the nature of the information provided by to tourists
- what have tourists been told to expect – what promotional promises have been made in any site advertising?
- what levels of fragility exist within the natural or built environments that host the tourists?

To those question the community must respond in order to increase its recreational offer. The municipality Suchohrad has real recreational potential, the nature beauties must be showed to possible tourist, especially using bicycles and water recreation. But for such a small village as Suchohrad is, it is very difficult to do it itself, the only way is linking with other villages in the area.

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Souhrn
Suchohrad je obec na samém západě Slovenska v regionu Záhorie v těsné blízkosti s Rakouskem. Leží na řece Moravě, v sousedství s nejzápadnější obcí na Slovensku – Záhorskou Vsí. Jedná se o malou ves s malým počtem obyvatel, což je v současnosti 646 obyvatel. Relativní blízkost hlavního města Slovenské republiky Bratislavy a okresního města Malacky vytváří možnost stát se jedním z rekreačních zázemí pro obyvatele těchto měst. K tomu je ale třeba, aby kromě neuvěřitelného bohatství přírody v obci tvořeného vícero chráněnými územími, byla vytvořena i environmentální a rekreační infrastruktura, což zatím v obci schází. Přitom je nesporné i vzhledem k naší analýze, že obec má jedinečné možnosti zejména v oblasti pěší turistiky, cyklistiky, vodních sportů a rybářství. Na druhé straně je třeba říci, že tak malá obec nemá jako samotná velké ekonomické a finanční možnosti, a proto je třeba, aby se při rozvoji rekreačních možností zaměřila na spolupráci s okolními obcemi.

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KNOWLEDGE AND AWARENESS OF SELECTED GROUPS OF SCHOOLCHILDREN IN THE FIELD OF FOREST UTILIZATION AND RECREATION

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Abstract

The aim of this study was the analysis of the state of knowledge of students from primary school, junior high school and high school in the field of forest utilization, hunting, tourism and recreation as well as a protection of forest undergrowth resources. The aim was also to study the current challenges and necessities in the range of forest education. The study has been conducted in the region of the Łuków Forest District (east part of Poland). The knowledge assessment and demand arrangement on the forest and natural education in different age groups have been analyzed. Information was obtained on the basis of survey analysis (289 respondents). It has been stated that the level of knowledge in the field of forest management, hunting, tourism and recreation among students is relatively low. Moreover, knowledge of the protection of species of forest undergrowth is very low (ie almost 100% of respondents did not know a single species of fungus or plants being protected). Studies have also shown a lack of basic knowledge on the state of forest management in Poland, as well as the importance of the forest and timber sector for the economy of the country.

Key words: forest management, forest utilization, forest education, hunting, forest recreation, non-wood forest products.

Introduction

Forest utilization, understood as a using from the forest's both material goods and the use of non-production functions, it is one of the most important elements of forestry, and certainly the oldest form of human intercourse with the forest. Today, forest utilization is defined as a "sustainable", which means a model of management, as a result of which we satisfy not only the needs of our generation, but also the needs of the next generation (Staniszewski 2013). Regardless, forest use is a form of interference in forest ecosystems and therefore is not unequivocally assessed by the public. This concerns both logging, which involves cutting down live trees and, in particular, the game management. Forest education in this field is therefore an urgent necessity (Staniszewski et al. 2016).

Educational offer prepared by foresters offers new opportunities for teaching environmental and natural issues. Forest education in the society can be realized in 3 ways: formal education (conducted at schools), informal education (out of school) and integrated education (implemented through the joint efforts of teachers and foresters) (Mrowińska, Mrowiński 2003). Natural and forest education is an important activity of the State Forest Holding. The purpose of educational activities undertaken

by foresters is to promote pro-ecological attitudes, sustainable and multifunctional forest management, the formation of ecological awareness among the society and appropriate attitude towards forests, as well as the activities carried out in the forest. Integrated education is based on cooperation between foresters and teachers in schools. Teachers have methodological and pedagogical knowledge. The advantage is a large foresters substantive and detailed knowledge (Będkowska 2006).
Non-wood forest utilization is especially contributing to the subject of education, and especially the use of commonly available goods, like mushrooms, fruits and herbs (Staniszewski 2013). Their availability in the forest is one of the important reasons for choosing a site for recreation (Gołos, Janeczko, 2002; Gołos, Zając 2004).
The form and effectiveness of forestry education must, of course, be derived from the recognition of knowledge, especially among the younger generation, in forest management. This paper presents the results of the survey on students' different levels of schools in selected aspects of forest management, wildlife management and recreation.

Material and methods

The study was conducted using the questionnaires. Surveys for students from elementary schools, junior high and high school, to some extent were different. They were adapted to age and ability of the respondents both in terms of methodology and method.
Research in primary schools was conducted among students in grades IV - VI (age 10 - 12 years), in rural and urban areas. The poll contained 14 questions, mainly about knowledge and awareness of the Polish forest cover and changes that occur in it; the ways in which respondents use the forest; issues related to knowledge of species, conservation, collection, and use of forest undergrowth, their opinions on hunting for animals.
Research in secondary (junior high) schools (age of respondents: 12 - 16 years) as well as in high schools (age of respondents: 16 - 19 years) was also carried out in schools in rural and urban areas. The questionnaire contains 17 questions, focused primarily on the knowledge and awareness of: Polish forest cover and changes that occur in it; knowledge of the term "forest utilization"; opinion on cutting down trees in forests; the ways in which respondents use the forest; issues related to knowledge of species, conservation, collection, and use of forest undergrowth; their opinions on hunting; knowledge and opinions on the development of tourism, recreation and education offered by the Łuków Forest District.
In total, the research included 289 respondents, out of which 106 were attending primary schools, 97 junior high schools and 86 high school (Kopeć 2016).
Due to the qualitative nature of the examined variables, the chi-squared test for independence was used to determine differences in percent structures. The hypothesis that there is no a significant association between the two variables was verified at 0.05 significance level. We looked for differences between the distributions of responses for the seven questions depending on the respondent's sex, place of residence or school level. For significant relationships between the two qualitative characteristics, Pearson contingency coefficient C was determined as the measure of strength of the relationship, used for contingency tables with any number of levels of both variables. The zero value of the coefficient is interpreted as non-dependency, and values close to unity signify a strong relationship between them.

Results

This article presents and analyzes the answers to selected questions, guided by such a criterion that you can fully compare the knowledge of students at different educational levels from schools in urban and rural areas which are most sensitive and perceived as controversial areas of forest management.

1. *Do you think that forests area in Poland: a) is still at the same level; b) is rising; c) is decreasing.*

83% of respondents said that the forest area in Poland is getting smaller, only 11% reported the correct answer recognizing that the forest area is increasing. The number of correct answers slightly differed by location (city: 10.7%, village: 11.4%) and type of school (primary: 12.3%, junior high school: 11.3%, high school: 9.8%). The older respondents, the less they answered correctly. Boys gave almost twice as much correct answers than girls (15.2% and 7.9%, respectively). However, the chi-squared test for independence has not indicate significant differences in the knowledge concerning to forest cover change in Poland between sex (p=0,130), place of residence (p=0.254) and school level (p=0.934).

2. *How often do you go to the forest? a) more than once a week; b) once a week; c) once a month; d) less than once a month.*

15.1% of primary school pupils, 13, 4% of middle school students comes to a forest more than once a week; none of the high school students marked such an answer. More than 50% of respondents visit forest less than once a month. Pupils of rural schools walk the forest more often than pupils from the city (13.9% and 5.3% respectively). 67.4% of high school students from the city visit forests less than once a month. The significant impact of sex (p=0.001; C=0.226), place of residence (p<0.001; C=0.292) and school level (p<0.001; C=0.280) on the frequency of visiting forests has been proved.

3. *What is your opinion about hunting for animals? a) one should not hunt; b) I have no opinion; c) one should hunt.*

Answer "one should not hunt" marked up 62.3% of the respondents (primary school: 76.4%, junior high school: 58.8%, high school: 48.8%), the lack of acceptance for hunting is much stronger in cities (70.2%) than in rural areas (55.7%), and is greater among girls (71.3%) than boys (50.4%). Acceptance for hunting management declared 9.7% of respondents (primary 5.7%, secondary school 15.5%, high school: 8.1%). Acceptance of hunting is four times higher in boys (16.8%) than girls (4.3%) and slightly higher in rural areas (10.8%) than in urban areas (8.4%). It has been proved the significant impact of sex (p<0.001; C=0.243), place of residence (p=0.036; C=0.150) and school level (p<0.001; C=0.268) on the opinion about hunting.

4. *In your opinion, cutting down trees in the forest is: a) good and necessary; b) I have no opinion; c) bad and unnecessary.*

This question was asked only junior high school and high school students. Rationale for cutting trees declared 10.9% of respondents (junior high school: 10.3%; high school: 11.6%), 64.5% evaluated it as improper (junior high school: 67.0%; high school: 61.6%). For "good and necessary" tree felling saw almost twice as many students in rural areas as cities (13.5% and 7.6%), and almost three times more boys than girls (respectively 16.5% and 6.1%). The statistic analysis has not

confirmed differences in percent structure of the answers between sex, place of residence and school level (p>0.05).

5. *Do you know any fungal species under strict or partial protection? a) yes; b) no.*
3.8% of primary school pupils, 4.1% of junior high school students and 8.1% of secondary school students (on average 5.2%) answered this question in the affirmative; 6.3% of pupils in rural schools declared their knowledge of such species and only 3.8% of pupils from the city. Regardless of these differences (not proved by statistic test – p>0.05), it is clear that the knowledge of students in this field is dramatically low, especially given that both the recreational and commercial collection of mushrooms in Poland has a significant tradition and is still widely practiced (Staniszewski 2013).

6. *How well do you know the educational tourism and recreation offer of the Łuków Forest District? a) I do not know at all, b) I know the whole, c) I know in part.*
This question was asked only junior high school students and high school students. It turned out that 57.4% of respondents did not know the educational offer (junior high school: 56.7% high school: 58.1%; village: 62.5%, city: 50.6%; girls: 62.2% boys: 51.8%). Only in case of place of residence the differences were statistically significant (p=0.032; C=0.190). Only 2.2% of the respondents admitted to know the full offer, with no response from any high school student and no school student in villages.

7. *How often do you use the educational tourism and recreation offer of the Łuków Forest District? a) more than once a week, b) once a week, c) once a month, d) less than once a month.*
This question also were asked only junior high and high school students. Answer "more than once a week" marked 2.2% of respondents (junior high school: 3.1%; high school 1.2% village 2.9%, city 1.3%; girls: 1.0% boys: 3.5%) 77.5% of respondents marked the answer "less than once a month" (junior high school: 74.2%; high school: 81.4%; village: 80.8%, city 73.4% ; girls: 83.7% boys, 70.6%). The statistic analysis has not confirmed differences in percent structure of the answers between sex, place of residence and school level (p>0.05).

Discussion
The above survey results indicate low level of awareness and knowledge of nature and forest among the youth. Both in Poland and in Europe, the use of forests is sustainable; in Poland annual harvesting is less than 60% of the yearly wood increment (Paschalis-Jakubowicz 2015). Meanwhile, more than 80% of respondents believe that forest area in Poland is getting smaller and smaller. In this regard, well-thought education is indispensable in every age group. It seems, however, that in this case the provision of reliable information should bring the desired results. Far more complex problem questions on timber harvesting and especially hunting. In both cases, emotions play a significant role. More than 62% of pupils think that they should not hunt at all, and almost 65% - that trees should not be cut at all, with the acceptance of hunting four times more by boys than girls, and the acceptance of cutting trees - three times more. It seems that nowadays (not only among young people) the concept of "game management" is associated mainly with hunting, treated as an absolute killing of animals. In addition, hunting rituals, resulting from centuries-old traditions, are increasingly not accepted by the public. Therefore, education should be directed not only to the promotion of wood, which has tens of

thousands of applications; not only supported hunting, which is associated with the necessity of regulating wildlife populations, and also provides healthy food, but also on historical conditions, tradition and cultural aspects, which after all represent the strength of Polish and European forestry. Tradition in Poland is also the widespread use of forest floor resources, primarily mushrooms. Putting the recreational values of mushroom picking aside, substantial part of the harvesting of mushrooms is treated as a way of earning money (Staniszewski 2016). Society in both urban and rural areas declare a good knowledge of mushroom species and stresses the importance of harvesting them for the domestic budget (Łopatko 2007, Nowacka 2012, Nowacka et al. 2014). Meanwhile, the survey has shown that almost 95% of respondents have no knowledge about the fungi under protection. According to the authors, introducing non-wood forest use in school education is deliberate: foresters' education in this field is of high social interest and, therefore, developing a knowledge concerning this particular field of forestry can be an effective tool for promoting forest management in general, contributing to the positive image of foresters in the eyes of society (Kopeć 2016, Staniszewski et al. 2016).
Declared by the surveyed students' knowledge of the educational offer of Łuków Forest District is dramatically low (2.2% knows it fully, 57.4% do not know it at all). Almost 80% of respondents use the educational facilities less than once a month. This may mean that the cooperation of foresters with schools should be intensified, spreading more broadly, eg outdoor education.

Conclusions

- The state of knowledge in the forest utilization, hunting, tourism and recreation among pupils in primary schools, junior high schools and high schools is low. Studies have shown that there is no basic knowledge about the state and area of forests in Poland, the basic concepts related to forest management, and the importance of forestry in the economy of the country.
- There is an urgent need for forest education among students from all types of schools (primary, secondary, high schools); special emphasis should be placed on the proper perception of hunting and wood harvesting and their importance in forestry.
- The State Forests should play a significant role in the organized and efficient system of forest and natural education. Utilization of forest resources is an indispensable element of sustainable forest management. Knowledge should be provided during field activities by foresters.
- Education in the forest utilization should be considered as a tool for the promotion of sustainable forest management, contributing to the positive image of foresters.

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Souhrn

Cílem této studie byla analýza stavu znalostí studentů ze základních škol, středních a vysokých škol v oblasti využívání lesů, myslivosti, turistiky, rekreace a zároveň ochrana lesních porostů. Dalším cílem bylo také zjistit současné výzvy a potřeby v rámci lesnického vzdělávání. Studie byla provedena v oblasti polesí Lukow (východní část Polska). V rámci studie byly analyzovány znalosti a požadavky na les a přírodní vzdělávání u různých věkových skupin.
Úroveň znalostí a vědomostí z oblasti lesnictví, myslivosti a turistiky u žáků základních, nižších středních a středních škol je nízká. Studie prokázaly, že u žáků či studentů nejsou žádné základní znalosti o současném stavu lesních porostů v Polsku, dále chybí základní pojmy vztahující se k hospodaření v lese a celkový význam lesnictví promítnutý do ekonomiky země. Je zde naléhavá potřeba vzdělávání v oblasti lesnictví mezi studenty ze všech typů škol. Zvláštní důraz by měl být kladen na správné vnímání lovu a těžby dřeva a jejich význam v celkovém

lesním hospodářství. Právě státní lesy by měly zaujmout významnou roli při lesnickém vzdělávání. Využití lesních zdrojů je nezbytným prvkem trvale udržitelného hospodaření v lesích. Vzdělávání v rámci užívání lesů by mělo být považováno za nástroj pro podporu trvale udržitelného hospodaření v lesích, což přispívá k pozitivnímu nahlížení na obor lesnictví.

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KONSTANCIN-JEZIORNA AS AN EXAMPLE OF RECREATIONAL DEVELOPMENT OF SPA FORESTS IN POLAND

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Abstract

The growing interest in spa health care in Poland is an integral part of spas in Poland. Spa resorts are unique places for patients as well as for residents. This is also the case of Konstancin Jeziorna, a health-resort city, which is Warsaw's immediate neighbor. The numerous nature reserves, as well as the Chojnów Landscape Park, determine the uniqueness of this place. Convenient location of the city and its natural assets are favorable to tourism development and are an encouragement to settle here permanently. Both the number of tourists and the number of residents is growing steadily. This in turn is an impulse for the municipal authorities to invest in tourism development, the creation of an appropriate infrastructure of tourism and recreation. The aim of the study was to analyze the possibility of recreational development of farms within health-resorts. Legal regulations concerning forest management within Konstancin Jeziorna were discussed as an example. The results show, among other things, that the current regulation and recommendation for forest management are not sufficient for the effective forest protection against excessive tourism and recreation pressure.

Key words: spa functions, recreational forest development

Introduction

Spa forests, as protective forests, are an essential element of space. Regulated by the provisions of the Act of 28 September 1991 on forests, they are located within the boundaries of the protection zones of spas or health resort areas. Spa forests can be a function of leisure and can also be a place of active recreation.

Spa forests represents 0.6% of the Polish forest area, and about 1.5% of the protective forest. They cover an area of 56 424 hectares. Compared to 2012, their area increased by over 200 hectares. In Poland there are 45 statutory spas[1]. The rules of conferring and depriving the area of the statute of the spa in Poland are governed by the provisions of the Act of 28 July 2005 on spa treatment, health resorts and health resort areas, and on health municipalities (Law on spas). In order to protect valuable spa values, within the boundaries of health resort can be created, the so-called, spa protection zones - A, B, or C. In each zone, certain conditions of protection, injunctions and restrictions and prohibitions apply, in particular as regards the presence of green areas and forests. In Poland, the principles of

[1] http://www2.mz.gov.pl/wwwmz/index?mr=m8&ms=625&ml=pl&mi=625&mx=0&ma=10282

shaping and implementing the spatial policy of each municipality are defined in the Act of 27 March 2003 on planning and spatial planning. Both the local plan and the study of the municipality, in the development of spa protection areas should be agreed with the minister responsible for health. The ministry once every 10 years accepts the so-called spa valuation.
Forests, which are located in the protected areas of the spas by their nature, can be managed with certain limitations so as to preserve the purpose for which they have been separated. The objectives and principles of forest management are defined in the forest facility plan. Determination of these plans in terms of borders and area of forests, including protective forests, should be included in local plans.

Purpose and methodology of research

The aim of the study was to review the formal and legal documents determining the possibilities of recreational development of the spa forests on the example of Konstancin-Jeziorna commune. The forests of the municipality of Konstancin-Jeziorna, due to their other important protective functions, are not formally recognized as spa forests. However, from attention to their location in the spa area, in this work they were treated as spa forests.
Data sources were in particular the formal and legal documents of the municipality as study and local plans. The analysis of the aforementioned data was supplemented with the information contained in the development strategy of the municipality as well as the statistical data contained in the databases of the Bank's forest data. An indispensable tool for the analysis was the spatial information system of the municipality of Konstancin-Jeziorna[2].
For the purpose of realizing the aim, within the administrative boundaries of Konstancin-Jeziorna, 5 forest areas were identified:
1. Forest area included in the Chojnowski Landscape Park and its surrounding area (1602 ha). There are the following nature reserves: Łęgi Oborskie, Skarpa Oborska, Obory, Łuczyna Olszyńska. The protection zones of the spa: A, B and C.
2. The forest area, located within the boundaries of the city of Konstancin-Jeziorna, outside the area of the Chojnów Landscape Park. Area within the boundaries of spa protection zones A, B and C. It is characterized by the so-called forest greenery with accompanying residential buildings.
3. Forest areas in the north-western part of the commune, Powsińska street, Bielawa villages (over 4ha) and Kierszek (0.47 ha). Area located in the spa protection zone C.
4. Forests in the northern part of the commune along Okrzewska Street in the villages of Okrzeszyn (10.54 ha), Kępa Oborska (7.37 ha) and Opacz (1.13 ha).The area is located in the Protected Landscape Area and in the spa protection zone C.
5. Forest areas in the southern part of the commune in villages: Cieciszew (6.6 ha), Kawęczyn (35.93 ha) and Słomczyn (5.86 ha). Forests in the village Cieciszew are located within the boundaries of the Protected Landscape Area. The whole area covered by the spa protection zone C.
The accepted above division of forest areas makes it possible to assess the possibilities of their recreational development.

[2] http://gsip.konstancinjeziorna.pl/map/

Research object

Konstancin-Jeziorna is the only spa in Mazovia, which is located in the immediate vicinity of Warsaw. The establishment of the statute of the spa occurred in 1972. Already in the interwar period Konstancin served as a summer and health resort for the inhabitants of Warsaw. The specificity of the particular microclimate of Konstancin-Jeziorna was attributed in particular to the forests located here - Chojnowski, Słomczyński and Kabacki, as well as to the Spa Park with a graduation tower.

Konstancin-Jeziorna is the urban-rural municipality with an area of 78,63 km^2 [3]. The city covers the territory of 17,75 km^2 and is characterized by residential buildings. The population of the municipality is 23659 people.

According to data from 2015, 61,77% of the area of the municipality prevailed in the land use structure in the commune of Konstancin-Jeziorna. Forests accounted for 14,67% of the municipality area, built and urbanized land, and other land respectively – 14,11% and over 9%. The area of forests in Konstancin-Jeziorna commune is 875,94ha (2015). Most of the forests are public forests (532.94 ha), supervised in part by Chojnów Forest District. Forestation of the municipality is 11,1% (in 2013 – 11,6% and in 2014 – 11,5%). The Konstancin-Jeziorna municipality, as a health resort, is located within the three spa protection zones - A, B and C. Konstancin-Jeziorna has a well-developed hotel and service base. In addition, tourist attractions include numerous bicycle paths, thiking trails, health paths and education trails.

Findings

The activity of the commune in the area of development of recreational forests of the commune of Konstancin-Jeziorna

The directions of spatial development of the municipality of Konstancin-Jeziorna are defined in the study of the municipality, in force since 1999. The main function of the spatial and economic development of the commune is the spa function and its accompanying functions: service with tourism and recreation, residential, manufacturing and agricultural. The study includes, among others, the maintenance and development of a moderate existing spa base, development of accommodation facilities, improvement of sanitary conditions. As part of the service function, the municipality aims to implement such projects as: construction of recreational facilities and sports facilities (bicycle and hiking paths, swimming pools, playgrounds, hiking trails), construction of catering and hotel facilities, camping and parking facilities development and agritourism development. The study highlights the important role of natural conditions, including forest areas, in the development of the spa function.

Implementation of the spatial policy of the municipality specified in the study takes place through local spatial development plans. Below, Table 1 shows the most important findings of the selected local plans for the development of recreational forests in the commune of Konstancin-Jeziorna.

The municipality Development Strategy assumes that by 2020 "*Konstancin-Jeziorna will serve as a health resort with high - at the national and EU - level spa treatment and rehabilitation (...) . Commune will be a friendly and healthy place to live, work*

[3] www.konstancinjeziorna.pl

and leisure. It will become a favorite and a valued place for weekend recreation for the inhabitants of Warsaw, especially Ursynów and Wilanow."

Tab. 1: Determination of local spatial development plans of Konstancin-Jeziorna municipality in the scope of recreational development of forests.

Forest area	Local spatial development plan	Arrangements for the development of recreational forests
1.Chojnów Landscape Park with its surrounding	Chojnowsko-Oborskie Forest and adjoining areas	Forest are allowed to locate tourist facilities - the path of health. It is mandated to maintain the forest stand and fleece. In the area: forest with the development of individual recreation, it is forbidden to expand and reconstruct existing buildings. The plan covers the nature reserve "Obory", the development of which should be in accordance with the provisions of the Act on Nature Protection.
	Land of Obory and Łyczyna	The plan includes nature reserves located within the borders of Chojnowski Landscape Park. The development of these areas should be in accordance with the provisions of the Nature Conservation Act. Within the limits of the reserves it is prohibited, among others. Construction or extension of buildings or technical facilities unless they are related to the functioning of the reserve. The area of the plan determines the areas for the implementation and maintenance of services related to: tourism, health, leisure and recreation. In areas, related to forest management, the plan introduces a complete ban on the location of objects that may cause nuisance caused by noise or pollution, as well as landfills. It is forbidden to implement hardened public roads. The plan has been set up realization of the bicycle path, which has already been partially realized.
	Parts of rural areas Obory Konstancin - Jeziorna “Oborskie Fields"	The local plan defines the main function - golf courses, as an ecologically active buffer zone adjacent to the Łęgi Oborskie reserve. The plan determines the need to preserve valuable stand. The plan determines a public pedestrian zone located within the park's enclosure and a pedestrian zone within the park boundaries.
2. Urban area of the spa	Zone "A" of the spa and adjoining areas - stage I.	The plan imposes an obligation to protect the existing stand. The plan covers the area of the district spa. On Parkowa Street, it determines the conversion of a part of the forest into publicly-designed greenery and in car parks for the disabled, sports and recreational facilities, water harbors, small architectural objects, playgrounds,etc. For the forest area the plan allows for the adaptation of individual recreation buildings and prohibits the construction of new buildings as well as the reconstruction and extension of existing buildings. The plan allows for the adaptation of existing forest roads. Grounds should be used for hiking and cycling routes. In areas with unfavorable soil conditions, a pavement or gravel surface may be used. The plan allows for the development of forest roads enriched with elements such as rain shelters, educational and information boards, trash baskets, benches - as long as the basic construction material is wood.

	Area of New Wierzbno	The plan covers areas primarily intended for residential purposes.The plan determines the allocation of public services with accompanying greenery (buildings related to health care, tourism, recreation, etc.) resulting from the transformation of forest land. The plan is to establish a forest green public access. In this area it is permissible to adapt existing farm buildings and prohibit the implementation of new buildings. The plan also allows forestation of plots.
	Chilicka Brickyard.	Within the limits of the plan it is possible to locate finely cubature objects and elements of small architecture. The plan assumes the use of existing ponds for recreational purposes, as well as the location of cubature buildings such as pitches, sports halls, spectators, along with car parks accessible to tourists. The plan specifies the protection of forest vegetation and trees.
	Land area "Chylice - summer resort"	Spa services on forest plots; spa services and one-family housing developments on forest plots; services and single family housing on forest plots and single family housing on forest plots; single family housing and spa services on forest plots. Forests are planned to cycle KR. For the entire area covered by the plan the protection of the stand is determined.
3. Northwestern part of the municipality (Bielawa, Kierszek)	Bielawa administrative district - the northern and eastern part.Warsaw Protected Landscape Area	The plan determines the area of forest land allocated for forest purposes. They are banned from building, except for buildings used for forest management, based on a forest management plan. In addition, it is mandated to preserve unmanaged forest roads. It is also possible to set up new economic roadways with pavement. For the forest area of the village of Kierszek, the local plan does not exist.
4. The northern part of the municipality (Okrzeszyn, Kępa Oborska, Opacz)	Village - Okrzeszyn	The terrain of the forests is defined in the plan. Acceptable use - technical infrastructure equipment for local needs, including forest regulations. The forests are located within the limits of the Warsaw landscape protection area. There is an obligation to maximize the value of the natural environment and to prohibit the implementation of cubature facilities, except for technical infrastructure in the field of public communications. The plan allows areas under forestation.
5. The southern part of the commune (Cieciszew, Kawęczyn, Słomczyn) - no local plans.		

The activity of Chojnów Forest District in the field of recreational development of the forests of the commune of Konstancin-Jeziorna

According to the forest facility plan of Chojnów Forest District, the forests located in the commune of Konstancin-Jeziorna are characterized by special qualities. This is due, among others, to a convenient location of forests in the vicinity of Warsaw, high natural and landscape values, and growing interest in the use of recreational forests. In the area of the forest district, there are many walking paths, biking trails and hiking trails. In addition, there are also educational paths.

The forest facility plan, in the adopted programming period 2008-2017, emphasizes the need to renovate tourist routes and to develop new educational pathways and additional car parks.

Discussion and summary

An increased population pressure on valuable natural areas, such as forests, affects how they are managed. As pointed out by Janusz i Piszczek (2012) for Ważyńskim (2000), the function of the forest and its position relative to the major cities and spas, determines the intensity of its recreational use[4].

Konstancin-Jeziorna, as a spa town with exceptional natural values, is becoming an object of interest not only to the residents but also to the inhabitants of Warsaw and the local population. On the one hand, the municipality carries out the needs of residents and tourists and, on the other, strives for sustainable development of the area. The municipality carries out tasks in forest areas in a way that emphasizes their protective features. Within the boundaries of the forest, the activities of the municipality are limited to small undertakings consisting in the construction of health paths, bicycle paths, car parks, pedestrian paths. The municipality, in local plans, preserves forest stands. Establishment of local plans prohibits the change of pavements of existing forest roads. In all areas as laid down in local plans, it is forbidden to build or locate any facility likely to cause noise or pollution as a landfill, as well as a landfill. Where the municipality has enabled housing expansion - within the boundaries of the health resort, the plan allowed for the development of forest roads enriched with elements such as recreation lounges, educational and information boards, rubbish bins, benches - as long as the basic construction material will be wood.

It should be emphasized that not only local plans shape the way of using forest areas in the commune of Konstancin-Jeziorna. Quite a large part of the forest area is located within Chojnowski Landscape Park. Taking into account the implementation of the forest management plan in the implementation of the spatial policy of the municipality is another important element of rational management in forest areas. The recreational development of the forests in Konstancin-Jeziorna is based on the right balance between the requirements and expectations of tourists and locals, and valuable natural elements of space. The analysis of the planning and strategic documents of the municipality and the plan of forest management for Chojnów Forest District was proved by this analysis. The municipality, taking into account the provisions of other acts (eg landscape park protection plan, forest facility plan) correctly implements spatial policy, especially in relation to forest areas.

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Souhrn

Konstancin-Jeziorna – lázeňské město s výjimečnými přírodními hodnotami se stává předmětem zájmu nejen místních obyvatel, ale také obyvatel Varšavy. Na jedné straně se město rozvíjí dle potřeb obyvatel a turistů a na straně druhé usiluje o udržitelný rozvoj území. Magistrát města plní své úkoly v lesních oblastech tak, že se snaží, aby byly podpořeny ochranné funkce. V rámci lesních porostů jsou zbudovávány zdravotní stezky, cyklostezky, parkoviště a pěší stezky. Město se v rámci územního plánu snaží co nejvíce zachovat lesní porosty. Územní plán města zakazuje změny stávajících lesních cest a dále je podle tohoto dokumentu zbudovávat jakákoliv zařízení či objekty, které by měly za následek šum či znečištění v podobě skládek. Vzhledem, že se i toto město rozrostlo, územní plán

umožnil rozvoj lesních cest obohacený o rekreační prvky, vzdělávací a informační tabule, odpadkové koše a lavičky.

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LAND USE LIMITATIONS ON THE EXAMPLE OF THE PROJECT PROPOSAL OF "SINGLTREK PÍSECKÉ HORY"

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Abstract
Land use limitations represent the limitation in a specific area in order to protect public interests. These limitations results from legislation or are determined tracing on the basis of separate legal regulations or follow from characteristics of a territory. All limitations located in a territory must be taken into account during a planning and realization of mountain bike trails. Specific land use limitations are presented on a particular case of the project proposal for mountain bike trails in the town of Písek in the area of Písecké hory. Limitations related to the presence of a natural park, elements of the territorial system of ecological stability, important landscape elements and for the protection of water were found to be the most important land use limits in this area. Recommendations which can help reduce the negative impacts on this area are seen particularly in the professional plan of mountain bike trails based on precise tracing in the terrain and consideration all details of intended trails.

