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MENDEL UNIVERSITY IN BRNO

Czech Society of Landscape Engineers

and

Department of Landscape Management
Faculty of Forestry and Wood Technology
Mendel University in Brno

Public recreation and landscape protection – with nature hand in hand?

Conference proceeding

Editors: Ing. Jitka Fialová, MSc., Ph.D.; Dana Pernicová

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ARE FORESTS PLANTED ON COAL MINE RECLAMATION SITES PREFERRED TO FOREST GROWTH FORMED IN SUCCESSION PROCESS?

Markéta Braun Kohlová, Jan Melichar
Charles University Environment Center, José Martího 2/407, 162 00 Praha 6, Czech Republic

Abstract
Large scale reclamation of landscape affected by surface coal mining has taken place for more than 50 years. Forest areas were established, however their visiting rates are rather low. People are not interested spending their time in reclaimed forests, despite the facts that they are located in vicinity of cities and that forest ecosystems are perceived positively by people all over Europe. We therefore investigate how the visual difference that is given by the process of creation, subsequent care and rather young age of growth of reclaimed forests explains the rather low attractiveness of these areas. Our study of preferences towards forests typical for reclamation of Sokolov post-mining landscape therefore focuses on visual characteristics of forest growths of different age with the aim to compare basic sites created either as forest reclamations or formed spontaneously in the process of succession. The environmental preferences are examined in the context of recreation; we conceptualize them as attitudes towards recreation in certain environment and measure in an on-line survey by means of visual representations. Environmental preferences significantly differ according to the type of reclamation, i.e. tree species planted or spontaneously growing on the dumps. The attractiveness of succession forests considerably increases with its age.

Key words: environmental preference, forest reclamation, surface coal mines reclamation, succession

Introduction

Post-mining landscape is a striking example of how deeply human activities change the environment and its aesthetical value. Previous empirical applications of theories of landscape aesthetics (e.g. Kaplan &Kaplan, 1989; Tveit et al. 2006) have confirmed detrimental effect of mining features and positive effect of the proportion of forest vegetation (Svobodová et al., 2012) on the attractiveness of post-mining landscape. Whereas the environmental preferences have been investigated in the extent of landscape, i.e. large scale (e.g. Sklenička and Molnarova, 2010; Svobodová et al., 2012), to our best knowledge, the effects of visual characteristics of various vegetation growth on small scale patches on dumps, which is the usual object of reclamation management in landscapes changed by human activities, have not been yet documented.

The objective of this paper is to explore how differences given by the process of creation of forests on the dumps, subsequent care and rather young age of growth explains preferences towards various types of forests that have been created in the Sokolov region.

Materials and methods

We have investigated the characteristics i) given by the process of creation of the forest and the subsequent care and therefore typically to be found in the Sokolov region and ii) assumed to affect environmental preferences (e.g. Ode et al., 2009;

Tveit et al. 2006). The terrain for reclaimed forest on dumps had been typically first straightened out, one tree species (spruce, pine, larch or alder) planted densely with rather unsystematic subsequent care which creates homogenous forest where the growth of trees is limited due to dense tree planting. Contrarily, succession forest came into existence on the terrain that had been formed by conveyor belt and is wavy; composition of tree species is diverse (including sallow, spruce or birch) and vegetation is rather thin. In addition the age of trees to be found in Sokolov is limited to 55 years which affects the maximum height of trunks in the area.

To evaluate the effect of some of the above described characteristics, the environmental preferences for 6 selected forest growths typical for the region are explored: 2 pine and alder reclamation forests (both in age of 35 years), 3 types of forest growths formed spontaneously in the process of succession (3 age levels), and the last category representing a reference planted spruce forest. These particular forests were selected for our study based on: judgements of experts as ecosystems typical for forest reclamation in Sokolov region; a field study of visual characteristics of forests in the area and state-of-the-art on effects of visual features on environmental preferences. The three age levels used in this study (15, 35 and 55 years) correspond to different phases of creation of dumps and their reclamation.

Each of the evaluated reclamation and succession forest growths were represented in the questionnaire by a quartet of colour photographs. The employment of photographs as valid and adequate stimuli for evaluation of environmental preferences was documented e.g. by Palmer and Hoffman (2001). The quartet of photographs was used in order to show natural diversity of the forest type and to minimise well documented effects of striking elements that may affect the valuation based on a single photograph (cf. De la Fuente De Val et al., 2006; Tveit et al., 2006). The forest was photographed from inside of the vegetation so that it shows rather homogenous vegetation to minimize the effect of path surface on the preferences. Figure 1 shows examples of photos of 35-years-old pine reclamation and succession forest in age 15 and 55 years. The characteristics of forest types used in the survey are summarized in Table 1.

Fig. 1: Examples of photographs (from left to right: Pine reclamation 35 years, Spontaneous succession - Wave 1 - 15 years, Spontaneous succession - Birch - 55 years)

Conceptual model

In our study, environmental preferences are examined in the context of recreation. We conceptualize them as attitudes towards recreation in certain environment, precisely as a one hour walk on a pathway in the forest displayed on the quartet of photographs. Walking for one hour as reference frame for environmental preference was chosen as it is possible in all the types of environments and usually does not require