Key words: regulation of land use changes, mountain bike trails, environmental impact evaluation, impacts on game management, impacts on forest management

Introduction

A popularity of mountain biking and mountain biking trails is still worldwide increasing. The same trend can be seen also in the Czech Republic in the last 20 years. Informal mountain biking is progressively changing into formal form due to progress in biking equipment, changes in leisure activities aiming to active physical activity in landscape and still higher demands on biking infrastructure. This progress result in new phenomena of mountain biking management, new destination for mountain biking activities (single trails, downhill, freeride) in the Czech Republic.
Although the mountain biking can be included between nature-based tourism and recreation activities, there can be also found negative impacts to nature mainly vegetation loss, compositional changes, soil compaction, erosion, muddiness, degraded water quality, disruption of wildlife (Mariot and Wimpey, 2007, Monz et al., 2010). Researchers deal with the comparison impacts among different types of trails and between informal and formal trails (Goeft and Alder, 2001; Hill and Pickering, 2006; Pickering et al., 2010; Müllerová at al., 2011; Mark and Pickering, 2015). Key observations about the environmental impact of mountain biking were summarized by Marion and Wimpey (2007).
Except environmental impacts mountain biking managers and local authorities deals with issues of safety of trail users, user conflicts and crowding of trails. A lack of understanding all associated impacts can lead to confusion, conflict between stakeholders and sometimes to regulations or final stoppage of mountain biking manager's efforts to establish formal trails and mountain biking centres during decision making (Edger, 1997; Marion and Wimpey, 2007). For example, Hardiman

and Burgin (2013) suggest steps to minimise the potential for such prolonged conflict over mountain biking (or any other emerging sport). The decision must be based on an ecological and social research and a wide communication of land managers with stakeholders. Final decision and reasons that underpin these decisions must be widely disseminated.
This paper presents stakeholder approach to the proposal of the project of the mountain biking destination in the locality of Písecké hory in the Czech Republic and a brief study of ascertained land use and management limitations in this area.

Materials and methods
The study is located in the area of Písecké hory in the South bohemian Region close to the historical town of Písek (Fig. 1). The localization of the project proposal close to historical city is unique within the whole Czech territory. Písecké hory are forested area covering almost 5 000 ha. The proposal of the project was located in the northern part of Písecké hory which is use for short term recreation by local inhabitants of the city and it is easily accessible. The land is owned by the city of Písek and the forest management is secured by the municipal company. In addition, the study area fulfils diverse recreational and other social and economic demands.
The methodology is based on the description of experience gained during the processing of the feasibility study of the proposed project of single trails destination for the municipality of Písek (Kozumplíková et al., 2016). The study was also focused on appropriate land use limitations which were obtained from standard map sources and structured and unstructured interviews with main stakeholders (forest management, nature protection, game management, tourism destination company). In addition, the analysis of general legal context for projects of this focus was made.

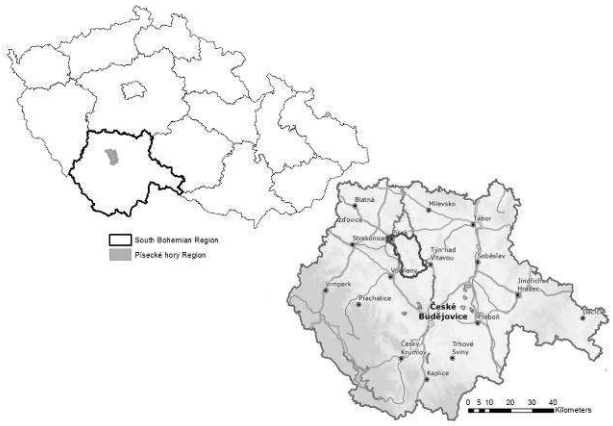

Fig. 1: Localization of the study area – Písecké hory region (Source: Own processing based on ©ArcČR, ARCDATA PRAHA, ZÚ, ČSÚ, 2016)

Results
Specific relations and possible impacts of mountain biking trails to environment and management in the area of Písecké hory were evaluated. Land use limitations present (according to § 26 paragraph 1 of the Law No. 183/2006, Coll. as subsequently amended) restrictions changes in the area in order to protect public interests resulting from legislation or established under special legislation or arising from the characteristics of the territory. The studied area is located in forested land within the natural park of Písecké hory under general protection according Act

114/1992, Coll. on nature and landscape protection (ANLP). All interventions in the natural park also have to deal with the protection of landscape character. According ANLP, all forests, water courses, their floodplains and water bodies on the area are protected from inappropriate interventions as important landscape components. Therefore, the project should request an opinion from the authority of nature and landscape protection.
According to data provided by Nature Conservation Agency of the Czech Republic (NCA CR), 103 specially protected species are found on the territory. This Agency is also the authority which gives expression to the proposed interventions. The locality is covered neither by large-scale or small-scale protected areas under a special protection area under ANLP nor European network of Natura 2000. On the other hand the area is interwoven with components of territorial system of ecological stability (TSES) on local, regional and supra-regional level (biocentres, biocorridors and interactive components). The fact of existence defined TSES in the natural park Písecké hory would to be reflected particularly in the phase of planning permission procedure when the compliance with the planning documentation including the protection of TSES projected in the zoning plan is examined. Interventions in regional TSES are judged by the regional authority, in the case of supra-regional TSES by the Ministry of Environment. The whole studied area falls to sensitive areas and the eastern part to vulnerable areas in terms of water protection. It is evident that considered project of mountain biking trails should deal with many land use limitations and the primary decision is within the competence of the relevant municipal and state authorities. Other specific issue associated with mountain biking trails planning is question of planning permission procedure and the environmental impact assessment but this issue is beyond the scope of this paper.
Projects of mountain biking trails deal with not only a settlement of impacts to nature and landscape but very often with requirements and objections of local stakeholders (forest managers, game managers, local inhabitants, visitors etc.). There is still the lack of understanding of all impacts of mountain bike trails in specific territory of the Czech Republic and it very often results in some misunderstanding between land managers and managers of trails. The study of the proposed project in the natural park of Písecké hory mainly dealt with comments from forest and game managers and local inhabitants. The biggest concerns arise from the expected limitations of the standard forest management, wildlife disturbance and conflicts among users of the territory.
Because there are no long-term studies in this field in the Czech Republic we suggest some recommendations following from experience and practice from already realized projects of mountain biking destinations.

Discussion

Obligations during mountain biking trails project planning and implementation resulting from legislation should be supplemented by voluntary tools that will reduce conflicts arising from the various requirements of stakeholders. Actual experience from mountain biking destination in the Czech Republic corresponds with knowledge from abroad centres. All below stated recommendations are consistent with other foreign authors´ suggestions (Chiu and Kriwoken, 2003; Marion and Wimpey, 2007; Mann and Absher; 2008, Davies and Newsome; 2009; Hardiman and Burgin, 2013; Newsome at al., 2016; Kozumplíková et al., 2016).

- Start an effective collaboration between land management and the mountain biking user groups and trails managers,

- involve mountain bikers in decision making regarding trail design and construction,
- suggest communication strategies to reduce conflicts,
- provide the effective guidance for visitors and other users,
- suggest and keep an appropriate risk management in the destination involving all groups of stakeholders,
- provide regular monitoring of considered impacts to nature, landscape and accept appropriate measures,
- define the method of maintenance and repairs of trails by a competent persons.

Conclusion

All projects of formal mountain biking trails deal with many land use limitations during the planning procedure. The territory of Písecké hory is protected as the natural park which is proclaimed for the protection of specific landscape character. The territory considered for formal mountain biking trails is forested area protected as significant landscape components. The area is also interwoven with components of territorial system of ecological stability (TSES) on local, regional and supra-regional level. Except presented land use limitations authors of the feasibility study dealt with requirements and objections of local stakeholders especially forest managers and game managers. The biggest concerns arose from the expected limitations of the standard forest management, wildlife disturbances and conflicts among users of the territory. There are no long-term studies in the Czech Republic. Therefore, we suggested some recommendations following from experience and practice from already realized projects of mountain biking destinations. The active collaboration between land managers and mountain biking managers during planning and realization procedure is according our opinion the most important practice.

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Souhrn
Horská cyklistika zažívá celosvětově značný rozmach a se zvyšující se poptávkou se zvyšují také požadavky na odpovídající infrastrukturu v krajině. V procesu plánování se musí projekty stezek v krajině vypořádat s četnými limity využití území. Záměr projektu stezek pro horskou cyklistiku v přírodním parku Písecké hory by se v případě realizace musel vypořádat s limity v podobě ochrany krajinného rázu, zásahy do významného krajinného prvku a zejména se zásahy do vymezeného územního systému ekologické stability včetně posouzení souladu s územním plánem. Při posuzování vlivů záměru na životní prostředí je nutno vzhledem k absenci výzkumů v českém prostředí využívat poznatky ze zahraničí. Zásadním pro realizaci projektů tohoto typu je efektivní komunikace se správci dotčeného území a ostatními stakeholdery. V případě Píseckých hor je to diskuse směřující k dohodě o spolupráci se zástupci lesního hospodářství, myslivosti a místními obyvateli.

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LOCAL GEOHERITAGE: ITS IMPORTANCE AND POTENTIAL FOR GEOTOURIST AND RECREATIONAL ACTIVITIES (A CASE STUDY FROM LOMNICKO AREA)

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Abstract
Geodiversity, respectively its valuable part – geoheritage is considered an important resource for the geotourism and recreation purposes. In the Czech Republic, there are a lot of examples of such use of geoheritage: sandstone rock cities (e.g. Elbe Sandstones), karst areas (e.g. Moravian Karst) or polygenetic relief at mountain areas (e.g. Krkonoše Mts.) and others. These geoheritage features are usually significant on the national level, their existence assure the attractiveness of the given area, enables the geotourist and recreational activities and support the local and regional development. However, in the local scale, the geodiversity (respectively geoheritage, represented by particular geosites and geomorphosites) can also serve the above mentioned purposes. Maybe these landscapes or landforms are not so breathtaking at the first sight, but they often reach high scientific, added (e.g. historical or artistic) and economical values, so they certainly dispose a potential for geotourist and recreation activities.
The paper presents the example from Lomnicko area (approximately 30 km northwest of Brno), which can be seen as an "average" area from the geodiversity/geoheritage point of view on the national level, but on the local and regional level, there is a considerable number of geosites and geomorphosites with a potential for geotourism and recreation.

Key words: geodiversity, geosite, geomorphosite, geotourism

Introduction: geodiversity/geoheritage as a resource for tourist and recreation activities

Geodiversity (respectively its valuable part – geoheritage) is considered to be the basic resource for geotourism and related educational and recreational activities and it is defined as "the natural range (diversity) of geological (rocks, minerals, fossils), geomorphological (landforms, topography, physical processes), soil and hydrological features, including their assemblages, structures, systems and contribution to landscapes" (Gray 2013).
This definition presents the geodiversity as value-free quality of the natural environment. Those elements of geodiversity, that are seen as significant (of course according to particular subjective criteria) are called "geoheritage" (Sharples 2002). The concept of geoheritage is based on the definition of natural heritage which was presented already in 1972 (UNESCO 1972). The term geoheritage was defined as those components of natural geodiversity of significant value to humans, including scientific research, education, aesthetics and inspiration, cultural development, and a sense of place experienced by communities (Dixon 1996 in Dingwall 2005:14). A similar definition was presented by Eberhardt (1997); he emphasises that geoheritage belongs to the "things we would wish to retain for present and future

generations". Sharples (2002) says that geoheritage is represented by those elements of natural geodiversity, which are of significant value to humans for non-depleting purposes which do not decrease their intrinsic or ecological values. In addition, it is represented by specific examples of features and processes, which are worth of protection and conservation.
In the above mentioned definitions of geoheritage appears the word "natural" (natural geodiversity or primary geodiversity, that means the features formed without the human impact or activity). Obviously, the natural features represent bigger part of geoheritage (both on global and local scale), but the secondary (or man-made) geodiversity should not be omitted as it also represents a significant resource for tourist and recreation activities (Kubalíková, Bajer, Kirchner 2016). Secondary or man-made geodiversity can be defined (analogically to the Gray's definition of geodiversity) as „the range/diversity of the man-made/anthropogenic landforms, including their assemblages, relationships, structures and systems". The anthropogenic (or man-made) geosites and geomorphosites often have high scientific and added values and they can increase the overall diversity (respectively landscape diversity) of certain area (Cílek 2002), so they form the full-value and indisputable part of the geoheritage both on global and local level.
If the statements mentioned above are accepted and taken into account, the slightly modified definition of the geoheritage can be presented: *components or features of primary (natural) and secondary (man-made or anthropogenic) geodiversity which are of significant value to humans, including scientific research, education, aesthetics and inspiration, cultural development, and a sense of place experienced by communities.*

From the globally important geosites and geomorphosites to the local geoheritage

Practically, the geoheritage is represented by particular geosites and geomorphosites or their systems and complexes for which can be used a term "wider landscapes" (Reynard, Panizza 2005) – that means the systems or complexes of several particular landforms.
The geosites are defined as portions of the geosphere that present a particular importance for the comprehension of Earth history, geological or geomorphological objects that have acquired a scientific, cultural/historical, aesthetic and/or social/economic value due to human perception or exploitation (Reynard 2004 in Goudie ed. 2004:440); geomorphosites are the landforms to which a value can be attributed and they can be used by society as a geomorphological resource (Panizza 2001).
Concerning the question of dimensions of particular examples of geoheritage, Grandgirard (1997 in Reynard, Coratza, Regolini-Bissig 2009:16) states that geoheritage is visible at all scales, from the small isolated landforms to large landscapes (Tab. 1). He provides following classification based on the number of landforms and processes:
Usually, the main resource for recreational and tourist activities on the global or national level is the highest level – geomorphological system or complex, so called geomorphological landscape. These systems cover larger area, they dispose high number of specific and particular landforms that have been formed by different processes. These landscapes are often the cores of the protected areas and national parks and they are traditionally exploited by tourism industry and abundantly visited. These areas plays a key role in the tourism and recreation on the

national level and they have an important influence on the regional development. Also, these areas usually possess the developed tourist infrastructure (including accommodation, catering services, transport facilities, marked paths, tourist shelters and other supporting services) so they are very popular, but also very overcrowded and overused especially during the holidays.

Tab. 1: The classification of geoheritage based on the dimensions of particular features (*source: Reynard, Coratza, Regolini-Bissig eds. (2009)*

number of processes and landforms	*specification*
one main process, one type of landforms	isolated landform or group of landforms („simple geosite or geomorphosite“)
one main process, several types of landforms	complex of landforms (wider landscape or complex of geosites and geomorphosites)
several main processes, several types of landforms	geomorphological system or complex (Reynard (2005) introduces the term “geomorphological landscape“)

Another type of sorting of the geological and geomorphological heritage can be based on the importance for particular area. It is linked with the dimension (mentioned above), but also with the knowledge and “popularity” of the site and other values (e.g. historical, economical, aesthetic or ecological aspects). From this point of view, we can sort the geoheritage into several groups:
1) *Global geoheritage*, which represents the highest level including the UNESCO sites or Global geoparks.
2) *National geoheritage*, which is represented by features (complex or system of features) that usually form a significant part (or core) of national parks, large protected areas, nationally protected nature monuments or national geoparks. This level of geoheritage usually corresponds with “geomorphological landscapes” or “geomorphological systems”, but this category can also include particular geosites and geomorphosites of high importance that are usually protected in the category of National Nature Monuments or National Nature Reserves.
3) *Regional or local geoheritage*, which usually corresponds with simple (or particular) geosites and geomorphosties and “wider landscapes” or “complex of landforms”. These features can be protected by law (usually in the lowest category of Nature Reserve or Nature Monument or Natural Park), but there are many cases where the legal protection is not established. However, it does not mean that these sites lack scientific or other values. In fact, these values can reach similar values as in the case of the geoheritage features of higher levels, but due to various factors (e.g. accessibility, knowledge and popularity of the site/landscape, localization or uniqueness and rarity), they are not considered the “nationally significant” geoheritage. Nevertheless, this local or regional geoheritage is very important for local development (on the level of communities, higher administrative units (districts) and in some cases particular regions or counties) and it represents an important resource both for local tourism and recreation as well as it offers the alternative to the traditional tourist destinations.
It has to be mentioned that this sorting of geoheritage according to the global/local importance is not definitive and it is sometimes hard to say in which category (or level) the particular feature of geoheritage (particular geo(morpho)site or landscape)

can be included in. It depends on various factors and also on the criteria that are set for the classification and sorting.

Local geoheritage as a resource and alternative (short reflection about factors that emphasizes the importance of local geoheritage)

As stated above, the features of local geoheritage are not usually so breath-taking, extensive or unique (as the geoheritage features on global and national level), but they possess the values that are very important for the tourist and recreational purposes (respectively for the potential visitors or users) and their possible further development. These can be:

1) *scientific, conservation and educational value* (e.g. the landforms and the processes are illustrative, visible and simple to understand, the integrity or conditions of the landforms are relatively good which can be affected by lower amount of visitors and less intensive use of the local geoheritage features),
2) *added values* (e.g. ecological, historical or archaeological values, artistic values represented by local legends linked with geoheritage, aesthetic values),
3) *economic value* (accessibility, presence of tourist infrastructure or background for short-term visits, financial availability – that means "local geoheritage – local prices"),
4) *number of visitors and knowledge/popularity of the site/area* (local geoheritage is not so well-known and popular and the number of visitors is not so high as in the case of national and global geoheritage, so it offers a friendly and nice alternative for visitors that are looking for something new, original, calm and not so overcrowded and overused at the same time),
5) *stronger feel of local identity* (local products, "real" or authentic local people and services, not only "theatre").

Of course, the list is not exhaustive, there are much more values, criteria and factors that can be taken into account and also, the most of them are disputable. To specify exact factors and values that influence and emphasize the importance of the local geoheritage, the detailed investigation should be done, but this task stands outside the frame/scope of this paper.

Study area

Lomnicko is situated 30 km northwest from Brno which is the second largest city in the Czech Republic (approximatelly 380 000 inhabitants, but real number of people living here is higher) and the capital of the South-Moravian region. It can be said that study area lies within the wider surroundings of the metropolis and represents the recreational and touristic background of the city. The study area lies approximately between these villages: Osiky – Synalov – Lomnice – Veselí – Ochoz u Tišnova – Běleč – Křeptov, but some specific segments of landscape within the close surroundings are included too.

For the study area, the harmonic landscape with well conserved natural features and with proofs of the sustainable use of them is typical and it offers a good example how the people exploited the landscape in the past. The part of the area is legally protected within the Natural Park Svratecká Hornatina, some specific segments of abiotic and biotic nature are protected within the category of National Reserve or National Monument.

Natural Monuments: Horní Židovka, Sýkoř, Míchovec, Synalovské kopaniny, Dobrá studně, Klášterce, Veselský chlum, Veselská lada, Hrušín, Luzichová.

Natural Reserves: Sokolí skála, Pod Sýkořskou myslivnou.

Geologically, the basement is formed by biotit-muscovitic, sericite-muscovitic gneisses of the Bíteš group (part of the Moravicum) covered by Quaternary sediments and in some specific places, there are remnants of the marine sediments of Ottnang age (webpage of the Czech geological survey). Just relatively monotonous geological composition of the area enabled the formation of extraordinary geomorphological landforms and features.
Geomorphologically, the study area is affected by several processes, but the most significant landforms were created mainly by periglacial and cryogenic processes: tors, ridges, castle-koppies, structural ridges, block accumulations and flows, nivation depressions, cryoplanation terraces, frost-riven cliffs, abri, rims, etc. (Demek et al. 2010) – these landforms are considered the main geoheritage feature with potential for tourist and recreational activities. Also, the anthropogenic features of the relief are present here: especially of agricultural origin (heaps, terraces, ramparts, small walls). Due to unique combination of geology and geomorphological landforms and features, Lomnicko area belongs to best preserved areas with periglacial and cryogenic rock landforms in the Czech Republic, which is the basis for a very high morphogeodiversity of the area.
The study area is rich in various cultural features, the most important are probably the historically and architectonically valuable objects in Lomnice on the southern part of the area (Jewish cemetery, synagogue, plaque column, castle, chapel and church). In the villages, other sacral objects and traditional agricultural buildings and other objects of folk architecture can be found. In the landscape, the small sacral objects are common (crosses, small chapels etc.).
Concerning the dimensions and character, the study area can be considered a "wider landscape". As stated above, the main process is represented by group of specific cryogenic processes that formed the most significant landforms. These processes were accompanied by anthropogenic, slope and fluvial processes in several parts of the area that also formed specific landforms (e.g. anthropogenic agrarian landforms, river or stream valleys).

A method for the analysis of the potential for tourism and recreational purposes

Although the assessment method for the evaluation of the tourist and recreational potential of the study area comes out from the numerical assessment methods that have been already used for different type of particular geosites and geomorphosties (e.g. Panizza 2001; Coratza and Giusti 2005; Pralong 2005; Serrano and González Trueba 2005; Reynard et al. 2007; Pereira and Pereira 2010, Kubalíková 2013, Kubalíková, Kirchner 2016), this assessment is not numerical, it only follows selected criteria that were set in specific methodologies. The result is qualitative evaluation of the touristic and recreational potential supplemented by SWOT analysis of the study area.
The assessment criteria (Tab. 2) are based especially on Kubalíková (2013), Bajer, Kirchner, Kubalíková (2015) and Kubalíková, Kirchner (2016) and they respect the principles and definitions of geotourism (Dowling, Newsome 2010).
Based on the detailed field research and assessment according to the selected criteria, the SWOT analysis of the study area is done (SWOT analysis summarize the Strenghts, Weaknesses, Opportunities and Threats).

Tab. 2: Criteria for the assessment of geotourist and recreational potential
source: Kubalíková (2013), Kubalíková, Kirchner (2016)

Scientific values	
Earth-science importance and rarity/uniqueness	scientific importance – from the geological, geomorphological point of view; presence of specific features, existence of the features that are unique also on the higher level, e.g. national level
Diversity of particular landforms and processes	number of different landforms and processes within the study area
Integrity, conservation	the degree of disturbance or the damage of the landscape within the study area, risks and threats to the landscape – both anthropogenic and natural, management measures to prevent the possible damage and disturbance, existence of legal protection, proposals of legal protection, other types of protection
Educational value	visibility and comprehensibility of the landforms and processes, intelligibility to the laic public, possibility of explaining the corresponding processes
Added values	
Aesthetic value	viewpoints, landscape pattern and visual diversity, colours etc.
Cultural value	historical, archaeological, artistic features of the study area
Ecological value	presence of specific biological features – protected species, rare ecosystems…
Economical values	
Accessibility	both by public and individual transport, parking places, the access to the particular site, the “permeability” of the landscape, safety of the access
Supporting services and tourist infrastructure	accommodation, catering, local products, tourist paths and shelters, information centres
Promotion of the area	promotion on the web pages of the local communities and elsewhere, where can potential visitor obtain more information, knowledge of the area, its popularity, eventually attendance etc.

Results
The analysis of the potential for recreational and geotourist purposes was done for the whole study area, not for particular geosites and geomorphosites. The results are presented in Tab. 3. The SWOT analysis follows (Tab. 4).

Conclusions
Lomnicko area is a good example of an area with high geodiversity and cultural-historical heritage. The region has a high tourist recreational potential, in spite of the fact that there are no top tourist attractions. Lomnicko area represents an area which can be considered as an alternative to tourist overloaded top destinations (e.g. Bohemian Paradise, Moravian Karst, Krkonoše Mts.). But even here, sustainable tourism must be take into consideration and suitable infrastructure must be developed with respect to protection of nature heritage.

Tab. 3: Assessment of the geotourist and recreational potential of the Lomnicko area
source: authors

Added values	
Aesthetic value	Within the study area, there are a lot of viewpoints to the open landscape. The landscape pattern is quite diverse (small pieces of fields, forests, little villages…), so the study area is quite attractive from this point of view.
Cultural value	Probably the most important cultural features are concentrated in the Lomnice municipality (Jewish cemetery, synagogue, Catholic church and chapel). There are numerous small sacral objects both in the villages (chapels) and in the open landscape (wayside crosses). Also, there are some old agricultural buildings and other objects of folk architecture. These issues (e.g. buildings or walls built of local stone) represent a significant part of geoheritage too and they enables to see the historical, architectonic and cultural features in the context of using the natural resources. There is also a specific artistic feature: the pathway of Jára Cimrman which is attractive for the theatre-lovers and admirers of this unappreciated Czech genius.
Ecological value	Most of the landscape segments which are legally protected are home to the specific and rare species, so the ecological value of the study area is quite high.
Economical values	
Accessibility	Generally, there is a possibility of parking a vehicle in the villages. The public transport is sufficient as the area is partly included into the Integrated transport system of the South-Moravian region. The accessibility to the particular sites is quite easy and safe as the terrain is not very difficult, there is a network of paths and local communications (both marked and not marked). The „permeability“ of the landscape is quite good thank to the presence of that network.
Supporting services and tourist infrastructure	There are marked paths within the study area, which lead through the most attractive segments and the main attractions are well signed. The limited possibility of accommodation is possible in the Lomnice or Tišnov (outside the study area), but as the area is rather used for one-day trips, this is relatively sufficient. There are also some local restaurants even in the smaller villages.

Promotion of the area	The area is promoted especially via web pages of the local communities and web pages devoted to the touristic attractions of the South-Moravian region. The information about scientific features of the particular landforms can be found on the Database of geological localities which is kept by Czech Geological Survey. Some specific sites are mentioned in the local guides and leaflets that are occasionally issued by local communities or other institutions. The knowledge and popularity of the area is rather local/regional (it can be said that it is not known on the national level), the area is used especially for short-term recreation and one-day trips as it is situated not far from Brno city. Due to the fact that there are more attractive areas close to the Brno (e.g. Moravian Karst), the study area do not suffer from the excessive number of tourists and it is not overcrowded even during the holidays and week-ends.

Tab. 4: SWOT analysis of the Lomnicko area (*source: authors)*

Strenghts	Weaknesses
- harmonic landscape with well-conserved natural issues and evidences of the regardful use of the landscape by man-made - the landforms and processes are well visible and comprehensible for the public - the terrain is not difficult, the accessibility is quite good - marked paths leading to the most attractive natural features - the network of the paths and communication that assure the permeability of the landscape - the area does not suffer from excessive attendance - presence of important cultural and ecological values	- the tourist infrastructure is not sufficient if the visitors want to spend here more time - the educational, recreational and tourist potential is not still fully recognized - the geoheritage features are not promoted to the public
Opportunities	Threats
- a good option for one-day trips from Brno city and other towns situated within the outskirts of the metropolis - better promotion of the area as the alternative to overcrowded sites - educational potential of the geoheritage that can be used both for the laic public (visitors) and organized groups of students of local/regional schools - reasonable developing of the recreational and tourist potential as a driving force for the local development (on the level of communities, voluntary associations of the municipalities or subjects within Local Action Groups etc.)	- the fast and inadequate development of the tourism can cause the disturbances and damages to the landscape - the building – up and construction of the tourist infrastructure can negatively affect the character of villages or generally, the harmonic character of landscape

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Souhrn
Geodiverzita je považována za základní předpoklad geoturismu a navazujících rekreačních případně vzdělávacích aktivit. Na regionální či lokální úrovni představuje geodědictví (geodiverzita) vždy důležitý zdroj lokálního turismu a rekreace a může nabízet alternativu k tradičním turistickým destinacím. V příspěvku jsme se zaměřili na zhodnocení turistického a rekreačního potenciálu území Lomnicka (území situované cca 30 km SZ od Brna). Hodnocení území vycházelo z koncepce geomorphosites a jeho výstupem bylo kvalitativní zhodnocení turistického a rekreačního potenciálu daného území doplněné SWOT analýzou. Lomnicko je dobrým příkladem území s vysokou geodiverzitou a kulturně historickým bohatstvím, což se odráží v jeho vysokém turistickém a rekreačním potenciálu. Jedná se typické území, které může být alternativou k přetíženým turistickým top destinacím. Nejvhodnější pro rozvoj region by měl být tzv. šetrný turismus, který bude v souladu s principy udržitelného rozvoje a ochrany přírody.

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MAPPING OF THE SOCIAL DEMAND FOR A DECISION SUPPORT ON THE EFFECTIVE USE OF THE RECREATIONAL POTENTIAL OF THE RIVERS IN CITIES

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Abstract
In the cities, rivers and their waterfront represent a valuable multi-funcional public space, which should be formed and best utilized to improving the quality of life of its inhabitants today. Efficient utilization of its potencial to realization the development strategies of „SMART CITIES" requires integrated spatial solutions, inter alia, take into account the needs and posibilities of local community. The aim of the article will be (1) provide an overwiew and assess the posibilities of using current approaches and methods to define the public demand for cultural and recreational rivers sevices for increasing social efficiency of utilization of river area in cities nad (2) suggest a way for their integration into a comprehensive methodological framework for evaluation and decision support about strategies for utilization of river area and improvig social benefits of the modification of water flows in cities.

Key words: watercorses, smart cities, quality of life of residents

Introduction

River landscapes and their economic and infrastructural ties form sub-sections of regions, cities and urban agglomerations. Using and forming of them is influenced by institutions at different levels of an economic governance and administration of a territory. Today, river represents a public space in the city, that should be designed, and best utilized to improve the quality of life of its inhabitants. When deciding on co-creating of this public river space, it is necessary to recognize the best potential of it in the urban ecosystem in terms of its functions and the changing requirements of its inhabitants. Due to this, a conceptual mapping of possibilities and needs of local community should be an integral part of decision support about modifying watercourses in the cities.

Public researches contribute to the theoretical understanding of the relationships between people and landscape changes (Westling, Surridge, Sharp et al., 2014). The main goal of social surveys is to raise an awareness of the modifying of the watercourses and public involvement in the decision-making process of restoring the rivers (Eden, 2006).

The identified factors that influence the perception of the river by residents include, for example, a scenic beauty; a condition of the off-shore vegetation and morphology of the riverbed; possibilities of observing flora and fauna; a cleanness of the river and its surrounding; an access to the river; a connection between the river and its surrounding landscape and the changes made after a revitalization in the landscape (Westling, Surridge, Sharp et al., 2014).

Another survey researching the impact of population on changes of the development environment around the river Chicago and people perception of this changes presented by Garett Wolf (2012) (Gobster, Lynne, 1998). They compile a network of political, social and economic factors that form and influence the urban environment around the Chicago River.
Ghermandi, Nunes, Portela et al. (2011) was concerned with a monetary expression of ecosystem price of environmental changes caused by a human activity. In this case, it was the assessment of costs and benefits, that the revitalizations brought (of the recreational point of view).
A holistic approach to mapping and evaluating the potential benefits of natural ecosystems to human society currently represents the concept of the ecosystem services. The ecosystem services represent the value expression of market and non-market benefits that individual ecosystems provide human (Costanza et al., 1997). Ecosystems contribute to human welfare in many complex ways in different scales of time (Turner et al., 2016). According to the Millennium Ecosystem Assessment platform, in which is found the most comprehensive overview and categorization, ecosystem services can be divided into 4 groups: supplying, supporting, regulating and cultural (MA, 2003).
In the solving field of study is increasingly felt the need to create a standardized framework for comprehensive mapping and evaluating of ecosystem functions, goods and services (Groot et al., 2002). However, some of the current studies have only a theoretical character (Hamel and Bryant, 2017).
For example, Seják et al. (2010), and Vačkář et al. (2014) are concerned with the assessment of ecosystem functions and services in the Czech Republic. IMES method is an effective tool for aggregating values of multiple ecosystem services at the local level (LIU, 2014). Another method is the transfer of benefits, which is used to estimate the economic value of ecosystem services by transferring available information from studies already completed in another location and / or another context (Troy and Wilson, 2006). A similarity (or lack of it) among the points is one of the most important potential pitfalls to evaluating the probable validity of the transfer of benefits. Czarnecki, Lewandowska-Czarnecka, and Zielińska (2014) was concerned with a research of demand for the ecosystem services and their interactions with the public sector. For example, a research in the Kiamichi River basin in south-central United States was concerned with the assessment of the socio-cultural preferences of its inhabitants (Castro, Vaughn, Julian, and Garcia-Llorente, 2016).
Multipurpose regulation of watercourses in urban and sub-urban landscape should significantly contribute to a more efficient use of the potential of the area and the sustainable development of cities and regions. Optimization of the use of the potential of river landscape to realization of the development strategies named "SMART CITIES" requires integrated spatial solutions of the rivers area that reflect not only the technical requirements for flood protection, transport infrastructure ... but also societal demands for cultural and recreational activities, which are the source of the formation of local identity. It is therefore necessary to develop a methodology for conceptual mapping of the development of the social demand for these services so that it can be integrated into all levels of the strategic decision-making on the development of the smart cities, which create an ideal place for living, work and leisure.

Materials and methods

For conceptual mapping of social demand for cultural and recreation services by the rivers in cities and using water flows in the political-economy practice is necessary to clearly understand significant factors to form social demand for function in this area (demographic, economy, ecology…).

In first part of implemented research was performed analysis and synthesis actual conceptual demarcation and methods evaluation social demand for this function and knowledges about their application, which resulting from realization empirical research in this area. Each method was compared from the perspective of opportunities and restrictions on its use decision making process.

Using knowledge from first phase it will be propose methodical procedure of exam in social demand for cultural and recreation function/services by the water flows in cities, that will be create premise for appraisement/evaluation social benefits. Methodical procedure contains combination qualitative and quantitative research, which will be continue to previously researches for example Frýdek Místek, Vlašim, Benátky nad Jizerou, Ostrava, Přerov, Znojmo etc. (Lampartová, Blažková, and Somerlíková, 2016). Methodical procedure continues to newly created method, which evaluate effect of recreation modifications of water flows (Lampartová, 2016).

In selected area in Czech Republic (Olomouc, Ostrava, Litomyšl) will be methodological procedures applicate to examples specific implemented projects of modifications water flows, in which will score of social benefits and evaluated evidence for needs conceptual mapping societal requests.

Results

For urban societies, river space plays an increasingly important role as a place for recreation, leisure and contact with nature. These changes can be under- or overrated in the decision-making process of the formation area rivers. Decision makers have limited data on recreation potential of rivers and social demand in cities. It is thus important that the impacts are evaluated in their monetary value and the spatial and recreational impacts are given appropriate weights in the decision-making process. However, the market fails to place an adequate value on river-space quality, when it is considered as a public good, which encompass both use and non-use values. In this case, non-market valuation techniques should be used to estimate the monetary value of a river-space changes (Garrod and Willis, 1999). It follows an increasing number of published studies linking ecosystem services of rivers to people's perception. In sum, non-market valuation studies of social benefits of river ecosystem services using various techniques can suffer from technical uncertainty due to accuracy problems or biases. Bateman et al., (2002) describe the problems of hypothetical or strategic biases that arise from the design of questionnaires in stated preference methods. Accuracy problems also affect revealed preference and pricing techniques. The first problem has to do with the availability of revealed preference and market data that is required to undertake such valuation studies. Market data availability is about both quantity and quality of the data especially in the developing world where market data may suffer from poor quality that misrepresents reality. The second aspect of the accuracy of revealed preference and pricing techniques has to do with the fact that these methods (by their design) cannot account for non-use values. Hence, market data can only provide a lower bound estimate of the value of a change in biodiversity or ecosystem services. The overview and assessment of possibilities using current approaches and methods to evaluate the public demand for recreational and cultural services of the river-space are summarized in Table 1.

Tab. 1: Overview and assessment of possibilities using current approaches and methods to evaluate the public demand for recreational and cultural services of the river-space (Source: TEEB 2009, adjusted)

Non-market valuation method		Principle of application	Type of estimated value	River-space benefit	Disadvantages
Indirect – Revealed preference approaches					
Market methods	Market prices (MPM)	Changes of scale or value of marketed goods and services (fish, permits ...)	Direct-use values	Paid or assessable cost recreational activities: Water tourism Fishing Services continue with stay and movement at the river	Market imperfections and/or policy failures may distort market prices
	Production-based (PBM)	Changes of production function or Factor Income	Indirect-use values		Requires explicit modeling of the „dose-response" relationship between the river space characteristics and recreation activity resources and some economic output, problems of double counting
	Cost-based (CBM)	Avoided cost, replacement cost mitigation/restoration cost	Direct and indirect use values		Diminishing returns and difficulty of restoring previous state of recreation potential, costs are usually not an accurate measure of benefits so long as it is not clear whether it's worth it to replace a lost or damaged recreational potential the cost of doing so is an inadequate measure of damage
Travel cost method (TCM)		Travel cost as a complement to river-space recreation	Direct use value	All of recreation activities for father population (no for residents)	Data Intensive; restrictive assumptions about consumer behavior (e.g. multifunctional trips); results highly sensitive to statistical methods used to specify the demand relation-ship.
Hedonic pricing method (HPM)		River-space recreation option as a part of property prices	Direct and indirect use values	All of recreation activities for residents of the area's river (no for residents)	Limited where markets are distorted, choices are constrained by income, information about river-space conditions is not widespread and data are scarce
Direct – Stated preference approaches					
Contingent Valuation Method (CVM)		Respondent's WTP to increase the level of the river-space characteristics they might enjoy recreation activities	Total economic value (TEV) Direct and indirect use values, option values, non-use values	Universal All recreation activities All recreational activities independent of the distance from the area's rivers	Practical limitations of constructed market techniques are derived from their hypothetical construction of market scenarios and payments, leading to poor estimates of true willingness to pay. Results sensitive to numerous sources of bias in survey design and implementation.
Choice modelling		Models of change/scenarios - choice experiments, contingent ranking, contingent rating and pair comparison.			
Deliberative group valuation		Construction during the survey what respondents are being asked to evaluate as a recreation benefits of river-space			

The economic valuation of the benefits provided by recreation faces several further limitations for integration into a comprehensive methodological framework for evaluation of changes in efficiency or recreation potential use. One of the main limitations is that recreational services and values are closely related to other cultural and social services provided by river ecosystems, especially landscape amenity values, inspirational, cultural and social identity values (see Figure 1). In practical terms of recreational potential of river space evaluation, inhabitants can have difficulty determining the value of river view (amenity value) while undertaking recreation activity such as walking or cycling along the river. From the evaluation point of view this implies that it is difficult to disaggregate the values given implicitly to other types of social benefits from the estimated value of recreational benefits. This represents a risk of double-counting that should be considered when designing surveys to estimate recreation benefits of the river space. Moreover, recreational benefits are partly overlapping with market benefits, since residents and visitors can buy market goods and services in accordance with the value she/he expected to extract from them.

Discussion

Opinion of the population is very important for design and implementation programs of recovery water flows (Åberg and Tapsell 2013). Importance of cooperation between stakeholders in the project and sharing knowledge from previous project emphasizes Palmer, Bernhardt, and Allan (2005). Alam (2011) says that actual knowledge about opinion of the population to revitalization of river are insufficient and biased, because we have not enough expertise and awareness respondents.

An important point of research of Lampartová, Blažková, and Somerlíková (2016) was found minimal consciousness of citizens in the select locations about the revitalization and flood treatment, projects, which were implemented on water flows in the cities. The project has demonstrated the impact of high dependence (Cramer coefficient = 0, 4863) on knowledge of the project site

Major the part of revitalization of water flows brings benefits to the public. Experts have tried to quantify the value that produces revitalization of rivers. Was created many variety of methods for quantifying cost and benefits revitalization of ecosystem. These methods include Hedonic pricing method, Travel cost method,

Contingent valuation method, The valuation of ecosystem services or Replacement cost method (Speed, 2016). These methods have advantages and disadvantages and get the final data so it is very difficult. For example, Method of contingent valuation assesses willingness of the population to pay for the revitalization of ecosystem (Kalasová, 2016).

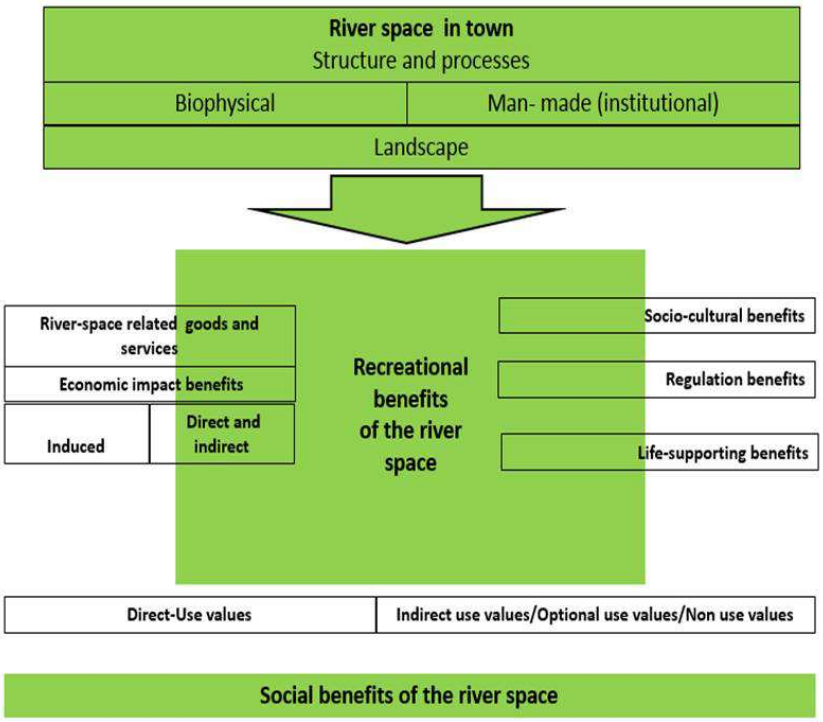

Fig. 1: Recreational benefits of river space in town (Source: Miškolci 2013, adjusted)

Rise of the public awareness about problems of water flows and the revitalized can involve citizens to the decision-making process about restoration of rivers. These activities can increase the sense of public ownership and importance of area by the river for residents (Eden, 2006). In addition, can this improve the probability of realizing and maintaining revitalization project (Junker, Buchecker, and Müller-Böker, 2007).

Conclusion - proposals and recommendations for further research

We suggest a site-based approach for the further study to estimate the economic value of the recreational benefits or the river space in town. In order to avoid double counting, the total economic value will be estimated by CVM i.e. the use value and the non-use value of urban open space and for residents and visitors to the area. Contingent valuation method (CVM) was selected to capture also significant non-use values of the public goods of the river-space changes . The spatial impact of the targeted development of the river-space should be evaluated, together with its cultural and natural amenities. Mapping of social demand thus involves the need to assess large amounts of information related to user preferences, user perceptions of conflict, and biophysical and institutional constraints found within the river

landscape. Geographic Information Systems (GIS) represents a tool that can help managers begin to evaluate potential recreation benefits and conflict within a spatial context. Representation of various recreation opportunities for various user groups within a single managed area of the river space allows for a range of potential opportunities to be compared and assessed simultaneously which according to Kliskey (2000) may lead to the development of management solutions for otherwise contentious activities.

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Souhrn
Cílem článku je představení přehledu současných přístupů a metod mapování a hodnocení společenské poptávky po ekosystémových službách řek, především kulturních a rekreačních. Následně byl v článku navržen způsob integrace těchto kvalitativních a kvantitativních přístupů do komplexního metodologického rámce, navazujícího na předchozí průzkumy pro evaluaci těchto ekosystémových služeb vodních toků. Cílem výzkumu je podpora důležitosti zakomponování těchto hodnocení do rozhodovacích procesů prostoru řek a zvyšování společenských přínosů realizace úprav vodních toků ve městech.

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MODELING OF ATTRACTIVENESS AND ACCESSIBILITY OF FOREST STANDS IN THE TRAINING FOREST ENTERPRISE KŘTINY

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Abstract

The paper is focused on creating thematic maps showing the attractiveness and availability of forest stands at Training Forest Enterprise Křtiny. The map was created using tools of multi-criteria analyzes and analysis of conectivity (spread function) in software ESRI ArcMap and depict the forest stands divided into classes depending on the degree of attractiveness and accesibility. The type and density of the road network, the type and density of cycleways, the distance from public transport stops, the distance from settlements, forest stand age, terrain slope and the occurrence of points of interest rank among the fundamental criteria for entering into analysis. Among other purposes, this map should serve the management of the Training Forest Enterprise Křtiny when making decisions regarding the forest management and creation of new points of interest for a given type of visitors.

Key words: multi-criteria analysis, analysis of connectivity, forest road network, thematic map

Introduction

Currently, there are a number of decision-making GIS analyses used for areas of interest that allow creating concepts to guide the movement of the public in the territory given and identify areas there which should be developed in a specific direction in the future. The decision-making analyses can be divided into multi-criteria (assessment of multiple criteria) and multi-destination ones (decisions relating to multiple targets: targets can be complementary or conflicting), (Eastman, 2005).

Recreation can be divided into active and passive recreation. Active recreation (active rest) includes physical activity. These are various sport activities such as skiing, cycling, mountain biking, roller-skating, etc. In contrast, when having passive recreation, the internal human perceptions are satisfied. This type of recreation makes use of relaxing places, various cultural and historical sights, and aesthetic points of interest (Laval, Matori and Balogun, 2011).

Recreation or leisure activities are becoming an important or even integral part of everybody's daily life. As a result, the demand for recreational diversity accessible by transport has increased (Gül and Gezer, 2004). Therefore, it is important to assess the demand for such areas - current and future - in terms of planning and use of recreational areas; additionally, it is necessary to focus on the sites that meet the requirements of the demand and include some facilities for the given type of recreation. The aim of recreational planning is the pursuit of a balance between available resources and the visitors' requirements (Laval, Matori and Balogun,

2011). The biggest development of recreational activities is associated with the use of roads and paths (Cordell, Lewis and McDonald, 1995).

Materials and methods

The area of interest is the Training Forest Enterprise Masaryk Forest Křtiny (hereinafter TFE). The TFE lands have a total area of 10492 hectares. It is a continuous complex immediately adjoining the northern edge of Brno and reaching up to Blansko. (ŠLP, 2002-8).

The aim of the study is to create a thematic map, which will be focused on cyclists and pedestrians — the terrain permeability for them with focus on the places attractive to see and places of relaxation and the cycleways usability. Thematic maps are created in the geoinformation system of software package ArcGIS and with tools of multi-criteria analysis. Tools of multi-criteria analysis are useful for different types of territorial planning and territorial management (Chen et al., 2009). Geoinformation systems are used to support territorial decision-making as they provide many options when working with spatial data. Solutions to complex situations or situations with multiple criteria can be challenging, or even impossible, without appropriate analytical and visualization tools (Jankowski, 1995).

To calculate the potential attractiveness of forest stands, we selected the method of multi-criteria analysis called weighted linear combination (WLC) with a subsequent analysis of connectivity (spread function) in the form of calculating the cost surface and the accumulative cost distance.

In the first place, points of interest were vectorized. These include public transport stops, springs, vantage points, Forestry Pantheon, an observation tower, and a castle ruin, on the basis of the Basic Map of the Czech Republic and the geoportal mapy.seznam.cz. Further, educational and hiking trails (again, based on portal mapy.seznam.cz), cycleways (based on portal cyklostezky.cz) were vectorized. Other paths and roads were taken from the base of geographic data (ZABAGED). Specially protected areas were vectorized based on WMS server gis.nature.cz. Then the stands were classified by age and the sloping analysis. Each of the points of interest, types of roads, stand age classes and sloping classes was assigned with a weight according to the following tables (Tab. 1 to Tab. 4).

These features were converted to raster and combined by multiplication in Raster Calculator, which gave the cost surface, assessing the "ease" of movement in the area of interest. The cost surface then entered the calculation of the accumulative cost distance, which is actually a measure of attractiveness and accessibility of the forest stands for pedestrians. This calculation was made using the Cost Distance tool. Subsequently, the data were reclassified into five classes based on the method of the quantile distribution.

Results

The result of the multi-criteria analysis calculation is a thematic maps that shows the area of interest – forest district Vranov – as regards its attractiveness and accessibility for pedestrians (see Fig. 1) and the usability and attractiveness of cycleways for cyclists (see Fig. 2). The calculation did not use the individual cadastral areas located within the area of interest; rather, access points (public transport stops or settlements) were considered. In terms of the attractiveness, the terrain or cycleways were divided into five classes: very high, high, middle, low and very low level of attractiveness and accessibility or usability. The places with a very low level of attractiveness and accessibility are primarily the locations where high values of all factors occur (steep slopes, young stands, low access to the stands,

lack of points of interest, and great distance from public transport stops or settlements, see chapter Discussion). Tab. 5 presents the area and the percentage of these classes in the area of interest. The resulting thematic maps combines the rate of attractiveness and pedestrian accessibility or cycleways usability of the area of interest. The entire area investigated was divided into five categories: those with very high, high, middle, low, and very low value of attractiveness. The territory with a very high value of attractiveness takes up 11.87% of the area of interest; and vice versa, the territory with a very low value of attractiveness occupies 13.62% of the investigated area. The territory with a middle rate of attractiveness occupies the highest percentage of the total area (31.38%). Analogously, in the case of cycleways (Tab. 6): 16,31 % of very high, 22, 74 % of very low and 21.01 % of middle value of attractiveness and usability.

Tab. 1: The assignment of weights to individual layers of road types and stand age classes; the weights were used in the calculation of the multi-criteria analysis, resulting in a thematic map for pedestrians.

Roads		Forest stand age	
Type	Weight	Age	Weight
Educational trails	1	<20	100
Hiking trails	2	20-60	10
Forest roads	3	>60	1
State roads	10	Other places	1
Other places	20		

Tab. 2: The assignment of weights to individual layers of points of interest and terrain sloping; the weights were used in the calculation of the multi-criteria analysis, resulting in a thematic map for pedestrians

Points of interest		Surface slope	
Type	Weight	Range	Weight
Protected areas	3	<10°	1
Castle ruin	1	10° - 15°	2
Observation towers	1	15° - 20°	3
Vantage points	5	20° - 30°	4
Springs	4	>30°	10
Forest monuments	2		
Other places	20		

Tab. 3: The assignment of weights to individual layers of cycleways types, the weights were used in the calculation of the multi-criteria analysis, resulting in a thematic map for cyclists.

Cycleways	
Type	Weight
Marked made cycleways	1
Unmarked made cycleways	4
Unmarked unmade cycleways	8
State roads	12
Cycleways only for MTB	16
Other places	NoData

Tab. 4: The assignment of weights to individual layers of points of interest; the weights were used in the calculation of the multi-criteria analysis, resulting in a thematic map for cyclists.

Points of interest	
Type	Weight
Castle ruin	1
Observation towers	1
Vantage points	20
Springs	20
Forest monuments	2
Other places	100

Tab. 5: Forest stand areas divided by the rate of attractiveness and accessibility

Rate of attractiveness and accessibility combination	Area (ha)	Proportion (%)
very high	367.2	11.87
high	814.66	26.33
middle	970.75	31.38
low	519.12	16.78
very low	422.08	13.64
total	3093.81	100

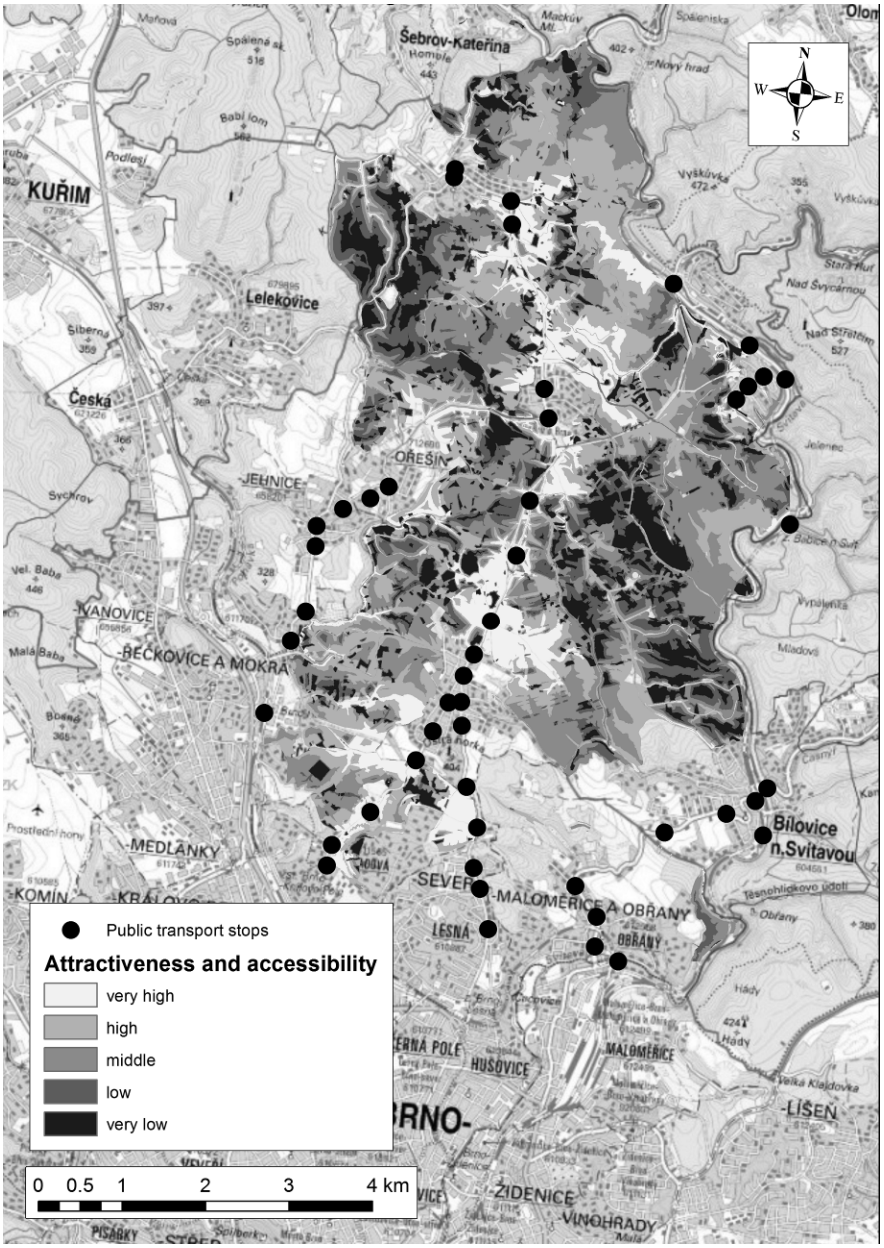

Fig. 1: The thematic map depicting the attractiveness of forest stands from the a pedestrian's perspective

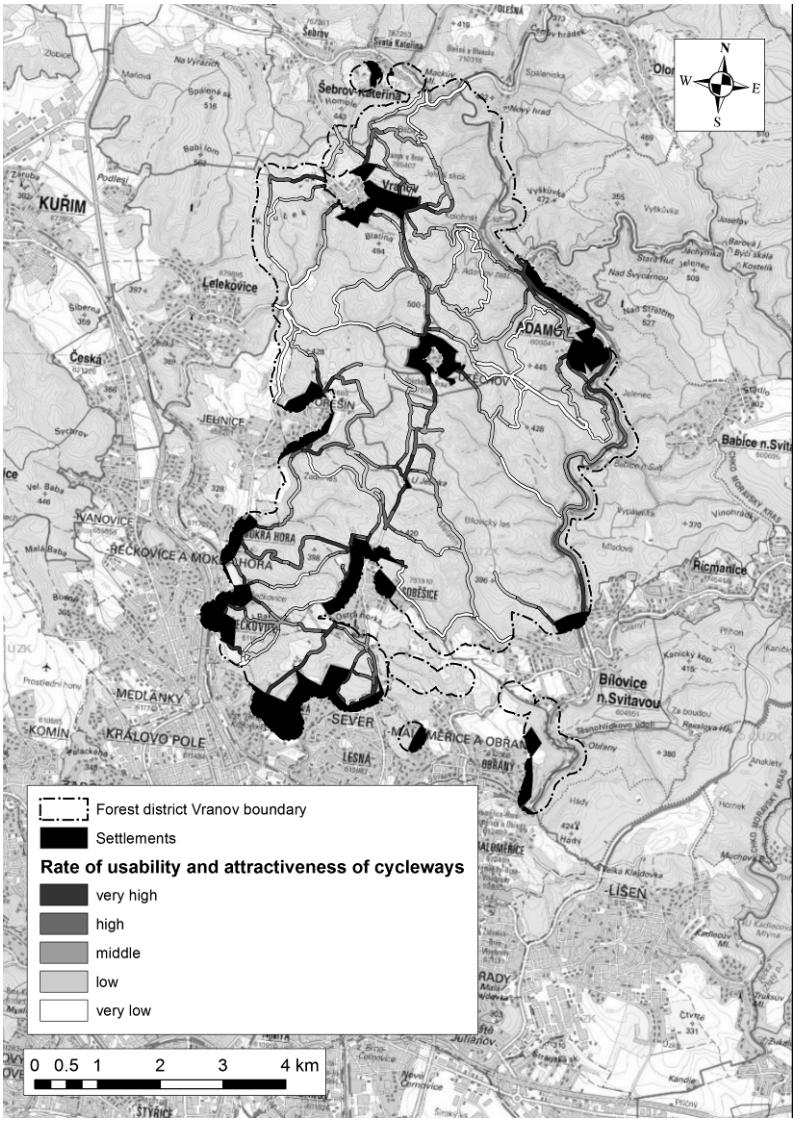

Fig. 2: The thematic map depicting the usability and attractiveness of cycleways from the a cyclist's perspective

Tab. 6: Cycleways length divided by the rate of attractiveness and usability

Rate of attractiveness and usability combination	Length (km)	Proportion (%)
very high	17.76	16.31
high	18.77	17.24
middle	22.87	21.01
low	24.73	22.72
very low	24.74	22.72
total	108.88	100.00

Discussion

The resulting thematic map can serve as one of the possible decision-making documents for the management of the Training Forest Enterprise, showing which places and how could be developed in the future. In this case, the area was assessed from the pedestrian's a cyclists perspective. Other conditions are valid for cyclists, who will prefer other types of roads, or visitors with disabilities, who will prefer areas with easier accessibility, whether in terms of distance from public transport stops or parking lots or in terms of the terrain slope, the type of road surface, or the type of roads.

The spatial data analysis indicated that the results of the multi-criteria analysis are markedly affected in particular by the setting of the factor weights and the way of result reclassification into classes.

It is possible to determine whether the weights were set correctly based on the zonal statistics: the mean value of each factor in each class of attractiveness and accessibility is calculated as well as the mean distance of the stands classified from public transport stops (Tab. 7) or as the mean distance between cycleway lines and settlements (Tab. 8). If there is a linear relation between the individual classes of attractiveness and accessibility within the given factor, it is possible to say that the weights have been set correctly. The larger difference between the first and the fifth class within a factor, the more weight the factor has.

Tab. 7: Mean values of factors for analysis from the pedestrian's perspective according to rate of attractiveness and accessibility

Rate of attractiveness and accessibility	Mean value of accessibility factor	Mean age of forest stands (years)	Mean surface slope (degrees)	Mean rate of attractiveness factor	Mean distance between forest stands and public transport stops (m)
very high	16.4	92	11.47	18.19	510
high	18.11	95	14.9	17.23	586
middle	18.73	85	16.43	18.69	725
low	19.17	49	16.1	19.9	805
very low	19.68	30	18.44	19.93	871

Tab. 8: Mean values of factors of cycleway analysis according to rate of attractiveness and usability

Rate of attractiveness and usability	Mean value of accessibility factor	Mean rate of attractiveness factor	Mean distance between cycleway lines and settlements (m)
very high	4.05	93.26	16.34
high	4.55	90.81	179.72
middle	5.93	88.39	335.16
low	8.26	94.53	412.03
very low	10.20	93.37	503.66

The tables indicates that the factor of distance between forest stands and public transport stops and distance between cycle ways lines and settlements were set most importanly. This factor also has the highest effect in the multi-criteria analysis (the biggest difference between the first and the fifth class), which is due to the fact that this factor was calculated after the weighted linear combination of other factors based on the accumulative cost distance. The relationship is also purely linear in the case of the factor of stands accessibility. A linear relationship is not achieved in the cases of the forest stand age between the first and the second classes and the surface slope between the third and the fourth classes. The layer of Points of interest has a very low impact on the multi-criteria analysis. There is a highly non-linear relationship as well as a small difference between the factor values within the classes, which is caused, among others, by the fact that the points of interest are with the exception of protected areas represented by points, or buffers around these points; therefore, the absence of points of interest should be penalized more. However, setting the weights of factors is always subjective, and in an analysis of a particular area, it is necessary to specify which factor should have a higher weight in the analysis.

Conclusion

A thematic map was created with respect to pedestrians and cyclists with with focus on the proposal of public movement guidance in the forest ecosystem. The area of interest is a part of the Training Forest Enterprise – forest district Vranov. This area, just as the rest of the TFE, is characterized by varied terrain and many visitor attractions, such as glades, vantage points, observation towers, etc. Additionally, the accessibility of the area from the road network (forest roads, forest paths, local roads) and public transport stops or settlements was investigated. After creation of particular layers, representing the access, the terrain permeability (slopes, stands), and places of interest, it was necessary to assign weights to these layers and then use the tools of multi-criteria analysis to model in the ArcGIS environment. The thematic map thus created can be used in the future by the management of the Training Forest Enterprise for the planning in the field of recreational use of the area - it facilitates specifying which places should be developed and, where appropriate, supplemented by other attractive features.

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Souhrn
Článek je zaměřen na tvorbu tematické mapy, která zachycuje atraktivitu a dostupnost lesních porostů na Školním lesním podniku Křtiny. Prezentovaná mapa byla vytvořena pomocí nástrojů multikriteriální analýzy a analýzy konektivity v softwaru ESRI ArcMap a zobrazuje zájmové území rozdělené do tříd v závislosti na míře atraktivity a dostupnosti. Vytvořená mapa by měla mimo jiné sloužit managementu Školního lesního podniku Křtiny při rozhodování zahrnující lesní hospodářství a plánování případných nových bodů zájmu pro určitý typ návštěvníků.

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OPTIMAL PRICING OF RECREATION IN THE CZECH PROTECTED AREAS

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Abstract
The article presents an estimation of the optimal entrance fees and corresponding potential revenues for different types of natural protected area. Optimal prices are derived by maximizing the objective social welfare function, which represents social benefits of visitors from the consumption of recreational services in a particular protected area. Using the economic optimization model, we derived a set of optimal entrance fees differentiating according to various categories of protected areas and zones in the Šumava National Park.

Key words: economic model, entrance fee, welfare maximization, protected area management, Šumava National Park

Introduction

With growing number of visitors in wilderness areas, the burden on touristic infrastructure increases together with the nature protection expenses. The management of protected areas is not able to fully cover these costs and their economy is partially or completely dependent on state subsidies. The pricing of recreation is one of the options how to manage the number of visitors entering the protected area, and how to enhance the budgetary self-sufficiency of the protected areas.

The pricing of outdoor recreation in the Czech protected areas is sporadic, there are several localities as nature reservation or natural heritage site, where entrance fee is charged by private companies or municipalities (see Table 1). The charging an entrance fee by the nature protection authority is even exceptional, one example is the pricing of vehicle entrance in the Krkonoše National Park and the other is the charging the boating on the Vltava upper river in the Šumava National Park.

Tab. 1: Entrance fees to the specially protected areas in the Czech Republic

Location	**Category**	**PLA / NP**	**Entrance fee** *(CZK)*
Soos	NNR	near Slavkovský les	90
Pravčická brána	NHS	České Švýcarsko	75
Edmundova soutězka	NR	České Švýcarsko	80
Prachovské skály	NR	Český ráj	70
Adršpašskoteplické skály	NNR	Broumovsko	70
Rejvíz	NNR	Jeseníky	30
Tiské stěny	NR	Labské pískovce	30
Votrubcův lom	NHS	near Český ráj	60
Vltava upper river	NHS	Šumava	500

Notes:
NNR - National Nature Reservation
NHS - Natural Heritage Site

NR - Nature Reservation
PLA - Protected Landscape Area
NP - National Park

In this article, we present an economic model, which optimize entrance fees into the landscape protected areas in the Czech Republic, and we also illustrate its application and present the results for the Šumava National Park. The optimization model is also transformed into a parametrized software tool Rec-Optim (Melichar et al., 2017) available to the managements of Czech protected areas.

Economic optimization model

Optimal prices are derived by maximizing the objective social welfare function, which represents social benefits of visitors from the consumption of recreational services in a particular protected area as suggested by Alpízar (2006). The optimization problem is set as a maximization of the sum of recreational benefits, revenues collected from entrance fees, positive spillover effect from tourism on local economy, while deducting variable costs and investments to tourist infrastructure and negative ecological impacts associated with tourism.

The optimization is based on first-order derivative based method. The objective function of the optimization exercise is given as follows (Ibid.):

$$\max f(p)$$

$$f(p) = \int_{p}^{\infty} x(v)dv + px(p) - C(x) - I - g(x) + T(x) \qquad (1)$$

given the following constraints:

$$i: px(p) - C(x) - I - R \geq 0 \qquad (2)$$

$$ii: x > 0 \qquad (3)$$

where:

f(p)	is the function of benefits to the society,
p	is the price (entrance fee),
x(p)	is the recreation demand for the natural area,
C(x)	is the variable cost to maintain the tourist infrastructure,
I	is the fixed cost to build the tourist infrastructure,
R	is the minimal revenue from pricing needed by the management of the natural area,
g(x)	is the external cost associated with the visitation in the natural area (negative effect on the ecosystems),
T(x)	is the spillover effect of the visitation in the natural area.

The optimization exercise consists of maximization of the sum of recreation benefits that accrue to the visitors of the natural area, collected fees, spillover effect, after deduction of the variable and fixed costs associated with the tourist infrastructure and the management of the area, and external costs. The first part of the objective function above represents the consumer surplus of the visitors to the area, whose entrance is subject to a fee; the consumer surplus calculation is derived from recreation demand $x = x(p)$. Second part of the function is the producer surplus, i.e. the amount of revenue from the fee. Third part of the function is variable costs (marginal variable costs are assumed to be constant, $C(x) = c\,x$). Fourth part of the

function is fixed costs, and the last two parts are the functions of external costs and spillover effect (both are assumed to be linear). The first constraint allows to generate an exogenously specified revenue to the management of the protected area, the second constraint assumes that the recreation demand is positive.

Data

The underlying recreation demand model in the optimization is the single-site model for the pilot site - the Šumava National Park, which is based on the results of the project Rec-Optim (Kaprová, 2015). The demand is available for the whole national park, and for smaller areas within the park (Jezerní moor, Tříjezerní moor and Prášily Lake). The regression parameter on travel cost and derived consumer surplus from recreation demand model is presented in Table 2.

Tab. 2: Recreation demand estimates

Variable	Coefficient	Mean
Travel costs	-0.001	651.2
Constant	0.450	-
Visits	-	1.9
CS per trip and person	-	998.8
CS per day and person	-	184.3

Notes:
CS - consumer surplus

The current visitation of analysed protected areas and zones in the Šumava National Park was derived in the Rec-Optim project using the guidelines on visitor monitoring (Braun Kohlová et al., 2016). The information on the demand side are supplemented by the supply side data on variable and fixed costs associated with tourism, which were also derived in the Rec-Optim project.

Results

The results of entrance fee optimization for different protected areas in the Šumava National Park are presented in Table 3 and Table 4. Based on recreation demand model presented in Table 2, we derived the changes in a yearly visitation assuming various levels of entry fee and corresponding total revenues (see Table 3).
Table 4 presents the results of the estimation of equation (1), the optimal prices range from CZK 23 per person day-visit for the case of zero variable costs (*vc = 0*) to CZK 86 per person day-visit for *vc = 10*.

Discussion and conclusions

The article suggests an economic optimization model for the optimal pricing of outdoor recreation in the protected landscape areas and national parks and hopefully represents a valuable input into the discussion of the pricing of recreation in protected areas and its effects in the Czech Republic. The results indicates that the optimal price of entrance fee depends especially on the type of protected area characterized by visitation rate and assumed marginal variable costs.

Tab. 3: Change in the yearly visitation according to different rates of entrance fee and corresponding revenues

Variable	Unit	Třijezerní moor	Jezerní moor	Prášily lake	Modrava area	Prášily area	NP Šumava central part
WTP	*CZK/entrance/person/day*	44	39	54	184	184	184
Without entrance fee							
V	*person-days/year*	37 709	44 007	39 528	214 937	168 769	983 530
CS	*mil. CZK/year*	1.6	1.7	2.2	39.6	31.1	181.2
TR	*mil. CZK/year*	-	-	-	-	-	-
Entrance fee at CZK 10 per person and day							
V	*person-days/year*	37 333	43 569	39 134	212 796	167 088	973 732
CS	*mil. CZK/year*	1.6	1.7	2.1	39.2	30.8	179.4
TR	*mil. CZK/year*	0.4	0.4	0.4	2.1	1.7	9.7
Entrance fee at CZK 50 per person and day							
V	*person-days/year*	35 868	41 858	37 598	204 443	160 528	935 506
CS	*mil. CZK/year*	1.6	1.6	2.0	37.7	29.6	172.4
TR	*mil. CZK/year*	1.8	2.1	1.9	10.2	8.0	46.8
Entrance fee at CZK 100 per person and day							
V	*person-days/year*	34 116	39 814	35 762	194 460	152 690	889 828
CS	*mil. CZK/year*	1.5	1.5	1.9	35.8	28.1	164.0
TR	*mil. CZK/year*	3.4	4.0	3.6	19.4	15.3	89.0
Entrance fee at CZK 250 per person and day							
V	*person-days/year*	29 359	34 262	30 775	167 343	131 398	765 744
CS	*mil. CZK/year*	1.3	1.3	1.7	30.8	24.2	141.1
TR	*mil. CZK/year*	7.3	8.6	7.7	41.8	32.8	191.4
Entrance fee at CZK 500 per person and day							
V	*person-days/year*	22 858	26 676	23 961	130 288	102 302	596 183
CS	*mil. CZK/year*	1.0	1.0	1.3	24.0	18.9	109.9
TR	*mil. CZK/year*	11.4	13.3	12.0	65.1	51.2	298.1

Notes:

WTP - Willingness-to-pay
CS - Consumer surplus in total
V - Visitation
TR - total revenues from charging entry

Tab. 4: Optimal entrance fees for different types of areas in NP Šumava and corresponding revenues

Variable	Unit	Třijezerní moor	Jezerní moor	Prášily lake	Modrava area	Prášily area	NP Šumava central part
WTP	*CZK/person/day*	44	39	54	184	184	184
Visitation	*person-days/year*	37 709	44 007	39 528	214 937	168 769	983 530
Fixed costs	*mil. CZK*	0.9	1.0	1.2	9.0	11.8	48.4
vc = 0	*CZK/person/day*						
entrance fee	*CZK/person/day*	25	23	31	44	75	52
visitation decrease	*%*	2.4	2.2	3.0	4.3	7.2	5.1
revenues	*mil. CZK*	0.9	1.0	1.2	9.0	11.8	48.4
vc = 5	*CZK/person/day*						
entrance fee	*CZK/person/day*	30	28	36	49	81	57
visitation decrease	*%*	2.9	2.7	3.5	4.8	7.7	5.6
revenues	*mil. CZK*	1.1	1.2	1.4	10.0	12.5	58.0
vc = 10	*CZK/person/day*						
entrance fee	*CZK/person/day*	35	33	41	54	86	62
visitation decrease	*%*	3.4	3.2	4.0	5.3	8.2	6.1
revenues	*mil. CZK*	1.3	1.4	1.6	11.0	13.3	57.7

Notes:
WTP - Willingness-to-pay
vc - variable costs

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Souhrn
Článek představuje ekonomický optimalizační model pro výpočet optimální výše vstupního poplatku do vybrané pilotní rekreační oblasti, v tomto případě se jedná o Národní park Šumava. Optimalizace je provedena na základě maximalizace cílové funkce společenského blahobytu, která reprezentuje vyjádření společenských přínosů plynoucích ze spotřeby služeb souvisejících s rekreací v posuzovaném území. Optimalizační úloha řeší požadavky Správy území na generovaný výnos ze vstupních poplatků. V tomto případě se jedná o optimalizaci s omezením, k cílové funkci byla sestavena omezující funkce zajišťující minimální výši požadovaného výnosu. Sestavený optimalizační model umožňuje optimalizovat výši vstupního poplatků z hlediska 2 forem zpoplatnění. V tomto ohledu lze rozlišit optimalizaci vstupného do maloplošného zvláště chráněného území (např. národní přírodní památka či národní přírodní rezervace) nebo vstupného do celého velkoplošného chráněného území.

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PERSPECTIVES OF THE ECONOMIC SUSTAINABLE DEVELOPMENT IN THE TERRITORIAL SYSTEMS WITH SPA TOURISM RESOURCES

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Abstract

As important branch of the health tourism, the SPA tourism is one of the oldest forms of tourism, its roots have been identified since Antiquity. Moreover, a number of resorts in Europe owes its existence to the presence and operation of local resources available to the spa. In this context, researching the way the spa resources could influence the economic development of the territorial systems that have such resources becomes particularly important. Determining the contribution that health tourism has in the development of the local economies becomes so essential in drawing the strategies for an effective management in terms of sustainable economic development. In this respect, the present study, analyzes at national level, the relationship between tourism and other economic systems parts with important economic resources. For this analysis, a comprehensive database, that includes the following indicators: number of employees and the value of turnover, for the period 2000-2014, was conducted. For these indicators the dynamics over time and how they relate to other existing territorial economic components was followed. The results show the crucial role they have in increasing the operational complexity of the spa resources in the sustainable economic development of territorial systems that have such resources.

Key words: health tourism, local economy, functional complexity; integrated development

Introduction

Maximizing the contribution of SPA tourism to the local economy is an important direction of research in the field of territorial management, policy-makers are concerned maximizing their multiplier effects on the local system generated the valorisation spa resources. Important research is also supported by the need to ensure sustainable development of these territorial systems, knowing that SPAs have reduced operational complexity, which exposes them to structural crises.

In numerous studies the importance of health tourism in the creation of jobs, increase incomes, improve living standards and the local economy, in general, is highlighted. (Hyma and Wall, 1979; Ross, 1992; Madrigal, 1995; Huse et al, 1998; Spivack et al, 1998; Gursoy et al, 2002; Mansfeld and Winckler, 2004; Horowitz et al, 2007; Keckley, 2009; Heung et al, 2010; Lee and Hung, 2010; Choi and Murray, 2010; Cormany and Baloglu, 2011; Košić, et al, 2011; Nikezic, et al., 2012).

Valorisation of the SPA resources can be the core for developing other economic activities. To support this type of development, by specific strategic territorial management strategies provide a functional complexity required for a sustainable future developments of the territorial systems (Peptenatu et al., 2012). The

application of these methods to quantify the health tourism role in the local economy can generate new qualitative features which can lead to a higher level of their understanding (Andronache et al, 2016; 2017).
Identifying the optimal functional for different territorial systems, it is an important concern in human settlements research functionality. Thus, modeling fractal and non-fractal patterns were determined relational quality between territorial systems or components was identified specific relationships between tourism and other components.
Research of the role of SPA resources exploitation in the sustainable development of local economies in Romania is important in terms of the large number of territorial systems, National Institute of Statistics estimated that in Romania 100 localities have spa resources, but only 46 of them were declared SPA resorts.

Material and methods
The analysis on the SPA tourism sector in Romania is done for 2000-2014 and is based two basic indicators (turnover and the number of employees). The data are provided at NACE (National Classification of Economic Activities) level for each SPA resort. Two boxplots were build, using the R-Software platform, showing the rank distribution of the two main indicators for the SPA sector. This methodology allows measuring the importance of the spa sector in the local economy. The study considered the resorts which, according to the National Statistics Institute, held the office resort.

Results
Currently, Romania has an large spa tourism potential, as evidenced by the 160 municipalities that have such tourist resources. However, statistically there are recorded only 46 spa resorts (Figure 1).

Fig. 1: Romanian SPA resorts

In terms of promotion these resorts as tourist destinations the Romanian Government, by the its authorities in the field of tourism are continuously seeking solutions to encourage the practice of SPA tourism by the existence of some special programs. The target is the elderly people, with modest financial possibilities. Among the best known resorts Băile Herculane (Caraș-Severin County), can be evoqued, resort well-known since the Roman Antiquity for its mineral resources. A well-developed double core is the Calimanesti-Căciulata, located on the Olt Valley, in Valcea county. Thermal mineral waters in this area complements its diverse landscape and tourism human resources (Cozia Monastery). Well known are also the SPA's in western part of the country, which benefited from a series of investments in the development of recreational activities. For foreign investment, Sovata resort (Mureș County), benefited also all the leisure activities (around Ursu Lake – like an aqua park). This causes the focus on a segment of tourists, most often ignored from SPA travel offers. They belong from the rich people category, with financial possibilities and who are willing to allocate their financial resources for leisure activities in these resorts, contributing in such way to their development.

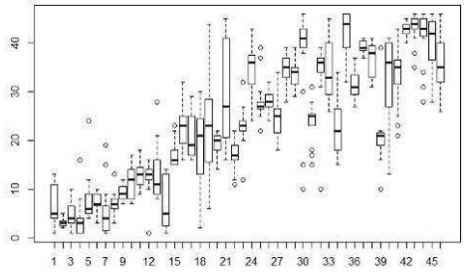

Fig. 2: Boxplot, representing the rank distribution of SPA resorts, by the number of employees

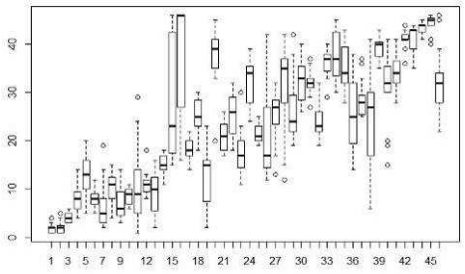

Fig. 3: Boxplot, representing the rank distribution of SPA resorts, by turnover

1 Călimanești Căciulata; 2 Govora; 3 Slanic Prahova; 4 Băile Tușnad; 5 Băile Olanești; 6 Predeal; 7 Moneasa; 8 Sânmartin; 9 Eforie; 10 Geoagiu; 11 Sinaia; 12 Bușteni; 13 Slănic Moldova; 14 Băile Herculane; 15 Sovata; 16 Merei; 17 Vatra Dornei; 18 Budureasa; 19 Săcelu; 20 Covasna; 21 Ocna Șugatag; 22 Mangalia; 23 Sângeorz Băi; 24 Bazna; 25 Amara; 26 Targu Ocna; 27 Techirghiol; 28 Turda; 29 Tășnad; 30 Sibiului; 31 Borsa; 32 Iași; 33 Bălțătești; 34 Tinca; 35 Bughea de Sus; 36 Lipova; 37 Onesti; 38 Chiscani; 39 Buzias; 40 Voineasa; 41 Pucioasa; 42 Calacea; 43 Valenii de Munte; 44 Borsec; 45 Soveja; 46 Bizusa.

1 Slănic Prahova; 2 Băile Tușnad; 3 Călimănești Căciulata; 4 Govora; 5 Sinaia; 6 Predeal; 7 Moneasa; 8 Eforie; 9 Băile Olănești; 10 Geoagiu; 11 Slănic Moldova; 12 Sânmartin; 13 Băile Herculane; 14 Sovata; 15 Ocna Șugatag; 16 Bughea de Sus; 17 Covasna; 18 Amara; 19 Săcelu; 20 Bazna; 21 Mangalia; 22 Târgu Ocna; 23 Bușteni; 24 Merei; 25 Vatra Dornei; 26 Sângeorz Băi; 27 Buziaș; 28 Ocna Sibiului; 29 Techirghiol; 30 Voineasa; 31 Turda; 32 Borșa; 33 Iași; 34 Soveja; 35 Bălțătești; 36 Tinca; 37 Tășnad; 38 Budureasa; 39 Chiscani; 40 Pucioasa; 41 Lipova; 42 Onești; 43 Borsec; 44 Calacea; 45 Vălenii de Munte; 46 Bizusa.

The boxplots in figure 2 show an interesting distribution of ranks of the 46 SPA resorts in Romania. The first distribution is according to the number of employees and it shows that 15 from the 46 SPA's are occupying the 20's ranks. Regarding the same distribution, but this time by the value of the turnover, the some of the 15 resorts have been replaced in top rank 15 by another's, and even some changes in the distribution could be identify (some of them exceed the 20 rank (Figure 3). We can admit that the 15 resorts are the most important in the whole country.

Discussion

Our results showed that in the most important SPA's in the country, in the last year some important investments could be observed. By using the spatial data of SPA tourism and the statistical analysis we provided information about the state and changes in SPA ranks during the last period. SPA activities in Romania are characterized by a general fluctuation trend over the period covered by the study due to the distribution of employees and the turnover.

This development is reflected by the economic changes during this period according to some improvement in legislation, after the socialist era in Romania.

In a longer perspective, SPA activities in Romania are characterized by significant changes over the last 50 years, due to socio-political factors that have a great impact of SPA management.

Conclusion

Statistical analyses of the SPA's resorts, provide the possibility to measure the impact of employees and turnover. Therefore the SPA activities are not connected to the European tourism activities and our analysis reflects changes between their ranks. This can show that every SPA resort has its own possibility to give a high value to their natural resources they hold.

SPA tourism can also be a real engine for economic development of the territorial systems, characterized by this type of resource.

The real stake belongs to the national and even local authorities to efficiently promote and manage their SPA fortune.

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Souhrn
SPA cestovní ruch patří v Rumunsku mezi nejstarší formy turismu. Cílem této studie je ukázat důležitost zvláště chráněných území (SPA) v hospodářském systému zemí, které disponují takovými prostředky. Tento příspěvek zabývající se zdravotní turistikou se může stát dobrým podkladem při navrhování strategií v plánování v rámci udržitelného hospodářského rozvoje v oblasti SPA. V rámci analýzy byla vytvořena databáze obsahující následující ukazatele: počet zaměstnanců, hodnotu obratu pro období 2000 – 2014. U těchto ukazatelů byla sledována dynamika změny v čase a jejich vlivy na jiné hospodářské složky. Výsledky ukazují klíčovou roli při zvyšování konkureceschopnosti a udržitelnosti hospodářského rozvoje. Statistické analýzy prováděné v rámci SPA středisek poukazují na možnost jak měřit dopady zaměstnanosti a obratu. To také dokazuje, že každá SPA lokalita má možnost

zúročit velkou hodnotu přírodních zdrojů. SPA může taktéž být hnacím motorem daného regionu.

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PHENOLOGICAL OBSERVATIONS AND THEIR POSSIBLE USE WITHIN THE MONITORING ALLERGENS

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Abstract
The paper deals with the relationship of long-term phenological observations and occurrence of pollen allergens. Analysis was carried out of the phenological data from the Czech Hydrometeorological Institute for the period 1992–2012. The analysis was performed for woody plant that have a major impact on the incidence of spring allergies - silver birch (*Betula pendula Roth.)* and common hazel (*Corylus avellana* L.). Predominant phenological phases of beginning of flowering (10%, 50% and 100%) and end of flowering were solved in this work. Hazel pollen, according to phenological analyzes, occurs in the air from 2nd of February to 28th of April. The analysis further shows that birch pollen emerges from 6th of April to 18th of May. Pollen grains, which are released in these phases into the air, causing respiratory allergies. Foreign articles state that the pollen calendar gives only a rough estimate of the term of the occurrence of allergens. The analysis of the phenological data might expand options for determination these dates.

Key words: silver birch, common hazel, beginning of flowering, end of flowering

Introduction

Allergy can be defined as an abnormal response of the human organism to a heterogeneous stimulus. This reaction usually occurs after repeated contact of the organism with the allergen. Allergenic disease arises as immune response of the allergen to the antibody (Petrů et al., 1994). Pollen grains released into the air cause respiratory allergies. World Allergy Organization (WAO) reports annual increase in allergies. According to WAO, allergy is the world's most common civilization disease. Approximately 20-30% of the world population suffer from some form of allergic disease. Approximately 87 million people in Europe suffer from allergic diseases (Pawankar et al., 2013). A study conducted by Khwarahem et al. (2017) reported that grass and birch pollen are the two main allergens causing allergic rhinitis in the UK and parts of Europe. Jochner et al. (2011) state that transport of pollen grain from cities can lead to extended period of time of the occurrence of allergens causing health problems. In their work from 2015, the authors state that the heat island from cities has a major influence on earlier onset of flowering of significant allergens (Jochner and Menzel, 2015). Pollen grains of plants are further transferred by the air to far distances from urban settlements to rural areas and vice versa (Spieksma, 1980, Jochner et al., 2011).
The Czech Republic (CR) uses a Pollen Information Service which is operated and guaranteed by the Czech initiative for asthma. Currently there are 11 monitoring stations in the Czech Republic. The Pollen Information Service produces a pollen calendar which lists the terms of most prominent allergens (trees, herbs and grasses). Frenguelli et al. (2010) reported that the pollen calendar provides only a

rough estimate of the terms of respective allergens. Analysis of phenological data might expand the options for definition of these terms. Phenological observations follow the onset of each phenological phase. Instructions for operation of the phenological stations state (2009) that phenological stage is an external, recognizable, usually annually recurring demonstration of development of aboveground organs of studied plant species. The prediction of the onset of phenophases of plants has significance especially in the area of agriculture, where it is used for the determination of an optimal term of application of means for the protection of plants, fertilizers and regulators of growth, during the selection (regionalization) of varieties, during the determination and forecast of the term of the harvest and the quality of the products, evaluation of the state of the stands, estimation of the impacts of the lack of moisture, and during the determination of the terms of sowing and planting (Středa et al., 2013). Phenology is finding its use also in medicine (determination of the term of occurrence of pollen allergens), in environmental sciences etc. Changes in the onset of phenological phases can be affected by climate change. In connection with the study of the change of climate, the knowledge of phenological data is proving to be a very important document of their impacts, mainly during the evaluation of the time series. Středová and Středa (2015) determinate increase of temperature sum above 10 degrees C and annual air temperature in 1961–2010 compared to the mean of 1901–1950 probably due to climate the mean of 1901–1950 probably due to climate change in the Central Europe. Climate change affects phenological manifestations of plant (on the of onset phenological phases and their duration). For examle, a significant shift in the onset of phenophase beginning of apricot flowering found out Chuchma et al. (2016) in the Czech Republic. Linear trend-line during the period 1940–2008 shows an earlier onset of phenophase beginning of apricot flowering approximately 2 days per decade

Material and methods

This paper deals with phenological data from the Czech Hydrometeorological Institute (CHMI) for stations Lednice (165 m a.s.l.), Březina (450 m a.s.l.) and Český Rudolec (540 m a.s.l.). These stations were selected based on two criteria – the amount of missing data and location of stations in small, medium and higher altitudes. The analysis works with data for silver birch and common hazel, both of which are dominant tree species that release most pollen in the spring period. Data was analysed for the period of 1992-2012. The paper concentrates on the phenological phases which cause the release of pollen grains, i.e. beginning of flowering (50% and 100%) and the end of flowering. The description of these phenological phases is shown in Table 1. The analysis defines dates of the earliest and latest time of flowering and average values for the period of 1992-2012. Furthermore, length of flowering (LF) of selected plants was determined which is understood as the interval between the onset of flowering 50% and the end of flowering. When processing phenological data, a blackout of data was detected as well. For common hazel, there is no data at Lednice station for years 1994, 2003, 2005 and 2010. The same station also holds no data for silver birch in 2009 (BF 50 a BF 100), 2010 (BF 50) and 2011 (BF 100). Český Rudolec phenological station did not detect any data in 2009 (EF) for silver birch and for common hazel in year 2007.

Results

Silver birch

Based on phenological data it was found that the allergen of silver birch may appear in the period from 6th of April to 18th of May.

The earliest onset of phenophase BF 50 was recorded on the 96th day of the year (6th of April) in **Lednice** in 2004. The latest recorded beginning of the flowering phase was measured in 1996 on the 114th day of the year (24th of April). The longest flowering period, 19 days, was recorded in 1997 and 2012, the shortest flowering period, 7 days, was measured in 1998 (Fig. 1). The earliest onset of phenological phase BF 50 in **Březina**, on the 110th day of the year (20th of April), was detected in 2000, while the latest one, on the 128th day (8th of May), was measured in 2011 (Fig. 2). In 2004, station Březina recorded the longest flowering time, 15 days. The shortest flowering period, 4 days, was measured in 2011. On average, the onset of phenological phases occurs on the following days (Fig. 7): BF 50 - day 120 (30th of April), BF 100 - day 124 (4th of May) and EF - day 129 (9th of May). Station **Český Rudolec** saw the average onset of phenological phases (Fig.7) BF 50 - day 115 (25th of April), BF 100 - day 116 (26th of April) and EF - day 125 (5th of May). The longest flowering time, 18 days, was measured in 2008 (Fig. 3). The latest occurrence of phenological phase BF 50 was detected in 2003 on 3rd of May as opposed to year 2004 when the onset of flowering was recorded on 18th of April which was the earliest of all analyzed years.

Common hazel

Phenological data shows that the allergen of common hazel is present in the air in the period from 2nd of February to 28th of April.

The longest period of flowering of common hazel, 46 days, was detected in **Lednice** in 1997. The shortest flowering, 6 days, was measured in 2008 (Fig. 4). The earliest onset of phenological phase BF 50 - on the 38th day of the year (7th of February) was recorded in 2011. The latest measured flowering began on the 93rd day (4th of March) in 2004. The average values of Lednice station show that phenological phase BF 50 occurs on day 60 (1st of March), BF 100 on the 68th day (9th of March) and EF on the 82nd day (23rd of March). The average length of flowering is 21 days at this station. The longest flowering period at **Březina** station was measured in 1997 when hazel blossomed from 14th of March to 12th of April, i.e. 29 days (Fig. 5). In 2007, the earliest onset of flowering was detected on the 47th day of the year (16th of February) as opposed to year 1996 when the latest onset of flowering occurred on the 105th day of the year (15th of April). On average, the flowering period lasts 16 days. The mean dates of onset of the observed phenological phases are as follows: BF 50 - day 80 (21st of March), BF 100 - day 86 (27th of March), and EF - day 96 (6th of April). In **Český Rudolec**, flowering of hazel takes 26 days on average. The average starting date of the phenological phases was observed as follows: BF 50 - day 67 (8th of March), BF 100 - day 69 (10th of March) and EF - day 93 (3rd of April). Year 1993 (Fig. 6) saw the earliest onset of phenological phase BF 50 on day 33 (2nd of February). The longest flowering period, 55 days, was measured in 2008. The latest onset of the observed phenological phases was recorded in 1996 (BF 50 on 11th of April, BF 100 on 12th of April and EF on 22nd of April).

The average values for the period of 1992-2012 show that the onset of the observed phenological phases occurs first at station Lednice, which is the station at the lowest altitude, and next at Český Rudolec with the highest altitude. Flowering of birch and hazel occur the latest at Březina station located at an altitude of 450 m above the

sea level. It could therefore be assumed that within the onset of the phenological phases it would follow station Lednice.

Discussion

The pollen calendar issued by the Pollen Information Service states that birch pollen occurs in March, April and May. This analysis of phenological data shows that birch did not flower at any analyzed station in March. Data shows that phenophase BF 50 occurred for the first time on th 6th of April (on the 96th day of the year) at station Lednice. The remaining stations saw the onset of BF 50 only during April and May. This conclusion is also confirmed in the Atlas of the phenological conditions in Czechia (Hájková et al., 2012) which states that the beginning of flowering for individual altitudes starts on average from 13th of April until 7th of May. According to the pollen calendar, common hazel blooms in February, March and April. This analysis performed on the basis of direct observation of phenology supports these time frames. Average values for each station show that the latest flowering occurs at station Březina, even though it is not located in the highest altitude out of the analyzed stations. This indicates a large variability of phenological data. These observations may be affected by mesorelief, microclimate etc.

Tab. 1: Description of the phenological phases (Methodical regulation No. 10, 2009)

Phenological phases	Abbreviation	Definition
Beginning of flowering	BF	Only male flowers are monitored for birch and hazel. Male catkins are released, at least some of the anthers releasing pollen. Three levels of this phenophase onset are observed (according to developed by flowers per plant 50 % and 100 %).
End of flowering	EF	This phenological phases is observed only in male catkins with silver birch and common hazel. Male catkins wilt, come apart and fall off.
Length of flowering	LF	The number of days between EF–BF.

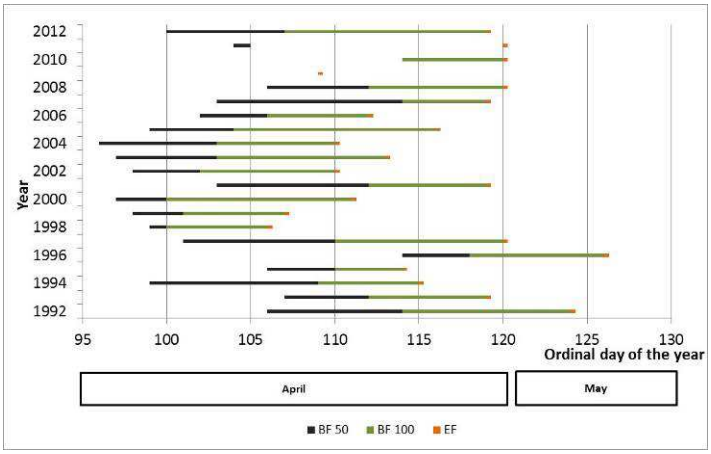

Fig. 1: The onset of selected phenological phases for silver birch at station Lednice

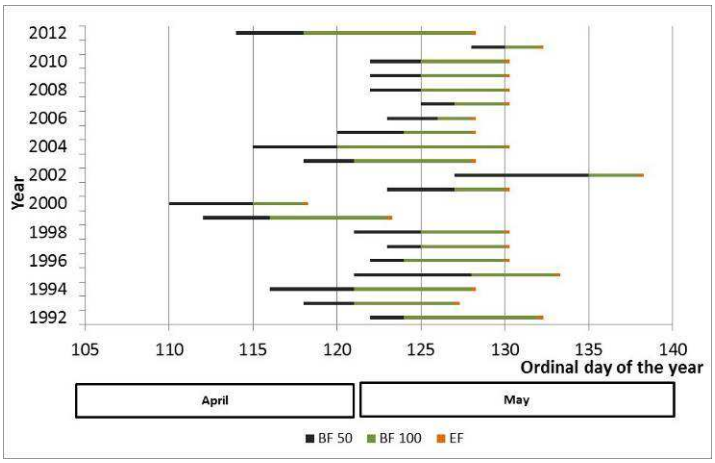

Fig. 2: The onset of selected phenological phases for silver birch at station Březina

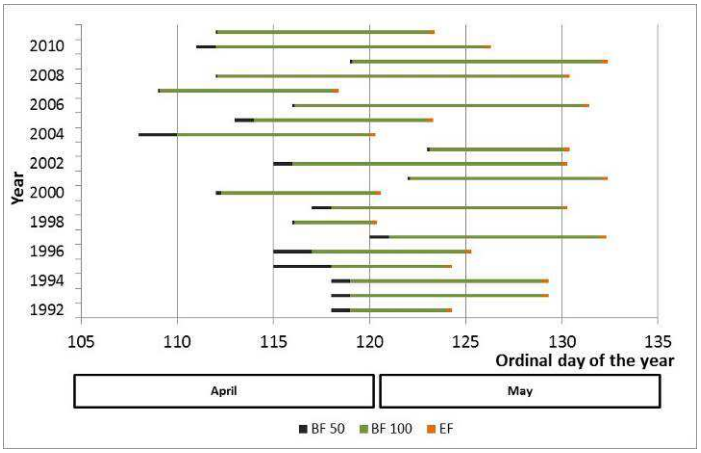

Fig. 3: The onset of selected phenological phases for silver birch at station Český Rudolec

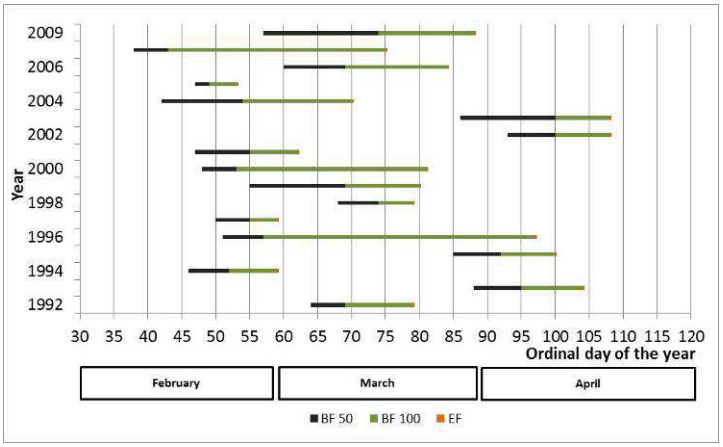

Fig. 4: The onset of selected phenological phases for common hazel at station Lednice

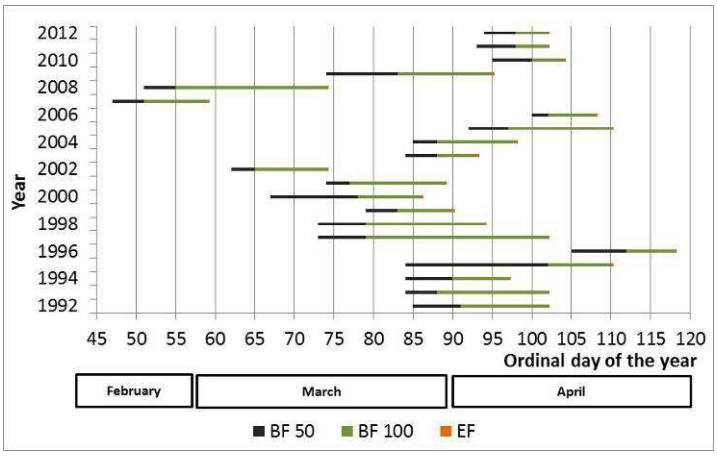

Fig. 5: The onset of selected phenological phases for common hazel at station Březina

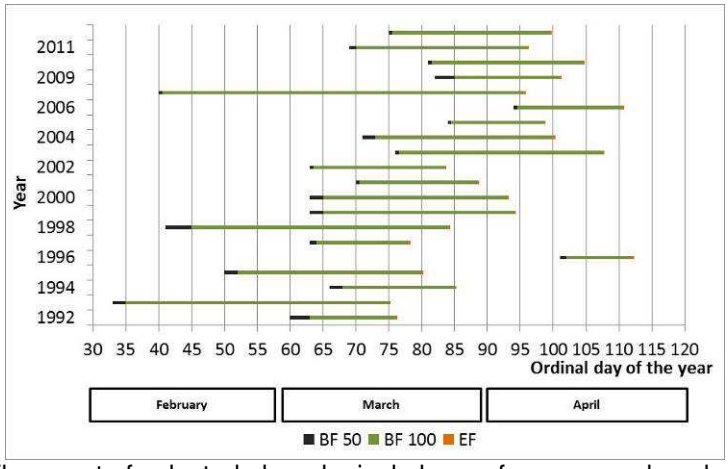

Fig. 6: The onset of selected phenological phases for common hazel at station Český Rudolec

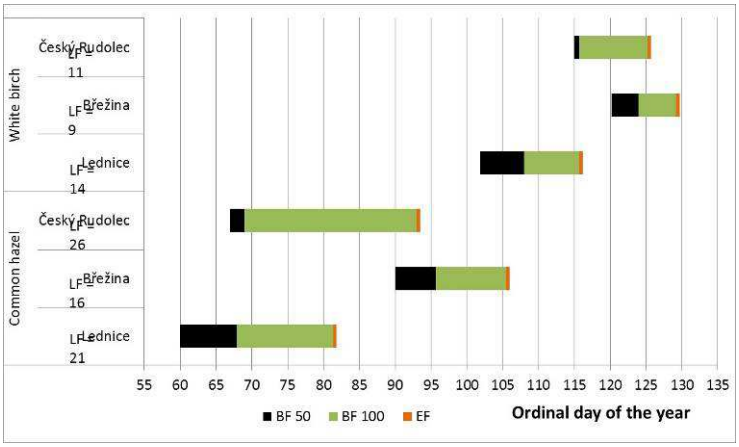

Fig. 7: Average values for the period 1992–2012

Conclusion

Silver birch and common hazel are two of the most common spring allergens in the Czech Republic. The trees of birch can be found across altitudes from lowlands to mountain areas. Hazel trees occur in levels from planar to submontane areas. Their wide spread across the height stages can be one of the main reasons for the significance of these species within the pollen season. Both of these trees also produce huge amounts of pollen. Hazel pollen, according to phenological analyzes, occurs in the air from 2nd of February to 28th of April. The analysis further shows that birch pollen emerges from 6th of April to 18th of May. The average length of flowering of birch is 14 days in Lednice, 9 days in Březina and 11 days in Český Rudolec. The longest average period of flowering of hazel is 26 days in Český Rudolec while its average flowering in Lednice lasts 21 days and in Březina 16 days.

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Souhrn
Příspěvek se věnuje vztahu dlouhodobých fenologických pozorování a výskytu pylových alergenů. V rámci práce byla provedena analýza fenologických dat Českého hydrometeorologického ústavu pro období 1992-2012. Byly hodnoceny tři fenologické stanice a to Lednice (165 m n. m.), Březina (450 m n. m.) a Český Rudolec (540 m n. m.). Analýza byla provedena pro břízu bělokorou (*Betula pendula Roth.)* a lísku obecnou (*Corylus avellana* L.). Byly řešeny fenologické fáze počátek kvetení (50 % a 100 %) a konec kvetení. V práci byly vymezeny data nejdřívějšího a nejpozdějšího termínu kvetení a průměrné hodnoty za období 1992-2012. Dále byla zjištěna délka kvetení vybraných dřevin. Obě analyzované dřeviny produkují obrovské množství pylu a při kontaktu s lidským organismem může u vybraných jedinců docházet k abnormální reakci na tento cizorodý podnět tzn. imunitní reakce alergenu s protilátkou. Pyly lísky obecné se dle fenologické analýzy můžou vyskytovat v ovzduší od 2.2. do 28.4. a pyly břízy bradavičnaté se mohou objevovat v období od 6.4. do 18.5. Z analýzy je také patrná velká variabilita fenologických údajů. Toto může být zapříčiněno mezoreliéfem, mikroklimatem dané oblasti a atd. Dlouhodobá fenologická pozorování mohou sloužit k rozšíření této problematiky. Výskyt pylových alergenů v jarním období může mít negativní vliv na cestovní ruch v rámci jarních a velikonočních prázdnin.

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PHYSIOLOGICAL AND MORPHOLOGICAL CHANGES IN YOUNG WOODY PLANTS STRESSED BY DROUGHT

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Abstract
Woody species have already threatened with drought during handling before planting out but also after planting because of ever more frequent periods of drought. The aim of this study was to consider chosen morphological and physiological parameters of European beech and Norway spruce stressed by drought during one year after planting. Bare-rooted and containerized plants were exposed with desiccation for 0-28 hours and planted. Vitality of plants was evaluated, chlorophyll fluorescence (Fv/Fm), size of needles and leaves and terminal increment were measured. Acute stress by drought before planting caused only small changes of chlorophyll fluorescence even 5 weeks after planting, amounts of vital plants were more than 90% even after 3-4 hours of desiccation before planting. There was registered an extremely low total precipitation during vegetation season, that caused high mortality of containerized plants and higher mortality bare-rooted plants exposed to desiccation before planting. Stress of drought didn´t cause a decrease of the terminal increment either the size of needles and leaves. The chlorophyll fluorescence (Fv/Fm) of survived stressed plants was high, higher than at plants that didn´t stressed by desiccation. We recommend bare-rooted plants with careful handling before planting at sites threatened by drought.

Key words: drought, planting, chlorophyll fluorescence, mortality

Introduction

Planting of woody plants in landscapes with a higher potential for tourism and recreation is affected by a number of factors, which may not only have negative influence on the new transplants but even can cause their death. This particularly concerns localities with the climate favourable for recreation, with higher average air temperatures and low total precipitation amounts. At such sites, the young plantations are often threatened by drought, and the threat becomes ever more pronounced due to the increasing number of drought spells occurring in consequence of climate change. At the same time, it should be pointed out that the prosperity of new young plantations without losses in the localities with increased use for tourism and recreation is very important.

Inadequate water losses often happen already at handling the transplants between lifting them up in the nursery and planting them out. The transplants are exposed to unfavourable conditions (heat, drought, airflow) with no protection against drying out for a relatively long time. Endangered by drying out are especially fine roots of the plants, a damage to which may reflect in the establishment of plants after their planting out. Since the woody plants are as a rule dormant at the time when they are planted out, massive loss of water is not necessarily visible in them directly. Although it can be detected by using several methods for evaluating the physiological quality of the plants according to MartincovÁ, NárovcovÁ (2000), the methods are subjective, affected by a range of factors, or applicable only in the laboratory conditions and commonly unavailable due to high costs. Measuring of

chlorophyll fluorescence could be however promising in this direction. Experts (Strasser et al. 2000; Force et al. 2003; Špulák, Martincová 2006; Vaněk et al. 2014) consider the method as suitable for detecting changes in the photosynthetic apparatus of plants caused by stress factors including drought. The most frequently monitored parameter is the F_v/F_m ratio – maximum quantum efficiency of chlorophyll fluorescence in a sample adapted to darkness. This parameter was used in the assessment of the physiological condition of beech transplants stressed and unstressed by the lack of water by for example Macková, Kmeť (2013). On the other hand, there are some studies (Slugeňová et al. 2011; Zlatev, Yordanov 2004), where no statistically significant differences were found in chlorophyll fluorescence established by using the F_v/F_m ratio in the plants stressed and unstressed by drought.

The goal of our study was to assess some physiological and morphological parameters of European beech and Norway spruce stressed by drought during the first year after planting, and to ascertain whether the measurement of chlorophyll fluorescence could be used to evaluate the physiological quality of the planting stock of woody plants with respect to their possible inadequate loss of moisture during handling and storage. Since the measurement of chlorophyll fluorescence in plants is a non-destructive method, the same plants can be repeatedly tested at different time intervals. There are many financially viable portable fluorescence meters, which can be used during planting young woody plants in the field, during the transportation of transplants or in the assessment of their quality in the nursery.

Materials and Methods

At the end of April 2015, an experimental plantation was established in the forest nursery operated by the Training Forest Enterprise of Mendel University in Brno, close to the edge of a forest stand. The forest nursery is situated at an altitude of 250 m a.s.l. in the warm climatic region (Quitt 1971). We used the bare-rooted plants – four-year old Norway spruce and two-year old European beech and the containerized planting stock – two-year old Norway spruce plants and one-year old European beech seedlings.

The planting stock was left freely lying on the ground at the plantation site, and exposed to drying out according to a schedule presented in Tab. 1; then it was planted.

Each experimental variant included 20 plants. The desiccation time of the plants was chosen subjectively according to climatic conditions so that gradual drying out of the planting stock could be monitored. In addition, air temperature and humidity were monitored during the plantation by using the Minikin Thi sensor. Parameters recorded during the plantation, ca. 5 weeks after the plantation and at the end of the growing season, were as follows:

- Chlorophyll fluorescence in vital plants (at the beginning of the growing season only in spruce because beech did not have the assimilatory apparatus yet); the F_v/F_m ratio was measured by the fluorpen Model FP 100 (value marked as QY),
- Vitality of plants, i.e. the proportion of vital plants (with no signs of decline), withered plants (with the signs of deficiency – yellowing, browning – or shedding of assimilation apparatus), and dead plants (with no functional assimilation apparatus),
- Height increment (cm) – terminal increment in 2015 (only in vital plants at the end of the growing season),
- Assimilatory apparatus size (in mm for needles and in cm for leaves).

The descriptive statistics was elaborated in the Microsoft Excel programme and the data sets were compared by using the Kruskal-Wallis ANOVA with α 0.05 level of significance in the programme Statistica 12.

Tab. 1: Time length of plants desiccation, time schedule of planting

Bare-rooted planting stock				***Containerized planting stock***			
Norway spruce		***European beech***		***Norway spruce***		***European beech***	
Time of planting	***Time of desiccation (hours)***	***Time of planting***	***Time of desiccation (hours)***	***Time of planting***	***Time of desiccation (hours)***	***Time of planting***	***Time of desiccation (hours)***
9.00	0,00	9.30	0,00	11.30	0,00	11.00	0,00
9.45	0,75	10.45	1,25	12.15	0,75	14.30	3,50
10.10	1,17	12.00	2,50	14.00	2,50	11.00*	24,00
10.30	1,50	13.00	3,50	15.00	3,50	12.30*	25,50
11.30	2,50	13.40	4,17	16.00	4,50	14.15*	27,25
12.15	3,25	14.05	4,58	11.30*	24,00	15.15*	28,25
12.45	3,75					16.15*	29,25
14.15	5,25						
15.00	6,00						

*planting second day after

Results

Site conditions at the time of plantation are characterized in Fig. 1. Daily air temperatures were rising nearly to 30 °C while air humidity was falling below 30 %.

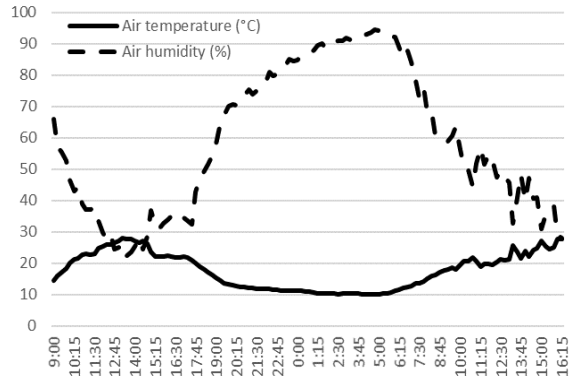

Fig. 1: Air temperature and air humidity at the time of planting

Before planting, all tested plants were vital with no signs of decline (Tabs 2-5) and there were usually no statistically significant differences in chlorophyll fluorescence among the spruce transplants in different variants of desiccation length. Only the containerized plants exposed to the longest desiccation (24 hrs) exhibited statistically significantly lower QY values (0.74) as compared with the plants unstressed by drought.

More than 90 % of plants stressed by drought prior to planting for less than 4 hours were vital and sprouting 5 weeks after the planting (Tabs 2-5). In the drought-

stressed plants, vitality was decreasing proportionally with the length of desiccation. The plants unstressed by drought at planting reached the statistically highest significant QY values (ca. 0.8 in both spruce and beech). Spruce stressed by drought before planting for a time shorter than 6 hours showed slightly lower values (>0.77) and spruce stressed by drought for the longest time (6 hours) as well as beech plants with no differences in the length of desiccation exhibited distinctly lower QY values (<0.74). In the containerized planting stock (both spruce and beech), a majority of plants were vital also in variants with the longest exposition to desiccation (24-30 hours), reaching comparable QY values.
Acceptable mortality (<10 %) at the end of the growing season was shown only at planting by the drought-unstressed bare-rooted planting stock – both of spruce and beech (Tabs 2-5). More or less a half of plants were declining or dead in the variants drought-stressed at planting for less than 5 hours in spruce and for less than 4.5 hours in beech. Plants stressed by drought at planting surviving for a longer time and being vital amounted to less than 5 %. The QY parameter in the drought-unstressed plants or in the plants stressed prior to planting for a short time (<2 hrs) reached significantly lower values at the end of the growing season than in the surviving vital plants stressed by drought before planting for a longer time, this applying also to the surviving plants of the containerized planting stock. A greater part of containerized spruce plants in all variants (even in the unstressed variant) died before the end of the growing season or exhibited apparent signs of decline. The containerized beech plants died nearly all; only in the drought-unstressed variant, the mortality was 10 % but the surviving plants were declining.
Tab. 2 shows that the bare-rooted spruce plants reached in all treatments a comparable increment; only one surviving vital plant of plants exposed to the longest drought stress at planting exhibited distinctly shorter increment. As compared with the bare-rooted spruce planting stock, the containerized spruce plants reached higher increments, the highest increment being reached in the unstressed variant (Tab. 4). The increment of the bare-rooted beech (Tab. 3) was decreasing with the desiccation length before planting. In terms of this parameter and in terms of the assimilatory apparatus size, the containerized beech plants could not be evaluated because there were only two (2) surviving vital plants of all experimental treatments (Tab. 5). Stress by drought before planting did not affect the length of spruce needles. In the bare-rooted beech planting stock, plants stressed by drought before planting for a time shorter than 3 hours exhibited larger leaves (both longer and wider) than plants stressed by drought for a longer time.

Discussion

In 2015, the Czech Republic suffered a severe drought spell (collective of authors 2015), which was apparently the reason to the high mortality of containerized plants towards the end of the growing season. The peat substrate of plant root balls tends to dry out and dry peat has a low capacity of water absorption. However, with respect to our results achieved 5 weeks after planting, this planting stock had a potential of good prosperity, high increments and even better vitality as compared with the bare-rooted planting stock under favourable moisture conditions in the growing season. This applies also to the case that it would have been left on the ground surface with no protection against drying out for a certain time (3-6 hours). The length of possible exposition to drought stress depends on the moisture content of root balls and weather conditions during desiccation. Desiccation longer than 1 day and more represents a risk even if the moisture content in the ball roots is relatively sufficient.

The bare-rooted planting stock left in shade lying on the ground with no protection against drying out for less than 4 hours is capable of establishing and growing. Nevertheless, in the case of drought spells occurring in the growing season, prosperous can be only plants that are not exposed to drying out prior to planting.
According to Vaněk et al. (2014), the F_v/F_m, resp. QY, value ranges from 0.75-0.85 in drought-unstressed plants. In stressed plants, the value of this ratio rapidly decreases. The tested vital and prosperous plants however reached even lower values with the drought stress not showing in this parameter immediately at planting. Even 5 weeks after planting, the plants did not exhibit essential differences in this parameter, apart from the variants of extremely long drought-stressed plants, which corresponds to conclusions presented by Slugeňová et al. (2011) and others. By contrast, vital plants exposed to desiccation before planting as well as during the growing season reached high chlorophyll fluorescence values at the end of the growing season, which may relate to their high drought stress resistance. It does not indicate however that there are no changes in the process of photosynthesis or in chlorophyll fluorescence occurring during the drying out of the plants. Zlatev, Yordanov (2004) explain that drought stress induces increase of minimal fluorescence (F_o), accompanied by decrease of maximal fluorescence (F_m), with the F_v/F_m ratio remaining practically unchanged.

Conclusion

We studied the response of plants morphological and physiological parameters to drought stress before planting. Our experiment included the planting stock of Norway spruce and European beech whose plants were exposed to desiccation for varying lengths of time before planting near the plantation site and then planted out. Experiment results can be summarized as follows:

- European beech is more susceptible to drought stress than Norway spruce.
- With respect to the frequent occurrence of drought spells in recent years, the planting out of the containerized planting stock in the spring is considered risky. Under favourable moisture conditions during the growing season, plants with sufficiently moist root balls, which were left in shade without any protection against drying out before planting for up to 6 hours, could thrive.
- Spring planting of the bare-rooted planting stock can be successful even in the case of drought spells during the growing season if the plants are not exposed to desiccation before planting. Plants stressed by drought prior to planting for less than 4 hours (left in shade cast by the stand) could thrive after the planting only if moisture conditions were favourable during the growing season, if their morphological and physiological quality was good prior to the drought stress, and if the planting procedure was carefully implemented.
- Chlorophyll fluorescence expressed by the F_v/F_m ratio reflects only severe stress by drought lasting for a long time. The parameter cannot be used to determine drought-stressed and unstressed plants.
- Some plants exhibit certain resistance to drought stress, good vitality, increment and high chlorophyll fluorescence (F_v/F_m ratio) even after severe drought stress.

Stress by drought before planting may negatively affect the vitality and increment of plants. Our results primarily point out the necessity of careful handling with the planting stock before planting, which is particularly urgent in climatically drier regions – usually areas of high recreational use where the risk of high mortality of the plants at planting cannot be taken also for aesthetic reasons.

Tab. 2: Morphological and physiological parameters monitored in bare-rooted Norway spruce transplants

Time of desiccation (hours)	QY of all plants	Percentage of plants (%)			QY of vital plants	Percentage of plants (%)			QY of vital plants	Percentage of plants (%)			Height increment (cm)	Length of needles (mm)
		vital	withered	dead		vital	withered	dead		vital	withered	dead		
	in time of planting				5 weeks after planting				at the end of growing season					
0,00	0,69[a]	100	0	0	0,81[a]	100	0	0	0,73[a]	95	0	5	6,2[a]	10,2[a]
0,75	0,70[a]	100	0	0	0,78[b]	100	0	0	0,71[a]	55	10	35	5,8[a]	10,5[a]
1,17	0,66[a]	100	0	0	0,78[b]	90	10	0	0,71[a]	50	5	45	6,9[a]	10,3[a]
1,50	0,72[a]	100	0	0	0,79[b]	90	10	0	0,69[a]	40	0	60	7,6[a]	10,1[a]
2,50	0,68[a]	100	0	0	0,78[b]	95	0	5	0,79[a]	40	10	50	5,9[a]	9,7[a]
3,25	0,69[a]	100	0	0	0,80[b]	95	5	0	0,81[b]	45	10	45	6,4[a]	10,7[a]
3,75	0,68[a]	100	0	0	0,78[b]	95	5	0	0,81[b]	65	15	20	5,6[a]	8,9[a]
5,25	0,71[a]	100	0	0	0,77[b]	40	15	45	0,81*	5	0	95	1,3*	10*
6,00	0,68[a]	100	0	0	0,74[c]	5	50	45	-	0	0	100	-	-

Letters in the upper index group the variants according to similarity

*value was ascertained in 1 vital plant only

Tab. 3: Morphological and physiological parameters monitored in bare-rooted European beech transplants

Time of desiccation (hours)	Percentage of plants (%)			QY of vital plants	Percentage of plants (%)			QY of vital plants	Percentage of plants (%)			Height increment (cm)	Length of leaves (cm)	Width of leaves (cm)
	vital	withered	dead		vital	withered	dead		vital	withered	dead			
	in time of planting			5 weeks after planting				at the end of growing season						
0,00	100	0	0	0,79^{a}	100	0	0	0,62^{a}	90	10	0	11,35^{a}	4,8^{a}	3,2^{a}
1,25	100	0	0	0,73^{b}	100	0	0	0,63^{a}	55	30	15	10,32^{ab}	4,5^{ab}	2,7^{ab}
2,50	100	0	0	0,73^{b}	100	0	0	0,81^{b}	65	5	30	9,6^{ab}	4,6^{ab}	3,0^{ab}
3,50	100	0	0	0,73^{b}	100	0	0	0,76^{bc}	60	10	30	6,8^{b}	3,8^{b}	2,4^{b}
4,17	100	0	0	0,73^{b}	85	0	15	0,78^{c}	75	15	10	7,4^{b}	4,1^{ab}	2,6^{b}
4,58	100	0	0	0,71^{b}	30	0	70	0,74*	5	35	60	7,5*	3,8*	2,1*

Letters in the upper index group the variants according to similarity

*value was ascertained in 1 vital plant only

Tab. 4: Morphological and physiological parameters monitored in containerized Norway spruce transplants

Time of desiccation (hours)	QY of all plants	Percentage of plants (%)			QY of vital plants	Percentage of plants (%)			QY of vital plants	Percentage of plants (%)			Terminal increment (cm)	Length of needles (mm)
		vital	withered	dead		vital	withered	dead		vital	withered	dead		
	in time of planting				5 weeks after planting				at the end of growing season					
0,00	0,78[a]	100	0	0	0,73[a]	100	0	0	0,77[a]	30	35	35	11,1[a]	11,9[a]
0,75	0,77[ab]	100	0	0	0,71[a]	100	0	0	0,75[ba]	40	10	50	7,9[ab]	10,8[a]
2,50	0,77[ab]	100	0	0	0,68[a]	100	0	0	0,81[bc]	55	15	30	8,1[ab]	11,9[a]
3,50	0,76[ab]	100	0	0	0,69[a]	100	0	0	0,79[bc]	35	10	55	9,0[ab]	12,2[a]
4,50	0,75[ab]	100	0	0	0,69[a]	100	0	0	0,80[bc]	20	5	75	5,9[b]	9,8[a]
24,00	0,74[b]	100	0	0	0,69[a]	85	15	0	0,80[c]	15	10	75	9,2[ab]	11,7[a]

Letters in the upper index group the variants according to similarity

*value was ascertained in 1 vital plant only

Tab. 5: Morphological and physiological parameters monitored in containerized European beech transplants

Time of desiccation (hours)	Percentage of plants (%)			QY of vital plants	Percentage of plants (%)			QY of vital plants	Percentage of plants (%)			Height increment (cm)	Length of leaves (cm)	Width of leaves (cm)
	vital	withered	dead		vital	withered	dead		vital	withered	dead			
	in time of planting			5 weeks after planting				at the end of growing season						
0,00	100	0	0	0,72[a]	100	0	0	-	0	90	10	-	-	-
3,50	100	0	0	0,73[a]	95	0	5	-	0	15	85	-	-	-
24,00	100	0	0	0,71[ab]	85	0	15	0,78*	5	10	85	4,1*	4,2*	2,6*
25,50	100	0	0	0,71[ab]	60	0	40	0,79*	5	0	95	6,1*	4,9*	3,5*
27,25	100	0	0	0,70[ab]	75	0	25	-	0	15	85	-	-	-
28,25	100	0	0	0,69[b]	60	0	40	-	0	10	80	-	-	-
29,25	100	0	0	0,73[ab]	60	0	40	-	0	5	95	-	-	-

Letters in the upper index group the variants according to similarity

*value was ascertained in 1 vital plant only

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Souhrn
Výsadba dřevin v krajině s vyšším turistickým a rekreačním potenciálem je ovlivňována řadou faktorů, které na ni mohou negativně ovlivnit či dokonce způsobit její zánik. Často se jedná o lokality s příznivým klimatem pro rekreaci s vyššími průměrnými teplotami vzduchu a nízkým úhrnem srážek. V takových lokalitách bývají výsadby často ohroženy suchem, což ještě umocňují stále častější přísušky nastávající v důsledku změny klimatu. Přitom právě v lokalitách se zvýšeným turistickým a rekreačním využitím je velmi důležité, aby vzniklé výsadby prosperovaly beze ztrát.
Cílem práce bylo posoudit vybrané fyziologické a morfologické parametry buku lesního a smrku ztepilého stresovaných suchem v průběhu 1. roku po výsadbě a zjistit, zda by měření fluorescence chlorofylu mohlo být využito pro hodnocení fyziologické kvality sadebního materiálu dřevin s ohledem na jeho možnou neúměrnou ztrátu vody v průběhu manipulace a skladování.

Prostokořenné a krytokořenné rostliny byly vystaveny vysychání 0-28 hod a poté vysázeny. Byla hodnocena vitalita rostlin, měřena fluorescence chlorofylu (Fv/Fm), velikost asimilačního aparátu a přírůst rostlin. Akutní stress suchem před výsadbou se projevil ve změnách fluorescence chlorofylu jen velmi slabě až 5 týdnů po výsadbě. Podíl rostlin vitálních byl 5 týdnů po výsadbě nad 90 % i po 3-4 hodinovém vysychání před výsadbou. V průběhu vegetačního období byl zaznamenán extrémně nízký úhrn srážek ve vegetačním období, což se projevilo vysokou mortalitou všech krytokořenných rostlin a vyšší mortalitou prostokořenných rostlin vystavených vysýchání před výsadbou. Stres suchem se neprojevil ve snížení přírůstu ani velikosti asimilačního aparátu rostlin. Fluorescence chlorofylu rostlin (Fv/Fm), které přežily jak vysýchání před výsadbou, tak sucho ve vegetační době, byla vysoká, mnohdy vyšší než u rostlin před výsadbou nestresovaných, tuto charakteristiku ale nelze využít pro rozlišení rostlin stresovaných a nestresovaných suchem. Na suchem ohrožené lokality doporučujeme prostokořenné rostliny s pečlivou manipulací před výsadbou.

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POSSIBILITIES OF DIGITAL TERRAIN MODEL VIZUALIZATION FOR GEOMORPHOLOGICAL FEATURES INTERPRETATION

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Abstract
This article deals with the comparison of several terrain visualization methods based on Airborne Laser Scanning (ALS) data and Digital Terrain Model of the Czech Republic of the 5th generation (DTM 5G). Evaluation of these methods was realized in a selected part of Rudická plošina and applied on the example of surface karst structures – sinkholes. These shapes are unique due to their specific geomorphology; they are significant nature phenomena and have an important role in biodiversity protection, water regime, Land Development Management and they also significantly contribute to the area attractiveness in terms of recreation and tourism potential. A wide range of tools and calculations in Geoinformatical Systems (GIS) environment are currently used for terrain modelling and visualization. It is necessary to compare results of these interpretations with field mapping, real sinkhole shapes and also with other surface features in the area. The automatic identification of these features is the next step in terrain analysis. Furthermore, these calculations are utilizable as appropriate, conclusive instruments and materials for terrain geomorphological investigation.

Key words: Airborne Laser Scanning (ALS), Digital Terrain Model (DTM), Geoinformatical Systems (GIS), sinkholes

Introduction

Airborne laser scanning and generated DTM 5G have wide range of use at present, e.g. in cartography as a basic source database to creating contour lines designed to large scale maps and computer altimetry vizualizations; during landscape mapping; for local terrain conditions analyses in civil engineering, in landscape consolidation and reparceling projects, planning and projection of traffic, water and structural constructions, in local natural phenomenons modellig, etc. It is also very useful in forestry, archeology and nature conservation (ČÚZK, 2017).

Materials and methods

In 2015, the study of automatic sinkhole calculation and identification in the context of diploma thesis was realised in the locality of Moravian Carst, area of Babická plošina (Balková, 2016). This thesis uses procedures of foreign studies and methods, which used previous DTM generations with larger pixel resolution, such as karst research in western Morocco (Theilen-Willige et al, 2014), many studies in USA (Denizman, 2003; Florea et al, 2002; Stafford et al, 2013) and in Slovenian karst (Komac, Urbanc, 2012). The method of automatic sinkhole identifiction is the result of this study from Babická plošina.

The significant need and importance not only of automatic, but also vizual DTM intrpretation and their mutual comparison clearly results from subsequent terrain verification. It is possible to vizualize DTM in many ways, the best results are reached by softwares using complicated matematical calculations (e.g. Geoproxima). ArcGIS and SAGA GIS tools are most available for common user of

geoinformatical systems. The outputs of these tools are subjects of subsequent comparison below, which was realised in the area of Rudická plošina, west of the village Rudice in Moravian Karst (***Figure 1***). ALS data were used as input material and DTM 5G was created using Natural Neigbour method with 0,5 m cell resolution. Then the layer of DTM was used to terrain vizualization via various techniques.

Following tolls were used for the comparison:

- *Hillshade (H)*

Creates a shaded relief from a surface raster by considering the illumination source angle and shadows (ESRI, 2017).

- *Sky View Factor (SVF)*

Sky View Factor is defined by the part of the visible sky above a certain observation point as seen from a two-dimensional representation (Zakšek et al, 2011).

- *Topographic Openness (PO)*

Express the degree of dominance or enclosure of a location on an irregular surface. Openness is an angular measure of the relation between surface relief and horizontal distance. It has two viewer perspectives. Positive values, (*Positive Openness*) expressing openness above the surface, are hugh for convex forms. Negative values (*Negative Openness*) describe this attribute below the surface and are high for concave forms (Yokohama et al, 2012; Doneus, 2013).

Simple combinations of these tools used in this study:

- SVF*H*Slope
- SVF*H
- PO*H
- PO*H*SVF
- PO*H*Slope
- NO*H
- NO*H*SVF
- NO*H*Slope

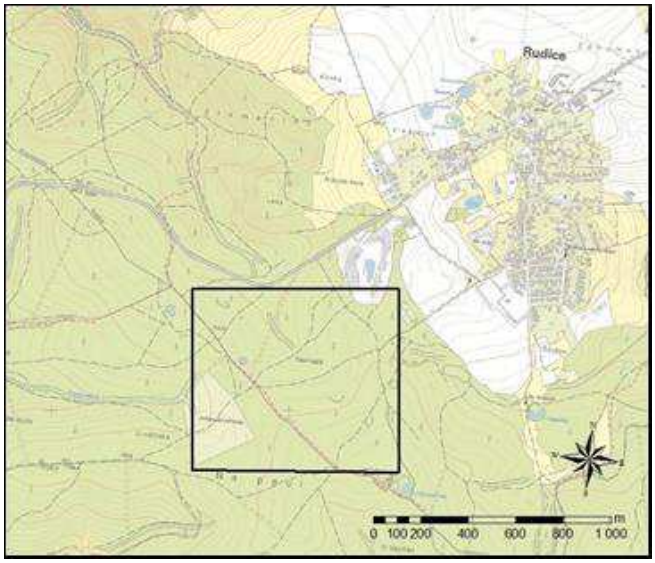

Fig. 1: Localization of area of interest on Rudická plošina

Results

In **Figure 2** we can see results of basic tolls useful to terrain vizualization – comparison of *Hillshade*, whitch was the first of them and newer calculations – *Sky View Factor* and *Topographic Openness*. These better depict relief shapes and changes. Other possibilities are represented by simple combination (means mathematical multiplication) of these layers. Results of several experiments are displayed in **Figure 3a, 3b**. If we combine any layer with Slope, visual result is almost the same, the slope factor degrades steep feaures, on the other hand it delays the shade present in SVF and TO layers and clearly depicts the places, where some depressions can be expected. Combinations of *SVF*, *TO* and *Hillshade* display quite smooth surface, where really detailed terrain changes are visible well.

As an example of use of these outputs, the visual and automatical sinkhole identification on *PO*SVF*Hillshade* layer is shown in **Figure 4**. Three sets of sinkhole databases are compared in the picture – automatically generated – white areas and mapped ones according to JESO – green polygons (AOPK ČR, 2017).

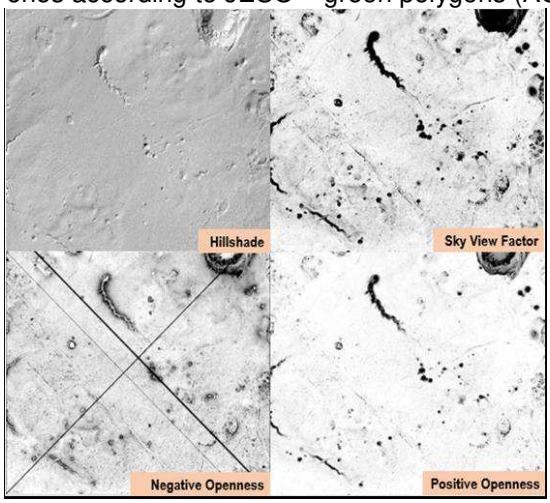

Fig. 2: Terrain vizualization using basic ArcMap and SAGA tools

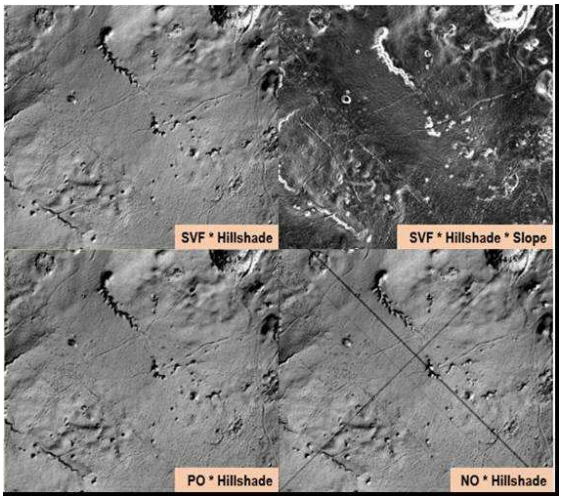

Fig. 3a: Terrain vizualizations as combination of basic ArcMap and SAGA tools

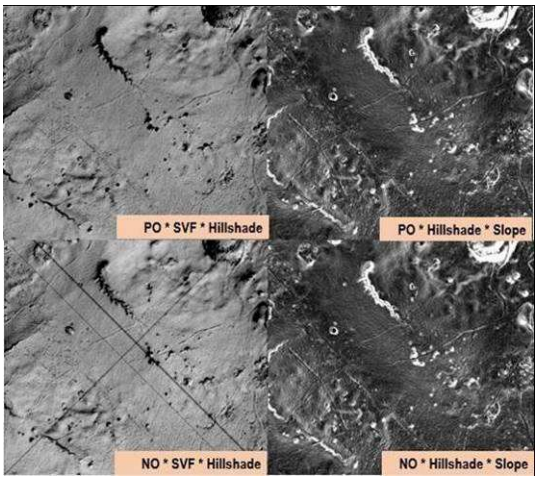

Fig. 3b: Terrain vizualizations as combination of basic ArcMap and SAGA tools

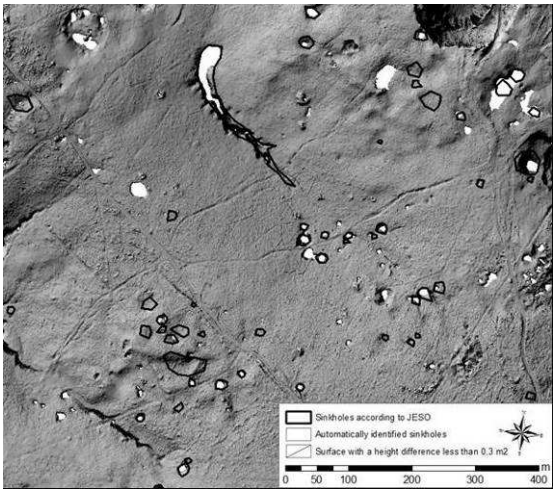

Fig. 4: Example of automatical sinkhole identification displayed on the layer created by PO*SVF*Hillshade combination

Discussion

In the text above, there are several DTM vizualization methods compared. Each method highlights or suppresses different pixel areas depending on calculation princip of the method. It is possible to reach better vizual results by mutual connection of some these methods and eliminate monolithic representation of areas, e.g. points from which the sky can not be visible and therefore the SVF alone displays them just in one color. On the other hand, by the approach of tools combination, an invalidation of the results can not be executed, especially in other parts, where this problem does not occur or conversely this monolithism is suitable for primal detection of specific terrain feature types. Nevertheless, using of tools combination seems generally best.

Surface vizualized this way, could be applied as one of the sublayer of attractive localities mapserves, e.g. National Parks, Protected Landscape Area, etc. 3D terrain model in these areas could be used to new educational instruments creation or

already existing ones improvement, e.g. educational boards, as well as interactive elements, which could acquire complex and wider view of the surrounding landscape, that is not able to gain by simple view the map neither direct human perception. Terrain model should give the visitor anusual and suprising insight to the locality and entice to active experience and cognitizion of the area. The database of all relevant informations about natural characteristics and other consequences, natural and antropological localities, geomorphological features and other animate and inanimate landcape components could bet the part of that interactive model, as well as hiking trails, singletrails network with infortmations about physical difficulty and duration, shading, perspective conditions etc. Furthermore, this model could serve as basis to create an educational game in terrain for the purpose of learning, improving the ability of orientation and to create a physical condition tests of various difficulty in terrain. In addition to these outputs, DTM is greatly suitable for access track and trail network itself optimalization and addition in connection with the most interesting localities identification.

Conclusion

DTM 5G currently represents one of the basic tools during interpretation of landscape, its features, historical develomepent and observing processes that occur slowly there. There are several choises, how DTM could be vizualized and brought closer to the reality. As the most suitable way using common software (ArcMap, SAGA) the combination of basic operations of these programes seems best. Selection of particular operations depends on the purpose of use. Generaly, combination of *Toporaphic Openness*, *Sky View Factor* and *Hillshade* with the 0,5 m pixel resolution can be recommended. Consequently, model could be uses not only for visual depiction of landscape, but it can also serve as the basic tool for automatical mathematical DTM analysis.

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Souhrn
DMR 5G České republiky představuje v současnosti jeden ze základních nástrojů při interpretaci krajiny, jejích tvarů, historického vývoje a pozorování procesů, ke kterým zde zvolna dochází. Existuje řada způsobů, jakými lze DMR vizualizovat a přiblížit ho tak reálně skutečnosti. Jako nejvhodnější způsob při využití nejběžnějšího softwaru (ArcMap, SAGA) se jeví kombinace základních operací těchto programů. Výběr konkrétních operací závisí na účelu využití. Obecně lze doporučit kombinaci nástrojů *Topographic Openness*, *Sky View Factor* a *Hillshade* a rozlišením pixelu 0,5 m. Model lze následně využít nejen pro vizuální zobrazení krajiny, ale i může posloužit jako základní pomůcka pro automatizované matematické analýzy DMR.

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POTENTIAL OF HEDGEROWS IN THE ENVIRONMENT OF THE CZECH LANDSCAPE

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Abstract
Hedgerows are multipurpose elements of woody vegetation in the landscape and represent one of its important parts. This shrubby linear vegetation is traditional mostly in England, however it is quite common in other European countries too. In the landscape of the Czech Republic there was a lot of scattered vegetation in past. Unfortunately, because of collectivization of agriculture these elements of vegetation were devastated. Hedgerows are appropriate for the restoration of scattered vegetation in our countryside thanks to its multi-functional character. They can contribute to better conditions for the life of animals and people. In this paper there are functions of hedgerows in the landscape described in more detail.

Key words: hedges, linear vegetation, scattered vegetation, functions of woody vegetation

Introduction

Woody vegetation is an inseparable part of our countryside and completes our environment. It has a significant influence on human life and to other living organisms in the ecosystem. Formerly trees and shrubs served to man primarily as a source of fuel, food, material for making tools and shelter from the weather. Woody vegetation was also a source of knowledge and inspiration. With the further development of civilization and human settlements, vegetation began to play an important role in the field of recreation too.
Hedgerows are linear woody vegetation consisting of trees, shrubs or both. They are widespread mainly in England, but we can find them in other countries too, e.g. in France, Germany or Netherlands. These continuous woody growths represent a multifunctional type of linear woody vegetation. In the Czech countryside, we find similar elements of woody vegetation, usually in the form of alleys, overgrown bounds and accompanying vegetation of waterways and paths. In recent years the intensive interventions in the agricultural landscape of the Czech Republic caused significant decreasing the amount of scattered vegetation. Current efforts are targeted for replanting of woody elements in our countryside. Hedgerows are a suitable alternative for such purposes.

Function of hedgerows in the landscape

As mentioned in the introduction, hedgerows have many functions. In the whole length of the hedge individual functions may vary depending on species composition and representation of the various kinds of woody plant in individual parts of hedge (Forman, Godron, 1993). There are many ways to describe each function.
Hedgerows have a significant impact on the surrounding ecosystem and its biodiversity. For animals represent shelter and livelihood. The occurrence of individual species is bound to both the woody and herbal composition of the hedge, and on the occurrence of each group to each other (within the food chain). In one of the studies from the UK showed the greatest species richness of insects is tied to

the hedges consisting of oak and hawthorn (Pollard et al., 1974, In Forman, Godron, 1993). Hedges are the refuge for different species of mammals (e.g. hedgehogs, rabbits, mice and many others) and birds that are building their nests there and searching food. Moreover, thanks to the seeds spreading by birds, a further richness of species in hedge is increasing. There are also many species of invertebrates (Forman, Godron, 1993). Other studies from England show hedgerows biodiversity very well. A single hedge was watched during two years and there were described 1718 kinds of insects, 97 species of other invertebrates, 50 species of vertebrates, 125 species of plants and 80 species of fungi and lichens (Wolton, 2015). Another study, which describes the old and intact hedgerow, states that there have been discovered 280 kinds of mushrooms over the twenty-five years (Müller, 2013).
In the context of biodiversity, it is necessary to mention the territorial system of environmental stability, which is defined as ,,an interconnection of natural and altered, but natural ecosystems, which maintains the natural balance" (Löw, 1995) and form a spatial structure of major importance (Míchal, 1992). In terms of composing elements of ecological stability system, we would probably rank hedgerows among the interactive elements. They can be represented by ecologically important landscape elements or linear vegetation that create conditions for the existence of plants and animals and significantly affect the functioning of ecosystems in the cultural landscape (Löw, 1995). Hedgerows can use within the territorial system of environmental stability as interactive elements for planting. It is possible to use e.g. as an accompanying vegetation of waterways or paths.
Another option to increase biodiversity in the agricultural landscape may be planting hedges as a form of agroforestry (Nair, Garrity, 2012). Agroforestry systems in Europe show that this method of farming positively affects biodiversity, soil and water management and, moreover, in the longer term, appear to be more profitable. Although agroforestry systems represent an appropriate form of management support rural development (Kotrba et al., 2015), in the Czech Republic, there is a lack of agroforestry legislation and awareness landowners for bigger widespread of agroforestry.

Ecosystem services of hedgerows

Ecosystem services are processes in a particular ecosystem that have some relationship to man. One service can be beneficial, but also harmful (Nátr, 2011). Biodiversity is not an ecosystem service but underpins for all ecosystem services (Wolton et al., 2014). In next part we describe hedgerows functions in the view of ecosystem services.
Within the regulatory ecosystem services, hedgerows e.g. improve water quality and availability for agricultural crops, reduce flood risk and soil erosion, reduce pest amount of agricultural crops, improve crop pollination and mitigate climate change (Wolton et al., 2014). Hedges have a vital role in open agricultural landscape without forests – they provide shelter for livestock and wildlife (Forman, Godron, 1993) and protect them against adverse climatic conditions and thermal stress caused by sudden changes in weather (Wolton et al., 2014).
From the perspective of supplying ecosystem services, hedgerows can be a source of wood (Forman, Godron, 1993), although this usually is not the primary purpose (Boček, 2007). To a limited extent, hedgerows have also a production function. They can be a source of different fruits (Sklenička, 2003). In case hedgerows consist of fruit trees, it is possible to use the potential of the wood, which is highly prized in the furniture industry, wood carving or wheelwright crafts (Boček, 2007).

From the perspective of supporting ecosystem services, we should mention the function of hedgerows as an element serving for better orientation of animals in space (Sklenička, 2003) and providing the transport function. They can have both positive and negative effect, depending on the specific type of animal movement (Wolton, 2015).
From a human perspective, hedgerows have an important function – the cultural ecosystem services. One of the main functions is hedge effect. They serve to define the land, prevent the movement of animals (Forman, Godron, 1993) or separate hunting grounds (Sklenička, 2003). Furthermore, the hedgerows, as part of scattered vegetation, are important elements of harmonizing the landscape, a source of shade for humans and animals in the open countryside (Sklenička, 2003), and also a source of knowledge and further education.
Finally, it is necessary to give their contribution to the recreation of man. The presence of vegetation in the landscape increases the recreational potential of the area. This is characterized as a set of ecological, vegetation, cultural and social factors that determine the maximum capability of influence of areas to recreational activities of man (Schneider, Fialová, Vyskot, 2008). It means hedgerows also support the recreational potential of the area.

Discussion
In the Czech Republic, there are hedgerows mainly in an urban area where they usually form the boundaries of land and garden, both for family houses as well as in large castle grounds. If we wanted to apply more hedgerows in planting into the countryside, it is necessary to take into account what function land owner primarily prefers. According to it, we plan the spatial arrangement and species composition of the woody element. In the Czech Republic, we would most likely consider bounding function, production function (wood, fruits, bee pasture) and regulatory function (e.g. antierosion).
Each planting can be planned with one specific aim or requirement, but it is never monofunctional vegetation. The mere presence of species in the open countryside carries a positive effect on its surroundings, although from the perspective of the owner it can seem like a secondary function.
There is no corresponding equivalent for hedgerows in Czech terminology. In the case we would plant a hedgerow; there will be a problem with naming this woody element. Resolving the question of a suitable name in our conditions is therefore currently a challenge for professional landscape engineers and other interested persons.

Conclusion
Thanks to the multifunctional nature of hedgerows, they may appear to be a suitable alternative for planting woody vegetation in our environment. While in England they have tradition and they are widespread, in the landscape of the Czech Republic they aren't very common. Hedgerows have a significant effect and many beneficial functions for surrounding ecosystems. From the perspective of landscape ecology, hedgerows are a very interesting opportunity to increase the biodiversity of the agricultural landscape. At present, our landscape becomes increasingly more uniform, and therefore plantings of these vegetation elements are highly desirable. When we plan to plant hedgerows, it is important to think of functions required by the landowner. Furthermore, hedgerows have a positive impact on the quality of soil, groundwater quality, quality of human life and organisms and ultimately they have a great contribution in the field of human knowledge and recreation in the countryside.

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Souhrn

Vzhledem k multifunkčnímu charakteru ,,hedgerows" se tyto liniové prvky dřevinné vegetace v mnoha ohledech mohou jevit jako vhodná alternativa pro výsadbu dřevin v našich podmínkách. Zatímco v Anglii mají svou tradici a jsou hojně rozšířeny, ve volné krajině České republiky zatím své pevné místo nenašly. ,,Hedgerows" mají významný vliv na okolní ekosystémy a v mnoha ohledech jsou přínosem. Z pohledu ekologie krajiny představují velmi zajímavou příležitost pro zvýšení biodiverzity zemědělské krajiny. V současnosti se naše krajina stává čím dál jednotvárnější, a proto jsou výsadby takovýchto prvků vegetace velmi žádoucí. Při zpracování návrhu jejich výsadeb je také potřeba přihlížet na funkce požadované vlastníkem pozemku.
,,Hedgerows" mají rovněž pozitivní vliv na kvalitu půdy, podzemní vody, kvalitu života organismů a člověka a v neposlední řadě jsou velkým přínosem v oblasti poznání a rekreace člověka v krajině.

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PROPOSAL FOR A SIGNIFICANT LANDSCAPE SEGMENT

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Abstract
This article deals with the development of the landscape in the region of Dačice, specifically in the municipality with expanded competence Dačice. Types of urban structures are evaluated using historical and current aerial photographs and indication sketches. The significant landscape segments are also identified and a way of its protection is designed. An illustrative example is pictured in ArcGIS-processed maps.

Key words: landscape, indication sketches, urban structure, Dačice region

Introduction

The term landscape is no doubt one of the most frequently used terms which has worked its way from the lay language into the scientific language of many professions of the human society (Kolejka; 2014). In the 1990s it became the key concept of natural sciences as well as of some humanities. The British school of landscape archaeology views the landscape as an assemblage of translucent maps interposed one over the other. Each map corresponds to a specific time segment which corresponds with a specific landscape type (Cílek; 2005). The landscape has been studied both as a single branch and also in inter-branch studies and is called "landscape science", the same as e.g. soil science. Kolejka (2011) alleges that in the Czech language the term landscape indicates primarily the space - that means as far as I can see, the region, as far as the skyline/horizon. In English-speaking countries landscape is more likely a visual aspect. Cosgrove (1998) perceives the landscape as a "way of seeing" rather than as an object and its image. He is an advocate of an ideological conception, i.e. how the social classes depict themselves and their world by means of images in relation to nature. By contrast German geographers incline towards the opinion that the content of the term landscape (Landschaft) is spatial. Lipský in Kolejka (2011) maintains that although we do not want it to sound as a cliché, the landscape is a true image of the condition and development of the society. Changes taking place in the society, be they technological, demographic, economic, political or social, within a short period of time become reflected in the physiognomy of the landscape, method of landscape use and layout of both the cultural and natural landscape. According to Bürgi, Hersperger and Schneeberger (2004) landscape use is researched primarily when serious environmental problems occur, e.g. soil degradation and erosion. They also explained the concept "driving forces" which make us observe the changes in the landscape, the powerful processes in the evolution trajectory of the landscape (economic forces, social forces and the public) practically confirming the opinion of the above authors. These forces make up an integral system in dependence on their interaction and feedback at various time and spatial levels.

Materials and methods

The results were based on field investigations carried out at the turn of April and May 2015. The field investigations included photographs made of the dominant features and settlements; in 19 of the identified rural establishments a well-preserved urban structure was confirmed. To evaluate the types of urban structures historic and contemporary aerial photographs were used and identification maps of the Stable Cadastre by means of which an important landscape segment was identified in connection with its protection, i.e. *historically preserved urban structure of the villages.* The urban values of the villages were primarily carried out by comparing indication sketches with current and historic (from 1953) aerial photographs and then by field investigations. The following criteria were determined, i.e. whether:

- the construction of buildings of the former collective farms (JZD) or other very large agricultural buildings had disrupted the original character of the village,
- the construction of blocks of flats or slab blocks had disrupted the original character of the village,
- in the period from 1953 to the present day the construction of family houses on the periphery of the village or outside the village had disrupted the original character of the village.

Records on each village indicated whether the urban structure had been ("yes") or had not been ("no") disrupted. The photographs were made using the ArcGIS programme.

Brief characteristics of the region of interest

The frontier region is considerably influenced by the political, economic and social-economic development of the landscape of the entire region. Dačice, a municipality with extended competence (ORP) (Fig. 1), originated in 2003 and in the region associates 23 villages situated on 85 cadastral areas of a total area of 472 km^2 and a population of more than 20 000 people. In terms of its structure, characteristic is the scattering of small villages over the entire region. They are mostly villages of populations of 500 (almost 87 %). The region is also characteristic as an intensively farmed region with a small proportion of forests. In terms of the administration the region belongs to the South-Bohemian Region in spite of the fact that its landscape structure geographically falls into western Moravia. The geo-morphology of this region belongs to the extensive Bohemian-Moravian Uplands which is part of the Bohemian-Moravian system of the Bohemian Uplands. The landscape of the Dačice region is harmonic given particularly by its moderately broken terrain with valleys, small streams and small areas of woodlands on the hilltops and agricultural areas of arable land. In terms of the climate this area lies predominantly in the climatic region B 5, moderately warm and humid with an average annual temperature of 7 °C. Predominant are brown soils (kambizem), in lower altitudes passing into illimerized soils (luvizem) and in the more humid higher altitudes these soils alternate and turn into rusty (kryptozol) and podzol soils (Nekuda; 2005). Due to nature and landscape conservation and also to the highly preserved landscape features 2 national parks have been declared in the region - Česká Kanada (Czech Canada) and Javořická vrchovina (Javořice Upland) and ca 20 specially protected areas, such as natural monuments (thereinafter PP) and nature preserves (thereinafter PR) (Nekuda; 2005).

Results

The region of our interest ranks among colonisation types of settlements and the colonisation is indicated as diverse. However from well-preserved sources we see that settlers flowed into the region in the 13th and 14th centuries in two main streams. In the east the settlers came from the foothills, specifically from the region around Moravské Budějovice and Jemnice; in the west they came from Jindřichův Hradec. These two main streams can be seen in the pattern of settlements of that time but also as it is today. The villages are mostly of the types of village greens and irregular field systems, i.e. club-shaped, spindle-shaped and forked types, villages of the forest-field type (after clearance of the forest), and locations with regular village greens (two- or four-sided). In some parts of the region small villages, hamlets and modern plots with streets or single or multi-row dispositions are spread. From the viewpoint of town planning and typology the most remarkable are settlements on the village greens or along an important communication running through the village, e.g. Velká Lhota. Here the valley large-field villages (road-type, street-type and brook-type villages) appear only rarely. Basing on the results an important landscape segment was identified - historically preserved urban structure of villages. Table 1 gives the proportional representation of the criteria in the villages of the region. In her study M. Venzlů (2015) gives details of the initial values and a list of all cadastral parts. The image of the village settlements changed most dramatically, i.e. 64 % of the villages, when agricultural buildings were constructed and collective farms established. Most of the blocks of flats and slab blocks were built in the towns of Dačice and Slavonice, but a proportion can be seen also in the neighbouring villages. New family houses are being built on the peripheries of the villages, that means on the green meadow and mostly concern member villages of the region. The proportion of new buildings is the highest in the following villages – Třebětice, Budíškovice, Červený Hrádek, Hříšice, Volfířov and Studená. It was discovered that 19 villages (see Fig. 2) had not changed at all, therefore their original urban structure had not been disturbed; as a rule this means the structure of the ground plan, parcelling determining the structure of the built-up area, dominant features and compositional relationships of the buildings and spaces. The urban value of the villages in the region is based particularly on the distribution typology and rustic appearance of the settlements which are usually concentrated around a chapel or other architectural dominant, pond, along important communications etc. Figs. 3 and 4 illustrate some historically preserved urban structures.

Discussion

We can, or rather we should, perceive the landscape as a change and inertia because it is constantly changing. So is land use permanently changing and registration of these changes is demanding and expensive; so no universal method is yet in existence to evaluate the development of the landscape, neither at a regional or international level (Gabrovec, Kladnik; 1997). Kolejka (2011) calls for research into the changes of the landscape in the course of time as an expression of many processes frequently interconnected and to apply various research methods. He also maintains that in the Czech Republic absent are such methods that would enable to collect data covering the complex cyclic and irretrievable processes in the landscape, particularly long-term station observations. From this it follows that the overwhelming majority of studies into landscape changes in the course of time is based on a variety of assessments of historic documents on land use in the past. It must be admitted that historic and contemporary aerial photographs provide a very good groundwork and source of information for the assessment of the changes,

however the proposed method would reliably prove how the landscape had changed up to the present day or if it had indeed changed. This approach would be very detailed and could be used to analyse the development of the individual cadastres. It could not be applied to the entire region due to the great amount of studies. However it could be applied in a multi-year project carried out by a team of researchers. As the entire southern part of the region under study borders on Lower Austria and since a proportion of the Dačice region used to be part of the German Sudetes, it would be very interesting to carry out an analysis of the development of land use in this region and to compare it with the development of the landscape on the Austrian side of the border. However it would be a problem to establish a uniform method of doing this because the system of filing the land planning documents and documents concerning complete land use is different on the two sides of the border.

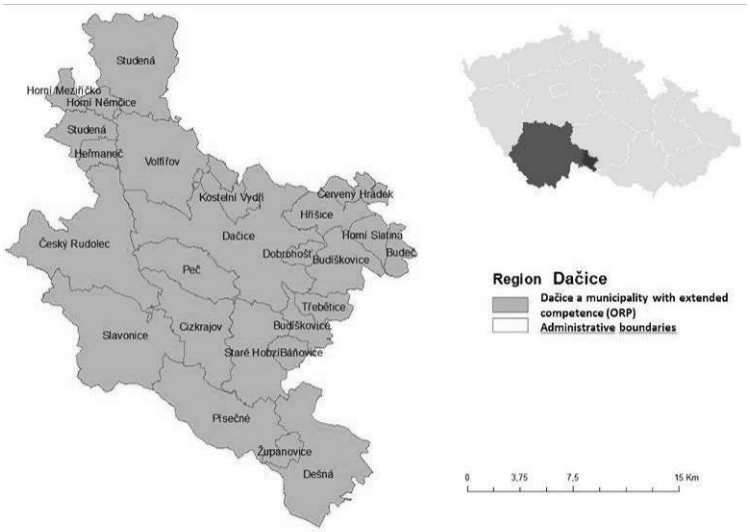

Fig. 1: Dačice, a municipality with extended competence (Source own work)

Tab. 1: Proportional representation of the criteria in the villages of the region

	Criterion		
Representation	agricultural collective farm (JZD)	Residential / prefabricated buildings	New buildings
Yes (%)	64	35	52
No (%)	36	65	48

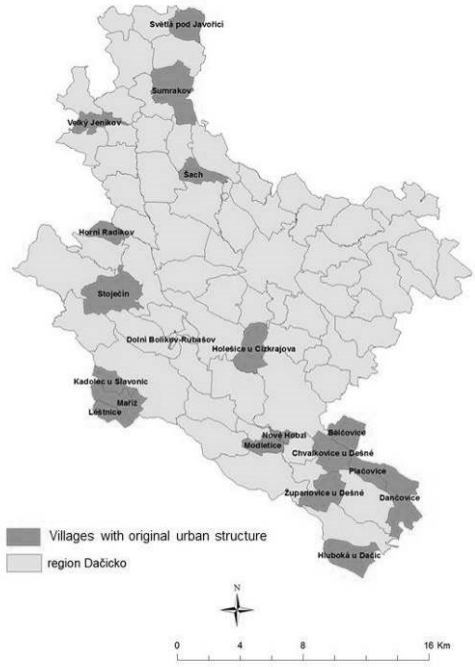

Fig. 2: Villages with original urban structure (Source. Own work)

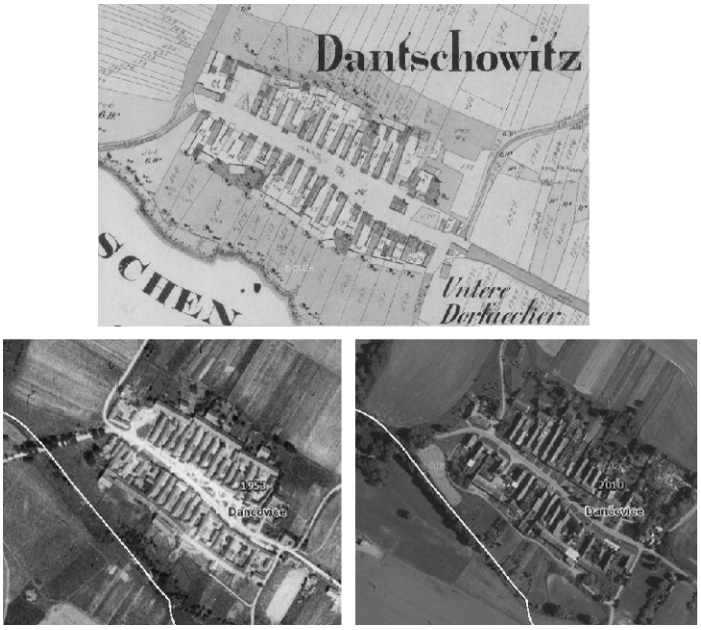

Fig. 3: Historically preserved urban structures of the village Dančovice (Source own work)

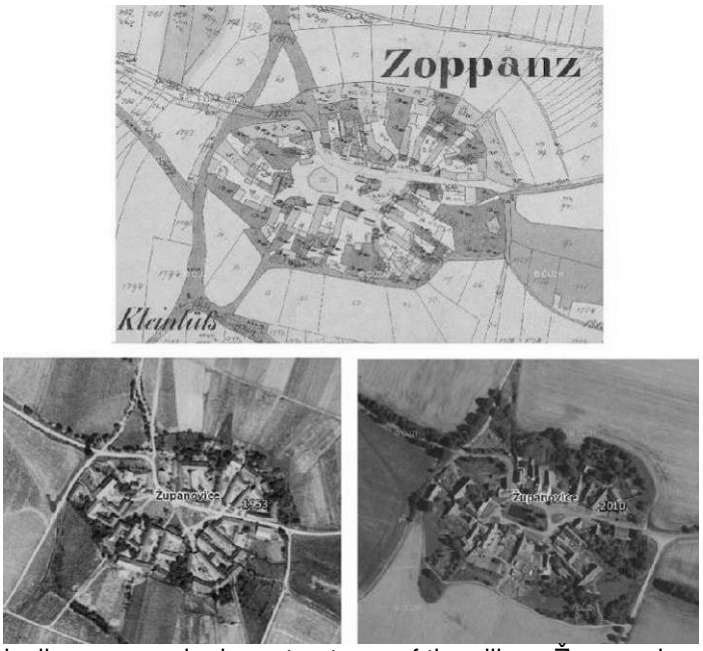

Fig. 4: Historically preserved urban structures of the village Županovice (Source own work)

Conclusion

It can be concluded that in spite of greater or smaller interventions the region under study is characterized by a historically preserved urban structure of the settlements. The proposals for its future preservation are as follows:

- careful and coordinated compilation of land planning documents and documentation
- thorough analysis of historic and cultural monuments in the region,
- to use EU funds for revitalisation of the countryside.

Another option for the protection of some villages is for the Ministry for Culture to enter them in the list of rural preservation zones. Today this list contains only the village Plačovice which was declared a village preservation area in 1990. The Dačice region is recognized particularly for its original landscape character and preserved architecture and cultural wealth. We should all be fully aware that it is necessary to protect the landscape rather than to leave it at the mercy of its own fate. Above all, it is necessary to realise our responsibility when making decisions about changes in the landscape and in this way to prevent the landscape becoming only a space for construction and similar ill-considered treatment. It is a paradox that this undesirable treatment is supported by legislation the original intention of which was to protect the character of the landscape from destructive influences of investors, however at present we are looking predominantly at creating documents for the purposes of land planning and other land planning activities.

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Souhrn
Článek se zabývá vývojem krajiny v regionu Dačicko, konkrétně na území obce s pověřenou působností Dačice. Jsou vyhodnoceny typy urbanistické struktury pomocí historických i současných leteckých snímků a indikačních skic. Dále je identifikován významný krajinný segment a je navržen způsob jeho ochrany. Vymezené katastrální části s dochovanou urbanistickou strukturou a jejich názorný příklad je zachycen v přehledných mapách zpracovaných v ArcGis.

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RECLAMATION, RESTORATION AND RESOCIALIZATION OF AN ANTHROPOGENICALLY AFFECTED LANDSCAPE AS TOOLS OF SUSTAINABLE DEVELOPMENT

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Abstract
Sustainable development is a basic concept for the preservation of comparable living conditions for our future generations. However, society today has unsustainable energy requirements, and that is why coal is still the largest source of energy. The landscape created after coal mining consists of remaining quarries and anthropogenic formations, such as spoil tips. This anthropogenically affected landscape is successfully integrated back into the surrounding environment through reclamation and restoration processes. These processes support the creation of new land designated for improving the ecological and environmental stability of the area, and also for recreational purposes.
This contribution is focused on the recreational potential of the anthropogenically affected landscape in North Bohemia, which consists of the Chomutov, Most, Teplice and Ústí nad Labem districts. Apart from forest and agricultural reclamation, hydrological and recreational reclamation is also being carried out in this area. This has resulted, for example, in the creation of the Milada and Most Lakes, as well as the Most city racecourse and racing circuit. Thanks to these newly created recreational areas, the once-devastated landscape has been socialized again. Reclamation and restoration processes are important tools for sustainable development because they take into consideration the ecological, economic and social potential of an anthropogenically affected landscape.

Key words: coal mining, recreation, North Bohemia, artificial lakes

Introduction

The most anthropogenically burdened region in the Czech Republic is formed by the Chomutov, Most, Teplice and Ústí nad Labem districts. This region has been significantly affected by intensive mining and industrial activity for almost 200 years. The area is 2,276 km^2 in size and home to 486,000 inhabitants. The area is a typical industrial region, which in the late 1980s was part of the Black Triangle area due to the open-cast mining of brown coal and its combustion in power stations. As a large portion of the population lives in this region, an attempt is being made to integrate the area into the surrounding landscape in the form of revitalization processes, thereby ensuring the permanently sustainable development of the landscape and society and supporting the tourist industry.

Materials and methods

Coal mining

From its beginnings in 1850 until the present day, open-cast brown coal mining has affected an area of approximately 250 km^2, reaching its peak with a volume of almost 70 million t/year in the 1980s (Fig. 1).

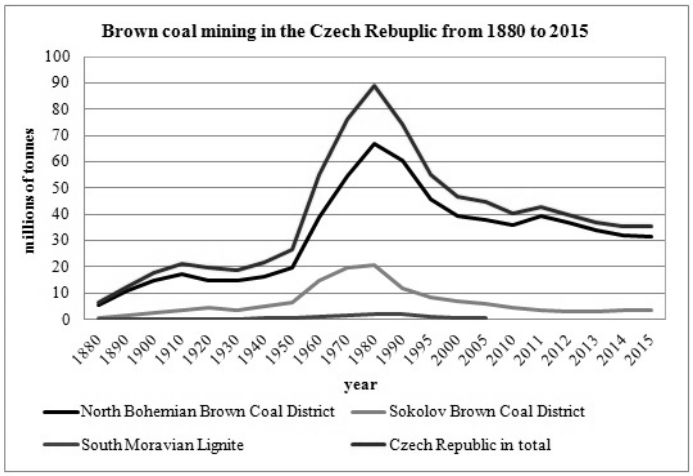

Fig. 1: Historical development of brown coal mining in the Czech Republic since 1880. Authors' own adaptation from Mining Yearbook 2005-2015

In 2015, mining in the Most Basin reached 31.65 million tons, and production on this territory under the Ore Mountains is carried out by Czechoslovak Army, Vršany, Libouš, and Bílina Quarries. According to current plans, given a similar annual mining volume and in compliance with the existing limits in the Czechoslovak Army Quarry, mining in the North Bohemian Brown Coal District (SHR) should end between 2050 and 2055 (Kašpar, 2015) . This will be done by mining the last of the coal supplies in the Vršany Quarry in the Slatinice extraction area and the Bílina Quarry, whose continuation beyond the originally stipulated limits was decided on by the government in October 2015 by Government Resolution No. 827 (Government resolution No. 827, 2015).

The concentration of production activities leads to an enormous emission and pollutant burden on the region's landscape, plays a part in the low comparative evaluation of the region's environmental quality factor within the scope of the Czech Republic and even affects the issue of recreation.

Regeneration of the landscape in the model area

The reclamation of the landscape must be understood as the managed regeneration process of a landscape affected by mining and possibly also other human activity. Its aim is the restoration of the landscape's natural balance. It includes work of a technical nature (landscaping, stabilization measures, hydrotechnical measures, etc.) and also of a biological nature (creation of agroecosystems, agricultural use, forest plantation, silvicultural care etc.). It is necessary to continue supporting revitalization, i.e. functional integration into the landscape or a final treatment of the devastated area that will ensure the creation of an aesthetic landscape phenomenon and the restoration of the ecosystem's natural functions, while at the same time enabling the full utilization of the area in accordance with the zoning plan (Dejmal, 2007). The largest share within the scope of reclamation completed by 2015 is represented by the reclamation of 6,426.39 ha (46%) of forest. Next in line is agricultural reclamation at 4,064.88 ha (29%); however, land fertilization during this process has been complicated. The area involving other forms of reclamation is constantly increasing (2,536.3 ha, or 18%), as the areas created adapt to society very well. That is why a significant expansion of these other areas is expected in the future. For now, the smallest share is represented by hydrological reclamation

(984.56 ha, or 7 %). However, with the end of open-cast coal mining, their share will increase thanks to the possibilities of utilizing residual quarries. The most promising types of reclamations are those classified as “other”. This mainly follows from the fact that the area of interest is significantly urbanized, and reclamation near settlements must be resolved by the purposeful creation of an attractive suburban leisure environment.

Other reclamations

Other reclamations are divided according to the purpose for which it was designed (Fig. 2). For example, it includes the following forms:

Other public green spaces: green spaces in sports and recreational zones, along watercourses, lakes, groves, and successional areas and along paths and roads.

Other roads: local and tertiary roads, parking areas.

Recreational and sports areas: pitches and stadiums, riding halls, horse racing tracks, shooting ranges.

Recreational and residential areas: camps, campsites.

Cultural and educational areas: zoological garden, open-air museum.

Areas for business activities: for commercial use.

In terms of the potential development of recreation, other forms of reclamation include the construction of sports grounds and racetracks in reclaimed areas. Examples include the car racetrack on the slag heap of the former Matylda u Mostu Quarry, and the Hippodrome and golf course on the Velebudice slag heap in Most. An advantage of these structures is that no additional land needs to be occupied for their construction because the initial devastation of the original agricultural or forest land has already taken place, and the form of recreational activities on this land will allow it to be put back into use. As another example of other reclamation, we can use the suburban park on the inner overgrown slag heap of the former Hrabák Quarry in the southern part of the town of Most (Vráblíková et al., 2009).

Fig. 2: Division of other reclamations (Vráblíková et al., 2009)

Results

The entire strategy for reclaiming the landscape under the Ore Mountains is based, in the long term, on the real possibilities in this area for creating conditions for this region to become, in its post-mining phase, a valuable recreational area, equipped not only for leisure-time activities, but also for a production capacity that is environmentally sustainable and undisruptive. If the concept of sustainable development is adhered to within the scope of reclamation, whereby all of its pillars

are taken into consideration, the newly created landscape will also be prepared for the possible consequences of global warming. Sufficient water and forests will create suitable conditions for housing, recreation and regional agriculture. An important concept that links the ecological interests of an anthropogenically burdened landscape with economic and social aspects is its so-called resocialization (Vráblíková et al., 2014) whose main aim is the return of people to a reclaimed and restored area. In this part, we will list several completed examples of the utilization of an area to develop the tourist industry in Podkrušnohoří region.

Coal safari

One successful project that is currently being organized by the companies Vršanská uhelná a.s. and Severní energetická a.s. is the so-called Coal Safari. This term, which has been used since 2009, refers to excursions into fully operational mines (quarries), as well as reclamations. This allows the public to learn about the technology of brown coal mining, as well as the regeneration of the landscape after mining (Fig. 3). Over the course of the project, more than 20,000 visitors from the whole of the Czech Republic and abroad have become familiar with this activity. Guided tours are divided into three routes, on which visitors can see the Most Hippodrome, the lookout terraces of the Czechoslovak Army and Vršany quarries, mining using an overburden excavator and a demonstration of the future Most Lake (www.uhelnesafari.cz).

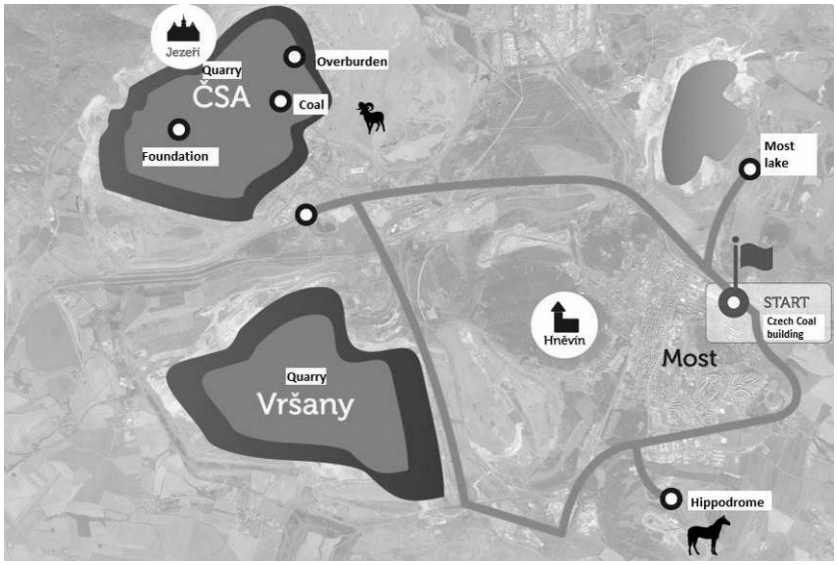

Fig. 3: The Coal Safari, Route 1 (www.uhelnesafari.cz)

Milada Lake

During the period 2001-2010, the residual pit of the Chabařovice Quarry – the future Milada Lake – was flooded as part of extensive hydrological reclamation performed by the state-owned enterprise Palivový Kombinát Ústí (Combined Fuel Company Ústí) within the scope of the revitalization of the area affected by mining activity. Although this is hydrological reclamation, the lake was created mainly for recreational purposes. On 08/ 08/ 2010, the flooding of the lake was completed, and its parameters are presented in Table 1.

Tab. 1: Parameters of the Milada Lake as of 08/ 08/ 2010 (www.jezeromilada.cz)

Parameters of the Milada lake	
Altitude	145,7 m n. m.
Acreage	252,2 ha
Cubic capacity	34 854 000 m^3
Average depth	15,5 m
Maximum depth	24,7 m
Shoreline perimeter	9 011 m
Maximum width in longitudinal direction	3 224 m
Maximum width in transverse direction	1 311 m

In 2006, cycling trail No. 3009 was established here, and in autumn 2013, the Milada Lake Educational Trail was opened, informing visitors about the history of coal mining in Chabařovicko region, which had a very significant impact not only on the appearance of this part of Podkrušnohoří region, but most importantly on the lives of many of the local inhabitants (www.jezeromilada.cz).

Podkrušnohoří Technical Museum

In 2003, the Podkrušnohoří Technical Museum was established on top of the former Julius III underground mine in Most-Kopisty, whose main aim is to show the public the history of coal mining and processing in the central part of the North Bohemian brown coal basin. Its specific aim is to create a zone of industrial and technical monuments in the Podkrušnohoří Region, focusing specifically on the fields of underground and open-cast mining in the brown coal basins of northwest Bohemia, the treatment and other utilization of coal and the chemical industry. The exhibitions deal with customs and traditions that were connected with mining life and the regeneration of a landscape disrupted by mining activity. The Podkrušnohoří Technical Museum, a public benefit organization, came into existence thanks to support from the Mostecko Economic and Social Council (www.ptm.cz).

The Most Hippodrome and Autodrome

The Most Autodrome was built between 1978 and 1983 on the slag heap of the former Vrbenský open-cast mine. The autodrome track is 4,219 m long, and is used not only for car, truck and motorcycle racing, but also for trial runs for vehicles under development; training for drivers of fire, ambulance and police vehicles; and training for drivers in crisis situations etc.

The Most Hippodrome is a horse racing track on the southern edge of the town of Most, which is operated by a joint-stock company of the same name. The horse racing complex was built in 1996 by reclaiming the Velebudice slag heap. The Velebudice slag heap belongs among the largest slag heaps (790 ha) in the former North Bohemia Brown Coal District. Horse races take place here from April to October. Since July 2008, there has been a 3,370-meter-long track for inline skating here, which was built along the perimeter of the horse racing track (www.mesto-most.cz)

Planned reclamation intended for recreation

In the Most Basin, the lakes created by flooding residual quarry pits will have particularly significant potential for recreation. In the coming years, Most Lake, which

was created by flooding the Ležáky Quarry, and which was filled in the year 2014, will be made accessible to the public (Tab. 2).

Tab. 2: Parameters of the Most Lake (www.mosteckejezero.cz)

Parameters of the Most lake	
Acreage	309,4 ha
Cubic capacity	70,5 mil. m^3
Shoreline lenght	9 380 m
Maximum depth	75,0 m

Table 3 depicts current and other planned lakes that will be created after mining in the Most Basin ceases completely. The largest body of water will be created after the Czechoslovak Army Quarry is flooded, and its area will be 1,259 ha.

Tab. 3: Current and planned hydrological reclamations in Podkrušnohoří

Quarry	Acreage [ha]	Cubic capacity [mil. m^3]	Maximum depth [m]	Filling period
Chabařovice	252	35	25	2001–2010
Bílina	970	698	170	2055–2075
ČSA	1259	760	130	2020–2050
Hrabák	310	25	20	2036–2045
Vršany	264	61	40	2060–2066
Most	316	72	70	2008–2014
Libouš	640	110	52	2030–2034
Vrbenský	38,7	7	4	1992–1995

Discussion

The planned termination of mining in the North Bohemia Brown Coal District in 2055 (Kašpar, 2015) is an important milestone, before which we should determine the manner in which the landscape in the model area will be developed, taking into consideration the principle of permanently sustainable development (Brundtland, 1987), which allows for the ecological, economic and social aspects of the development of society and the countryside. An important concept within the scope of the reclamation of the anthropogenically burdened region is its resocialization (Vráblíková et al., 2014), which takes into account humans as an important element when returning the post-mining landscape to the surrounding environment. Reclamation for the purpose of recreation has a particularly positive effect on the region's economy, as it supports the tourist industry in an environment that is not very attractive. The future flooding of residual pits after mining represents great potential for the future development of a sustainable tourist industry in the Ústí nad Labem Region.

Conclusion

Reclamations aimed at recreation are essential processes that help make an anthropogenically burdened region accessible to people again. Thanks to a good reclamation practice, the Podkrušnohoří model area is guided not only by the ecological needs of a region destroyed by brown coal mining, but also by society's right to recreation. This is slowly leading to the creation of a lake district that will serve not only as a refuge for animals and a habitat for plants, but also as a leisure space for local residents. The inspiration for the hydrological reclamation in Mostecko may have been the Lusatian Lake District in Saxony, Germany, which was also created by flooding open-cast mines.

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Shrnutí
Příspěvek se zabývá rekreačním potenciálem antropogenně zatížené krajiny severních Čech, jejíž nejpostiženější oblast zahrnuje okresy Chomutov, Most, Teplice a Ústí nad Labem. Těžba uhlí zde přímo ovlivňuje 2 276 km^2, ale díky dobré praxi je zde antropogenní krajina úspěšně začleňována do okolního prostředí. Kromě lesnických a zemědělských rekultivací jsou v této oblasti stále více rozšířené rekultivace hydrologické a ostatní, v rámci kterých vzniklo v této oblasti například jezero Milada a Most nebo mostecký hipodrom a autodrom. Díky rekreačně využívaným plochám dochází k resocializaci území, které bylo poškozeno těžbou. Rekultivace a revitalizace jsou důležitým nástrojem pro udržitelný rozvoj území, jelikož zohledňují ekologický, ekonomický i sociální potenciál krajiny.

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RECREATION VERSUS NATURE PROTECTION - EXAMPLE OF SELECTED ROCK STRUCTURES, VSETINSKO REGION

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Abstract
The article presents different approaches to the protection as well as different ways of recreational use of three rock structure natural monuments located within the Vsetinsko Region. However all of them are protected as natural monuments and all of them are very attractive for recreation their current natural status and recreational impact is different. The differences come especially from different combinations of the nature protection management measurements given by the management plans and their practical enforcement on one side and the pressure of visitors (esp. climbers and hikers) on the other side. Significant role in the influencing the localities play also management of surrounding landscape. Describing and clarification of the reasons determining the current status of selected localities is one of the main goal of the article.

Key words: nature protection, recreation, rock structures, Vsetinsko Region

Introduction

Nature protection in the Czech Republic faces a lot of problems at present. Some of them originated in past some of them reflects actual trends within the society. The tendencies to protect areas with some natural value using the special protected area institution can be considered to the first group of the problems. These activities were dominantly carried out in fifties and sixties years of the last century where the goal of nature protection was mostly the absolute natural conservation. That approach destroyed a lot of localities at least. After 1992 the new nature protection law was elaborated (No. 114/1992) and it meant in fact the new wave of special protected areas statement. The process was enforced after acceptance CR to be a part of EU as well. The new point in nature protection in this period was changing the understanding of nature protection from nature conservation to nature management (with the first plans of management). In the same time (latest nineties of the 20th century) the pressure to use naturally valuable localities for recreation started to increase. Preferable kind of recreation was and still is the touristic hiking but also different sport activities are increasing in their importance. One of the specific sport kind of recreation in nature is climbing which is directly bonded with natural rock areas, rock structures or open rocks.

Protection of rock natural phenomenon is generally regulated by the Act 114/1992 Col. according to §2, paragraph 1c. Rock structure can be also registered as important landscape element (§3, par. 1b) or as specially protected part of nature - geological structure (§3, par. 1h). Except of mentioned the locality with rock/geological structure can be protected also as the cave (§10), paleontology phenomenon (§11), phenomenon of landscape character (§12), temporarily protected area (§13) or on the base of European legislation implementation can be stated as the "Site of Community Importance", a part of NATURA 2000.

Materials and methods

1. Natural monument Svantovítova skála
Region: Zlinsky, district - Vsetinsky, cadastral area - Mala Bystrice, area 1 854 m^2
Established by the regulation of the District Authority Vsetin in 1999.
The object of the protection: Distinguished and aesthetic sandstone rocky massive with height close to 12m which originated in preparation from surrounding rocks during selective disintegration.
Natural monument is a part of important area of migration. It is located witin important karst and pseudo-karst region Vnejsi Zapadni Karparty (Lacina 2016c). Locality is visited by tourists. Educational trail Klenov is situated nearby. Rocks serve as the training rocks for climbers. There is also located geo-caching point somewhere there.

2. Natural monument Jarcovská kula
Region: Zlinsky, district - Vsetinsky, cadastral area - Jarcova, area 806 m^2
Established by the regulation of the District Authority Vsetin in 1999.
The object of the protection: Distinguished coarse-grained sandstone rocky massive with height close to 8m (rock tower) and other small-scale rocky elements in surrounding.
The longtime goal of nature protection: Protection of geomorphology, geology and aesthetical value of sandstone rock tower (Lacina 2016b).
The rock was in past and still is at present used as the training climbing rock. There is tracked educational touristic trail named by T.G. Masaryk in the immediate surroundings of the locality as well as marked touristic trail and the bike trail. There is also located geo-caching point somewhere in the locality.

3. Natural monument Čertovy skály
Region: Zlinsky, district - Vsetinsky, cadastral area - Lidecko, area 5 407 m^2
Established by the regulation of the District Authority Vsetin in 1966.
The object of the protection: Unique paleogenous sandstone rocky massive.
Locality is situated
The longtime goal of nature protection: Protection of geomorphology, geology and aesthetical value of sandstone rock bench (Lacina 2016a).
All the area is traditional climbing locality. In 1995 the climbing regulations as well as the establishing the climbing paths were fixed there (Pavelka, 1996).
Except of climbing also another kinds of recreation cause considerable pressure to the locality. Touristic trail is marked there as well as the educational trail Vařákovy paseky and the biking trail Hornolidečská magistrála. There is also located geo-caching point somewhere in the locality.

Results

The locality Natural Monument Svantovítova skála is simultaneously protected as a specially protected area, interested landscape element by law, stated geological locality, geo-touristic interest point and regional bio-corridor of TSES. The only practical and effective tool of nature protection there is after all the institute of the specially protected area.
Recreational utilization is reduced. Locality is relatively faraway out of touristic trails only the turn-off of educational trail is leaded there. The access to the locality takes certain physical effort and adequate time. The attractiveness of the locality might be increased by the geo-cache hidden there. More important is seasonal usage of the locality as local climbing terrain with 35 signed climbing paths. Climbing activities

cause overstepping the herbaceous communities around the particular rocks, scratching the rocks and impossibility of the development of lichens communities on the rock sites.
The locality Natural Monument Jarkovcovská kula is simultaneously protected as a specially protected area, interested landscape element by law, stated geological locality and geo-touristic interest point. Also here as in case of previous locality only the institute of the specially protected area is the practical and effective tool of nature protection there.
Recreational utilization is more significant here. Locality is relatively easy and quickly accessible from the Jarcová village. The trail of the Czech Tourist Clubs are tracked here and for one of them is the Natural Monument the target point. Also the education trail TGM is situated here. Attractiveness of the locality can be enforced by geo-cache hidden there. Climbing activities are limited here due to limited space and possibilities to climb but on the other side easy accessibility of rocks leads to using them as the training rocks. Due to mentioned the negative impact of climbing there is caused above all by scratching the rocks and impossibility of the development of lichens communities on the rock sites.
The locality Natural Monument Čertovy skály is simultaneously protected as a specially protected area, interested landscape element by law, stated geological locality, geo-touristic interest point and the protected zone of regional bio-corridor of TSES. The only practical and effective tool of nature protection there is as well as in case of previous Natural Monuments the institute of the specially protected area.
Recreational utilization of the locality is considerable and is caused by the significance of the locality on the one side and by the perfect accessibility on the other side. Very close to the locality was built parking place and opened restaurant with children playground. All the massive is surrounded by the net of paths where original herbaceous communities are overstepped. The touristic trail as well as the bike trails are tracked immediately by the massive. Locality is used also for geo-caching. The most important kind of recreation here is climbing. More than 30 climbing paths is signed there. Climbing activities cause as in previous cases before all scratching the rocks and impossibility of the development of lichens communities on the rock sites.

Discussion and conclusion

All the described localities belongs according to the Act no. 114/1992 Col. to the several regimes of nature protection. Utilization of the important landscape element institute is problematic because the forest ecosystem are protected by it not rock elements. As for using the institute of Terrestrial System of Ecological Stability (TSES) solved localities are too small to be a part of it and what more all of them are more local abnormalities than stabile landscape ecosystems normally used as the parts of TSES. The term "geological locality" has no factual importance as for nature protection. The landscape character institute could be important in case of Natural Monument Čertovy schody but only in case of so called "place of landscape character" as is used in process of territorial planning. The only practical and effective tool of nature protection in case of all the three localities is after all the institute of the specially protected area. Due to mentioned above there is a question: "Where is the general nature and landscape protection which should be a base for the protection of natural values lost?
The extent of threats or damages by the recreational and sport activities is different and reflects above all on the area and accessibility of the locality. Combination of the area and accessibility contributes significantly to the attractiveness of the locality.

When the area of the locality is bigger the space and attractiveness for recreation is higher. When the locality is better accessible the threats and damages are higher.

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Souhrn

Článek hodnotí míru zatížení rekreací tří pískovcových skalních útvarů ve Zlínském kraji, v bývalém okrese Vsetín. Všechny lokality spadají dle zákona 114/1992 Sb. do několika režimů ochrany. Využití institutu VKP je problematické, protože se vztahuje na les, nikoliv na skalní útvar. Pro využití v ÚSES se jedná o malé lokality (snad s výjimkou PP Čertovy schody), navíc jde spíše o lokální anomálie, které nejsou primárně předmětem zájmu ÚSES. Evropská soustava EECONET nemá v našem právu žádnou oporu. Samotný pojem „geologická lokalita“ nic neznamená. Až další členění na tři kategorie odhaluje, že základní ochrana je pak řešena skrz institut ZCHÚ. Institut ochrany krajinného rázu by mohl mít význam jen u PP Čertovy schody, ale pouze v případě, že by se jednalo o „místo krajinného rázu“, se kterým pracuje i územní plánování. Přitom existuje značně rozdílné nazírání na metodické vymezování tohoto institutu ochrany v rámci ČR. Účinným nástrojem ochrany je ve všech třech případech institut zvláštní ochrany přírody, a to formou MZCHÚ. Nabízí se ale otázka: „Kam se vytratila obecná ochrana přírody a krajiny?“, která by měla tvořit základ ochrany přírodních hodnot.
Míra ohrožení nebo poškození rekreačními a sportovními aktivitami je různá. Je závislá především na velikosti a přístupnosti lokality. Kombinace těchto dvou veličin vytváří ještě další – atraktivitu. Čím větší lokalita, tím více prostoru pro návštěvnost a větší odolnost. Čím lépe dostupná lokalita, tím vyšší ohrožení i reálné poškození. Čím atraktivnější (velká a dostupná) lokalita, tím větší potenciální i skutečné poškození.

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RECREATIONAL POTENTIAL OF ALLEYS AND ROWS OF TREES – CASE STUDY OF SOUTH MORAVIA REGION

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Abstract
The rows of trees and alleys full fill many functions in landscape. The most valuable (from natural and cultural point of view) elements are protected by law, other elements are neglected in the planning and conceptual practice. This state have to be changed. The first step is to undertake remedial evidence and documentation of these line elements. The inclusion of alleys and row of trees to the observed phenomena within land use planning (in form of analytical documentation) is the target state.
Currently, the database of these elements is created within each region, this article provides inter alia, an overview of the status of mapping in the Southern Moravian Region and highlights the potential use of these elements in local development.

Key words: landscape planning, landscape mapping, protection

Introduction

European landscape character is co-determined by numerous green line elements – hedgerows. We can point out its specific appearance – the alleys and rows of trees. In the Czech Republic, term *alley* has not the legislative background, a definition can be inferred just on the basis of the legislative term *row of trees*. According to Czech valid legislation (decree No.189/2013 Coll., on the trees protection and their felling authorization), the row of trees is contiguous line of at least **ten trees with regular spacing**. We can inferred alley as just such element in two or more lines. The connection to the road (any kind and level) is another fundamental premise for determination of the alley. Despite of the indisputable non-production functions of these elements, alleys and rows of trees are neglected within spatial planning. The legislative change is necessary because of the formal framework of protection, creation and care. The inclusion of alleys and row of trees to the observed phenomena within land use planning (in form of analytical documentation) is the target state.
The overview of real status in landscape is also essential. The national complex database of alleys and rows of trees is currently created. The major part of the territory of the Czech Republic is mapped out, just now the field works is going on in South Moravia Region. Mapping out of alleys is based on the methodology Dusek, Klemensová (2015) – see bellow cap. *Materials and methods*. The results of mapping work are continuously publicised as an individual thematic layer in frame of Public Administration Portal (INSPIRE managed by Ministry of the Environment of Czech Republic according to Act No. 123/1998 Coll., on access to environmental information; geoportal.gov.cz).

Materials and methods

As it was mentioned - currently the national complex database of alleys and rows of trees (include also the elements without protection) is created. The major part of the territory of the Czech Republic is mapped out, just now the field works is going on in

South Moravia Region (last unsheltered area is Region Vysočina – historical border region on Moravian and Bohemian side). Mapped parameters we can divide into two groups:

1. **quantitative data** (number of trunks, the average height of the trunk, trunk circumference average, spacing of individual strains, spacing rows of trees etc.),
2. **qualitative data** (health state of trees, completeness of rows, planting method).

For case study of South Moravian Region, the methodology is further complemented by a comparative analysis of alleys´ historical localization in the middle of the 19th century. This is found out from the maps of II. Military Survey (2nd Military Survey, Austrian State Archive/Military Archive; oldmaps.geolab.cz) and an analysis of landscape functions in the context of the territory within own scale. The result of South Moravian Region case study will be used for to create specific tool for local/regional development (educational program for Primary and Secondary Schools, bike trail around the significant alleys, proposal of new planting/renewal historical alleys etc.).

Results

Mapping of rows of trees and alleys in the Southern Region was initiated in 2016 and mapping work is still ongoing. Currently, district Brno-venkov and Vyškov are mapped completely – this paper brings out the brief evaluation and summarisation for these territories. During the year 2017 the mapping work in Znojmo, Blansko and Breclav district will be finished. The plan of further work is to map the Hodonin district. The city of Brno is earmarked of mapping.

District Brno-venkov

Within the territory of the Brno-venkov district, there are a total number of 718 elements, the largest number of these elements are located in the wider area of small town Tišnov. The majority of all elements in district are rows of trees, there are only 274 alleys. Most of these elements is located in the open countryside, 266 elements is situated in the urban area. The longest line measures almost 2,800 meters. The oldest trees have a circumference of 500 cm. One quarter of the elements has a circumference lower than 50 cm, there is evidence about new foundation of elements and about process of renewal.

The largest number of rows of trees and alleys (total 340 members) consists of deciduous ornamental trees (mostly basswood and butternut), slightly less falls on fruit trees (almost 300 members, mostly cherry and plum). Other elements are formed by a combination of mainly fruit and deciduous trees, conifers rarely then. Health state of elements is assessed almost as good or excellent. Only ten elements ware evaluated as catastrophic health condition. Majority of elements can be considered as complete (no further need of replenishment).

District Vyskov

In the district there are a total number of 224 mapped elements, most of them are rows of trees. The largest number of elements has been mapped in rural areas, surrounding the town Vyškov.

The most of elements has the character of abundant deciduous ornamental trees (dominate planting a linden and maple). The third of mapped elements are created by fruit trees (cherry and plum). There are also several elements (exactly 32) created by combination of planting deciduous ornamental and fruit trees. These are mainly old fruit avenues and alleys, which are currently mainly fed by maples. The health condition of trees was most often rated as good and excellent. Impaired

health was recorded in 17% (38) elements. No element was in a catastrophic condition. Poor health was recorded in one element.
Clearly dominated by elements that have been assessed as incomplete.

Discussion
Rows of trees and alleys are a significant elements in the landscape with respect to the performance of a wide range of functions. In the literature, these elements are most often observed in relation to their agro climatic and erosion control features. E.g. Tamang, B. et all. (2010), Spáčilová B., Středová, H. (2014), Mužíková, B. et all. (2013), Gromke, Ch., Ruck, B. (2012).
Frequent performance is also associated with hygiene functions (eg. Gromke, Ch., Blocken, B., 2015).
The connection with spatial planning and landscape values of the alley in foreign literature is mentioned very sporadically. Rows of trees and alleys are, (rather in terms of global territorial development) associated mainly with the urban environment, an essential aspect of the correlations between social preferences of the population and location of the alley. There is usually a study confirming this bond, a distinct preference for residents spaces planted with rows of trees and alleys (eg. Seymour, M., 2009; Newell, JP et all., 2013; Seymour M. Trindle, TB, 2015; Moreira, et all., 2016).
For the purposes of accepting alleys and rows of trees as important landscape features within the land use planning (based on conservation, management and the creation of new elements) in the first stage requires careful documentation of the current status, including qualitative evaluation of individual elements. In a geographically different environment, there was made similarly focused research (eg. Nagendra, H., Gopal, D., 2010). Czech initiative remains rather rare. In the Czech environment issue devoted to the nonfiction level, especially Klemensová (Dusek, Klemensová, 2015) and the scientific and research base Hendrych (2010, 2015).

The role of national protection system is crucial. In the Czech Republic, the protection of alley and rows of trees is guaranteed by Act No. 114/1992 Coll., on nature and landscape protection (as amended) in the form of memorial trees (and its groups) and in form of general territorial protection (significant landscape elements registered by authority). These values are reflected in frame of territorial *analytical* records (within spatial planning). On the other hand, within the *conceptual* planning documents on regional level the alleys are not taken into account, neither as landscape quality characteristic (as one of demand of European Landscape Convention). The situation on local level is similar.
In the Czech Republic, there are 283 elements registered (with the total number about 18,600 trunks) under the protection of Act No. 114/1992 Coll., on nature and landscape protection as groups of protected trees. Majority of these elements is located in Bohemia (predominantly in the landscape with small settlements in the wider Prague surrounding). Finally, there is located also majority of alleys with more than 100 trunks as well as the longest protected alley with the current number of trunks 542.
The second – less common – protection form is guaranteed within Act on State Cultural Care (in the central list of cultural monuments of the Czech Republic there are recorded only 5 alleys).

Conclusion

Based on the preliminary results of the mapping work (identification, documentation, evaluation and evidence) of rows of trees and alleys in the South Moravian region can be noted the great potential of these elements for local development, a large space can be seen in recreational use. Avenues and alleys provide the basis for the design of nature trails or design new cycling trails. Within the South Moravian Region are currently proposed several of these new bike trails. The basic precondition for alleys and row of trees definition is the relation to communication - the majority of elements belongs to communications II. and a lower class. This is an ideal prerequisite for the design of routes with recreational use. What is important is the link to the land use plan for eventual changes in land use proposals. Emphasis should be placed on participatory strategic planning, there is large potential for formulation of demand.

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Souhrn
Charakter evropské krajiny je spoluurčován četnými přírodními liniovými prvky. Zvláštní pozornost zaslouží jejich specifická podoba – aleje a stromořadí. Tyto prvky jsou dle platné české legislativy považovány za hodnoty krajiny, i když zde nejsou vyjádřeny v explicitní formě. V České republice se v případě alejí nejedná o legislativní pojem, jejích definici je však možné dovodit z legislativně vymezeného pojmu *stromořadí.* Stromořadí je definováno (vyhláška č. 189/2013 Sb., o ochraně dřevin a povolování jejich kácení), jako souvislá řada nejméně 10 stromů s pravidelnými rozestupy. V tomto kontextu můžeme aleje definovat jako dvě či více takovýchto linií. Dalším předpokladem pro vymezení alejí je její souvztažnost k cestě jakékoliv úrovně (viz. ČSN 83 9001 Sadovnictví a krajinářství, kde je alej definovaná jako *„dvou a víceřadé stromořadí podél komunikace")*. Problémem je malá míra zohlednění alejí a stromořadí v plánovací a koncepční praxi. Cílovým stavem je zahrnutí alejí a stromořadí mezi sledované jevy územně analytických podkladů. Příspěvek prezentuje dílčí výsledky mapování alejí a stromořadí na území Jihomoravského kraje. Mapovací práce provádějí odborní pracovníci a studenti Mendelovy univerzity v Brně. Výsledky mapování jsou průběžně publikovány jako samostatné tematické vrstvy v rámci národní databáze INSPIRE. Základem mapování alejí byla metodika dle Duška a Klemensové (2015). Mapované parametry této metodiky lze rozdělit do dvou základních skupin:
1) kvantitativní data (počet kmenů v řadě, délka aleje/stromořadí, výška průměrného kmene, rozestup jednotlivých kmenů a jednotlivých řad, obvod průměrného kmene),
2) kvantitativní data (lokalizace v zástavbě/volné krajině, druhy zastoupených dřevin, výskyt podrostu, stupeň ochrany, tvar, úplnost aleje/stromořadí a zdravotní stav, způsob výsadby ve vazbě na bezpečnost silničního provozu). Pro území Jihomoravského kraje je metodika dále doplněna o komparativní analýzu historické lokalizace v první polovině 19. století (na základě map II. vojenského mapování) a o zhodnocení krajinotvorné funkce v kontextu celkové kompozice krajiny.
Mapování alejí a stromořadí bylo zahájeno v roce 2016 a práce stále pokračují. V současné době je zmapován celý okres Brno-venkov a Vyškov. Do konce roku budou dokončeny práce na mapování okresu Znojmo, Blansko a Břeclav. V plánu dalších prací je mapování okresu Hodonín. Území města Brna je z mapování vyčleněno. Vedle průběžných výsledků mapování v Jihomoravském kraji článek poukazuje na potenciál využití těchto prvků v lokálním rozvoji.

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RECREATIONAL PREFERENCES OF OLDER ADULTS – SELECTED ASPECTS

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Abstract
For twenty five years we have been observing the process of population ageing. It is estimated that the percentage of older people in Poland in the year 2050 will exceed 40%. The factor which plays an important role in preserving psychophysical condition in this age group is the appropriate level of physical activity. The article reports the level of physical activity of the Poles aged over 60 years and examines the frequency of their activity as well as the most popular forms of active recreation. People aged over 60 years undertake physical activity several times a week (24% of respondents) and the activity lasts 0.5–1 hour at a time (39% of respondents). The most popular forms of activity include walks (70% of respondents), cycling (28%), and Nordic walking (24%). As best places for active forms of relaxation the elderly regard forests (33%), urban parks (23%), and meadows (17%).

Key words: recreation, leisure-time activity, forest

Introduction

The research conducted by the Central Statistical Office of Poland (GUS 2014) reveals that in the last twenty five years Poland's demographic growth has slowed down and the structure of age of its population has changed significantly. Poland ended 2014 with a population of 38.5 million, of which 8.5 million constituted people aged 60 years and above, accounting for more than 22% of the population, compared to 14.7% in 1989. The percentage of children and young people decreased in that period by more than 12% – from almost 30% to 18%. The process of population ageing in Poland results from three factors: increasing life expectancy, low fertility rates and a sizable outflow of young people.

In the sub-population of elderly people the largest group (nearly 1/3) constitute people aged 60-64, with significantly more women (59%). This predominance of women over men increases in more advanced age groups.

According to demographic estimates provided by GUS in 2014 and covering the period up to 2050, the following years will bring the decrease in the number of children (aged 0-14) and adults (aged 15-59), while the number of people aged 60 and above will grow. As estimated, in 2050 the percentage of older people in Poland will increase to 40.4% (13.7 million).

Over the years physical activity of humans decreases gradually as a result of the process of ageing, health state and the influence of living conditions. As shown in the last survey conducted by GUS (2016), self-assessment of health condition of older people living in Poland has slightly improved in the last 5 years. The majority of older adults assessed their health as neither good nor bad (43%), 29% as bad and very bad, and only 28% as good and very good. This self-assessment worsens with time. However, one of the conditions of healthy ageing is retaining independence. With age the percentage of people with disabilities increases, and the disabilities impair both complex activities and simple daily routines. The number of people who

need assistance in their daily activities amounts in Poland to 750 thousand. Physical activity, health and the quality of life are closely interrelated. Designed to move, the human body requires regular physical activity for optimum functioning and avoiding diseases. Physical activity requires not only exercise but also acquiring knowledge and changing bad habits. In addition, it improves perception, feelings, processes of independent thinking, creative activities, memory, concentration and attention.
Factors that significantly affect health of older people include: systematic physical activity in various forms, reducing the dietary intake of salt, smoking cessation, limiting alcohol consumption, proper nutrition, weight loss in obese (Gębka 2012). Insufficient physical activity may accelerate the process of ageing or cause degenerative changes in joints (Grzanka – Tykwińska, Kędziora-Kornatowska 2010) which in some cases are likely to cause infirmity and physical invalidity. On the other hand, regular physical exercise has a positive effect on mental performance of older people. Lampinen et al. confirm this statement and prove that mental and physical well-being at a more advanced age are closely related to physical activity. Moreover, Gębska-Kuczerowska (2002) in a survey carried out among people aged 65 and above reported that people physically active not only had better physical and mental condition, but also were less affected by cardiovascular diseases and less frequently sought hospital care. Regular physical training is beneficial for the cardiovascular system and results in positive changes in the circulatory system. Physical activity improves the functioning of the respiratory system and reduces the risk of type 2 diabetes. In the digestive system exercise may contribute to the improvement of intestinal peristalsis and reduce constipation (Gębka 2012). Regular exercise is associated with a lower risk of infections and may influence the overall medication use. In addition, Kaczmarczyk and Trafiałek pay attention to the fact that increasing the activity of older people prevents their loneliness and isolation, as well as enables them to stay independent into old age. The research conducted by Gębka (2012) confirms the positive influence of physical training on the emotional condition of women in advanced age.
As the number of older people systematically increases while their physical activity slows down the process of aging and prevents many diseases, it was decided to determine where older adults most frequently undertake physical activity and which forms of physical activity are most popular in this age group. In the future this will enable to arrange the facilities with the particular needs of the elderly in mind.

Research methodology
This article presents selected results of the survey research of recreational preferences of adults above 60 years of age. The survey was carried out in 2016 via the Internet with the use of an on-line questionnaire and by conducting interviews with older adults living in Warsaw and its surroundings.
The obtained research data were reviewed, encoded and processed for statistical purposes. Final conclusions, after the exclusion of incomplete questionnaires, were reached based on the analysis of 173 questionnaires.

Results
As previously mentioned, 173 persons were interviewed, of which 60% were women (104 persons) and 40% were men (69 persons). The largest group of 115 persons (66.5%) were people aged 66-75, 37 persons (21.4%) were aged 60-65 (this group was distinguished due to the fact that at the age of 60 women could already retire). People aged 76-85 accounted for 9.2% of all respondents (16 persons), and as few as 5 persons were older than 85 (2.9%). The interviewees were mostly residents of

towns with a total population of 100-500 thousand, accounting for 45.1% of all interviewees (78 persons), 32.4% (56 interviewees) lived in large cities (above 500 thousand people), significantly less (22 interviewees accounting for 12.7%) were from small towns (up to 100 thousand people), and 9.8% from rural areas (17 persons). More than 71.7% were pensioners (124 persons), while 21 (12.1%) were full-time employees and 28 persons (16.2%) were part-time employees or contract workers.

More than 41% (72 of all respondents) assessed their physical fitness as good, whereas 58 respondents (33.5%) considered it moderate. 19 interviewees assessed their physical fitness as very good (11%), and as few as 9 people (5%) as very poor. 15 persons claimed to have a poor level of fitness. Despite such an assessment, as many as 25% of respondents (44 persons) state that they do not undertake any kind of physical activity, similar number (42 of all respondents accounting for 24%) take part in different forms of physical activity several times a week, 33 persons (19%) engage in regular physical activity once a week, whereas 31 (18%) undertake physical activity several times a month – on an irregular basis. Only 12 of all respondents (7%) undertake physical activity on a daily basis, while 11 persons (6%) exercise only several times a year. Almost 39% of respondents (67 people) spend on physical activity from 0.5 to 1 hour, 47 respondents (27%) exercise 1-2 hours at a time. As few as 15 people spend on recreational activities up to 0.5 hour at a time, whereas 40 people (23%) confirm that they do not engage in any kind of physical activity. Two people exercise for 2-3 hours at a time and also two spend on physical activity more than 3 hours at a time.

Walking is the most popular form of physical activity for 121 of respondents (70%). Other popular forms of physical activity among older people include cycling (28% of respondents) and Nordic walking (24%). 20% of the interviewees regard gardening as the most popular form of physical activity, while 14% of all respondents practice fitness training at home or collectively in fitness rooms. None of the respondents practice jogging.

As best places for regaining physical strength people in advanced age regard natural and close to natural areas, among them forests (33% of all respondents), urban parks (23%), meadows and fields (17%). 12% of the interviewees regard sports facilities such as swimming pool or gym as a good place for the regeneration of vital forces.

Discussion

Numerous studies, including those carried out by Gębka (2012), show that physical activity is one of the most important factors favourably affecting physical condition and functional independence of elderly people, however the fitness program must take into account the overall health and capabilities of an individual. Reasons for undertaking physical activity by older people include the improvement of health and preserving condition. On the other hand, high costs of activities like for example swimming constitute an obstacle in undertaking certain types of activities, but also the lack of habit of such leisure time spending and the lack of acquaintances participating in sports activities. Active older people most frequently choose walking, exercise, cycling, swimming, jogging or hiking. The authors of hereby studies received similar results, with walking as the most frequently undertaken type of physical activity. In the vast majority of cases inactive older people concentrate on listening to the radio, watching television and reading books or newspapers [30].

Similarly, the research by the Public Opinion Research Center (CBOS) show that almost all retired people (98%) watch television in their leisure time, meet friends at

home (87%) or outside (76%), go to church (81%), listen to the radio and music (81%), read books, magazines and newspapers (80%), visit relatives outside their place of living (77%) and practice walking and hiking (73%). More than half of retired persons work in a garden or garden plot (55%); slightly lower percentage was obtained in the analysed research (20%). A large group of the elderly help their family: take care of grandchildren and great grandchildren (44%), help in housekeeping chores (34%) or in family businesses. Approximately one in three go on sightseeing tours around the country (35%), whereas half the number (17%) travel around Europe and the world.

An intensification of physical activity of older people should be pursued, and this could be achieved by means of education, although the research carried out by the Central Statistical Office of Poland (GUS) points out that older people are reluctant to gain knowledge and new skills. Another good method is appropriate site adaptation, which takes account of the needs and expectations of older people. According to the research results places which are most suitable for the regeneration of vital forces include natural and close to natural areas. Therefore it becomes important to recognise these opinions and consider them in designing recreational spaces in forests, urban parks etc.

Conclusion

1. The number of elderly people in Poland is increasing.
2. Physical activity favourably affects psychophysical condition of humans, also in older age.
3. More than 40% of older people do not undertake any form of physical activity.
4. People in older age who do practice active forms of relaxation devote 0.5-1 h to this activity.
5. The most popular forms of physical activities carried out by older adults include walking, cycling and Nordic walking.
6. Natural areas, as places which older people preferably choose for their relaxation, should meet the needs of this age group.

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Souhrn

Během dvaceti let jsme prováděli pozorování v oblasti stárnutí populace. Odhaduje se, že podíl starších lidí v Polsku v roce 2050 bude vyšší než 40 %. Fyzická aktivita hraje důležitou roli při zachování psychologické kondice. Aktivní odpočinek nejen zpomaluje proces stárnutí, ale také brání vzniku mnoha nemocí oběhového,

dýchacího a pohybového systému. Bohužel velké procento lidí v pokročilém věku už neprovozují žádnou formu fyzické aktivity. Proto je zásadní se zaměřit na rekreační preference starších lidí. Lidé ve věku nad 60 let provádějí různé fyzické aktivity několikrát týdně (celkem 24 % respondentů), 0,5 – 1 hodinu v kuse (39 % respondentů). Mezi nejoblibenější formy aktivního trávení volného času patří procházky (70 % respondentů), jízda na kole (28 %) a nordická turistika (24 %). Jako nejvhodnější místa pro provozování aktivních forem rekreace u starších lidí jsou považována: lesní prostředí, městské parky a louky (33 %, 23 % a 17 % v uvedeném pořadí).

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RECREATIONAL USE OF MUNICIPAL FORESTS IN KOŠICE

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Abstract
The interest to use suburban forests by city residents for recreational purposes is currently growing. Significant feature of forest management with its recreational function is to create an aesthetic forest environment and conditions that can meet requirements of visitors while maintaining the forest its natural production function. This paper deals with the solution how to make forests accessible and to develop their recreational purposes. Our area of interest is located at the Municipal Forests of Košice. Forest accessibility of the given territory and the present use of recreational facilities in this area was mapped and analyzed by field work. The research detected that the area is well equipped by a forest road network (total length 50.3 km, density 25.8 $m.ha^{-1}$). The status of the territory in terms of recreational use is of high quality. Based on the review of the presented results, there have been recommended several another routes and facilities for various forms of recreation, which give the area better value. The total length of recommended trails in the area is 33 km. There are various proposals to be considered to increase the attractiveness of the area of interest.

Key words: tourism, suburban forests, recreation, forest accessibility

Introduction

The aim of forest management in municipal and recreation forests is to create optimum conditions for recreation while maintaining forest production qualities and eliminate negative impact of recreational activities in forests to minimum.
The most important tool to regulate and to practice physical activities in forest environment visitors is a forest road system.
Direct contact with forest and continual development of urban zone with forested area creates an exceptional environment for the town of Košice within Slovakia as well as in Central Europe. Forest accessibility has conditioned quite a long tradition of the use of surrounding forests for short-term recreational, medical and sport use by the town citizens and its visitors.
The aim of the paper based on the analysis of the present state of accessibility and recreational use of municipal forests of Košice, particularly the interest area of Čermeľ, is to design perspectives for its further development and to increase its recreational function.

Materials and methods

The researched area of the Municipal Forests of Košice is with its total area of 18, 984 ha the largest forest property in Slovakia. These forests together with its management function perform mostly their extra-production functions (83%). The ratio of the forests of specific definition in sub-category of municipal forests with priority of medical, cultural and recreational function of Košice forests counts for almost ¼ of the whole area (23%). Majority of this area is part of the Slovak Rudohorie mountain range and the minor, southern part is part of Lučenecko-

košická lowlands. From the point of view of higher management – regulation units, the forest property of Košice is divided into nine forest areas (http://www.meleskosice.sk/).
Our research was conducted in the forest unit Čermeľ, which is together with the forest park the most significant recreation area of the second largest town in Slovakia. Due to its locality and easy access from the town as well as its pleasant natural environment away from the town traffic, it is the centre of majority of recreational activities. Forest unit Čermeľ spreads on the area of 1, 951 ha, while ⅓ its total area is the Košice Forest Park. The ratio of the LC area accounting for recreational function represents 36%.
In our methodology we focused on terrain data collection, mainly mapping of traffic accessibility and its use for recreation and next on the further development and new design of the interest area. Traffic accessibility was mapped according to technical standard STN 736801 Forest Traffic Network. Evaluation of the technical state of the traffic network focused on the possibilities of its use for various types of tourist trails and these were consulted with the KLČ, KRÁLIK (1991) methodology. For aesthetic attraction and aesthetic facilities of the forest roads was used KLČ, ŽÁČEK (2008) methodology.
Part of the terrain research was also mapping of the existing tourist and physical activities as well as specifying the research further potential of the area. Based on the field research results we designed the proposal for the use of function area, tourist trails, including also small buildings of recreational character. The proposed trails were designed by the software Bicycle Routes 2.40. Conceptual designs of functional areas, minor buildings of recreational character were designed by 2D/3D system ArchiCAD 18 application. Visualisation was realised by Artlantis Studio 5 programme. Map appendixes depicting traffic access and recreational use of the area were designed in software ArcGIS environment.

Results and discussion
Traffic accessibility of the interest area can be defined by favourable indicators (Table 1). Altogether there are 27 routes with the total length of 50.3 km that represents the density of route network of 25.8 $m.ha^{-1}$. There are mostly forest roads; in the area there is also a state road of 2nd class – II/547 (8.1 km) and a local approach road (0.8 km). Positive fact is also its qualitative attribute. Transport forest roads and other roads that are of bitumen or gravel finishing count for ⅔ of all roads. We can state that company of Municipal Forests Košice Plc. maintains the quality of forest road network as this is considered to be positive. None of the roads is in rather bad condition; actually 85% of all roads are in excellent or good condition. Quantity and quality of road network gives a good precondition for its efficient use and also for recreational purposes.
The area of interest can be characterised as highly attractive for recreation as it is equipped by recreational facilities and has a considerable tourism potential. The highest concentration of tourists is in recreation areas of Alpinka and Hrešná cottage, or in the area of commercial cottages Diana and Hlinné. Tourist trails and bicycle routes are frequently used too. The advantage of the municipal forests is their accessibility from the town centre (ca. 6 km).

Tab. 1: Categories and road density in the area of interest

roads	category	length [m]	ratio [%]	density [m.ha^{-1}]
forest (own)	1L	11,100	22.1	6.68
	2L	13,165	26.2	6.74
	3L + TPC	17,110	34.0	8.76
other	state	8,100	16.1	4.15
	local	800	1.6	0.45
total		50,275	100.0	25.8

Alpinka is a recreational centre of all year-round operation situated in pleasant forest environment. During summer it hosts a variety of events. It is equipped by different facilities and attractions such as:

- Restaurant with summer terrace, buffets with refreshments;
- Children's playground;
- Rope climbing park Tanzánia consisting of three routes of 32 different obstacles placed in different heights;
- Paintball and airsoft playground of 10,000 m^2 with 60 obstacles;
- Golf course of 14 ha;
- Final stop of the historical narrow gauge children's railroad which is a unique historical monument and the oldest functioning steam powered locomotive in former Czechoslovakia;
- Nature touristic trail „Chodník zvedavých myšiek" (Trail of Curious Mice) is 1,500 m long and offers a lot of information about nature to the smallest visitors;
- The area is crossed by many tourist trails and cycle routes (http://www.alpinkakosice.sk/).

Chata Hrešná is a tourist cottage with a buffet and a tea room situated at the top of ski lift of the ski resort Kavečany. It offers a variety of services both during summer and winter seasons. It hosts many various sport events (Kavečiansky pedal, forest run, ping-pong tournament, football tournament), entertainment events (tea festival, country show, Moltan fest, evening open air cinema), or events of educational character (lectures and film shows, travellers documents, etc.). There are also horse stables, with riding possibilities, various small recreational buildings for accommodation or of an information character (shelters, barbeque spots, open air picnic places, information boards, orientation directions). Except a ski resort there are also many cross-country skiing tracks and hiking trails, or bicycle routs.

In the researched area there are also many interesting spots of a natural character, which are frequently visited and accessible by tourist trails, e.g. Vysoký vrch (mountain) with nature preserve serving as protection area of virgin forests fir beech wood, Biela skala (rock) with a variety of precious and protected plant species, Poľana with isolated grass meadow stand of endangered plant species, nature touristic trail Vrabčie skaly (rocks) focusing on bird habitat or caves (Krížová cave, Previsová cave, Veľká sokoľská cave).

As for the line tourist trails the research area offers very good possibilities for tourists. There are 5 marked hiking trails, including a trail of European character (E8) of the total length of 31.5 km, 3 bicycle routes of 32.4 km and during winter season also 4 cross-country skiing tracks of total 14.0 km. Each track is well marked with a high level of information elements (Table 2, Pic. 1).

Tab. 2: Characteristics of marked hiking trails

	Route No.	Route identification	length (km)	elevation (m)	gradient (%)	difficulty
Tourist/ hiking trail	0901	fork Hrešná - saddleback Repy (E8)	6.3	223	4	medium
	2815	Alpinka - saddleback Repy	7.7	498	6,5	medium
	5741	Čermeľská hollow - fork Hrešná - Diana	7.4	305	4	medium
	8724	Stará Jahodná - Čermeľská walley fork	2.3	150	6,5	easy
	5715	Stará Jahodná - saddleback Repy	7.8	313	4	medium
Bicycle route	1	Alpinka - Nemcova dolka – Alpinka	24.1	390	1,6	medium
	1a	Hlinné – Gajdošova	2.8	170	6,1	medium
	2	fork Kavečany - Kráľova studňa	5.5	135	2,5	medium
Cross-country skiing track	1	Hrešná - saddleback 0901 trail and back	2.0	54	3	easy
	2	Hrešná - Janošová meadow and back	3.0	54	2,7	easy
	3	Hrešná - before turning Krížna and back	4.0	58	1,5	medium
	4	Hrešná - Krížna meadow and back	5.0	63	1,3	medium

The design proposal for increased recreational use of the area comes from good potential of the surrounding forests and well equipped area by recreational elements. To make the area even more attractive we suggest 3 new starting points, bicycle route, in-line trail, 4 horse riding routes, forest trainer track, and 2 rest areas (Pic.1).

Starting points were designed in the following localities: fork Kráľová studňa, cottage Hrešná and Alpinka Centre as starting points for the proposed trails. We took into consideration the existing trails and their location to be possible as starting points for the suggested trails, accessibility by transport vehicles or parking spaces for longer periods of time. We planned also a parking lot and smaller buildings of recreational character.

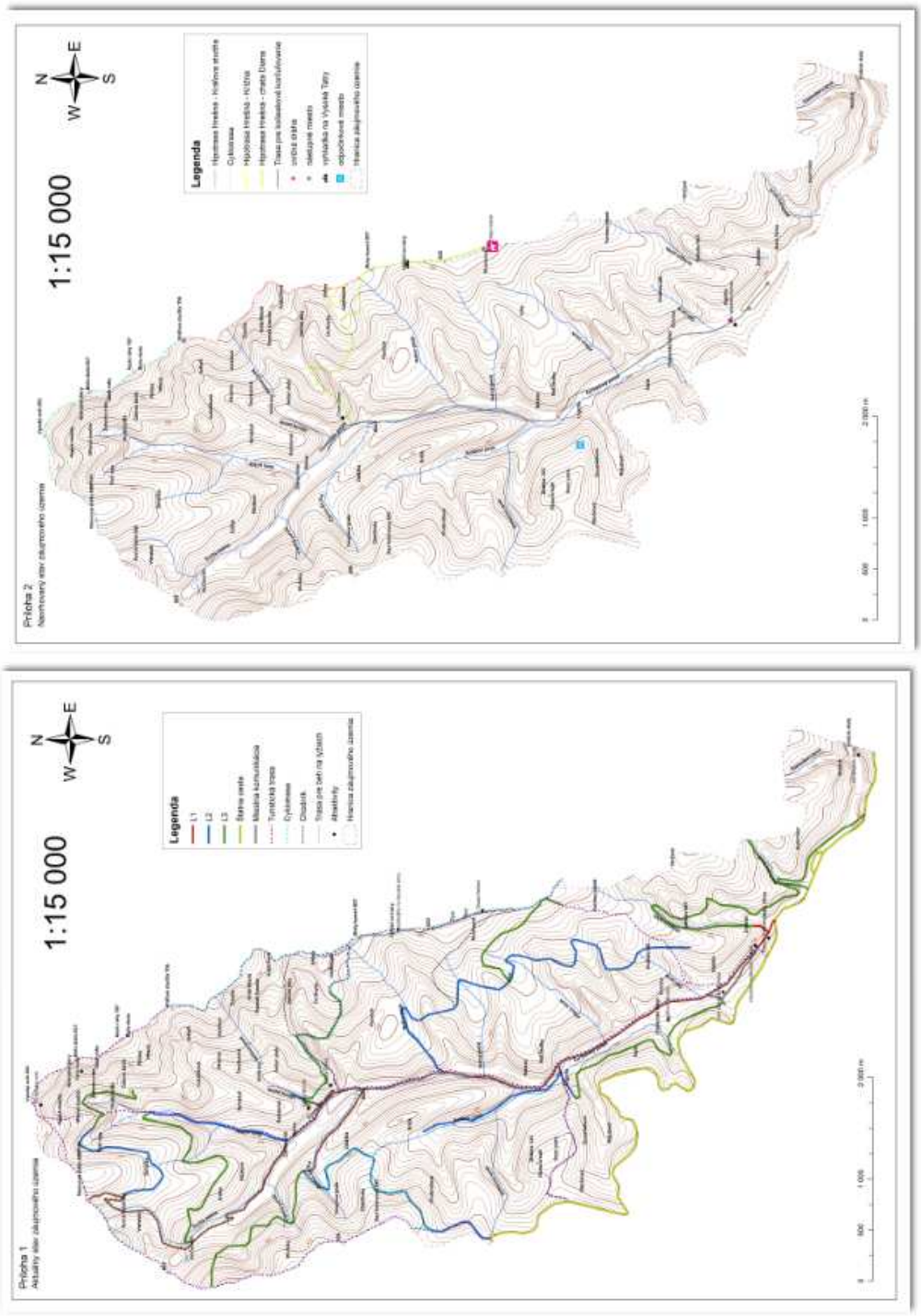

Fig. 1: Maps of the area of interest

Bicycle route – as there are plenty of existing bicycle routes we designed one new route that would connect two already existing routes (1 and 2). The route leads from Kráľová studňa leading up to the saddleback Repy and then further down below Vysoký vrch to Nemcová dolka (Pic.1). Route parameters are following: length 3.54 km, elevation 120 m, total time 20 minutes, average uphill gradient 5.5% and downhill gradient 8.4%.

In-line route – since the routes for in-line skaters were absent, there was suggested a two-way route Alpinka – fork at Hlinné cottage (pic.1). The proposed route uses forest road of 1st class, main valley bitumen route of Čermeľská dolina (valley), which has been recently reconstructed. The quality and gradient ratio of the road are suitable for the proposed use of the road. The parameters of the road are: length 4.8 km, elevation 110 m, gradient 2.5% total time 30 minutes, average uphill gradient 2.5% and downhill gradient 1.3%. The use of the route is multiple, not only for sport such as in-line skating, running, jogging, hiking but also as a family route for family walks.

Horse riding routes – as the cottage Hrešná offers walks to nature on horses without existing and marked routes there were suggested 4 different horse riding routes. Based on the requests of visitors these are designed for short rides as circle riding routes where both starting and finishing point is at horse stables at Hrešná cottage. Design of the routes comes from the basic route which is connected to other routes (Table 3).

Tab. 3: Design of horse riding routes

Route No.	Route identification	length (km)	difficulty	time (h)
1	Hrešná – Janošova meadow and back	3.6	easy	0:45
2	Hrešná – Janošova meadow – Krížna meadow and back	4.8	medium	1:00
3	Hrešná – Janošová meadow – fork at Kráľová studňa and back	7.8	medium	2:00
4	Hrešná – Janošova meadow – Diana cottage and back	8.5	medium	1:45

Forest trainer track is designed close to Alpinka centre at meadow complex. It focuses on those visitors who use natural environment to improve their physical fitness. We suggest six different stops equipped by exercise gear. The proposal for the arrangement of each exercise point is to gradually focus on all muscle parts while the sequence of exercises is not determining. It is possible to choose one's own sequence and number of exercises at each stop depending on individual abilities and capacities. Similar trainer tracks are built and intensively used also in urban parts of Košice.

Rest areas are designed at places where majority of visitors gather and there is absence of smaller buildings of recreational character. We proposed two areas, one at the existing tourist trail no. 8724 and one at scenic vista to the High -Tatras, situated approximately 800 m from cottage Hrešná, where is also the bicycle route no.2 and the hiking trail E8. The project includes small buildings of recreational character such as shelter with sitting capacity, information board and orientation directions.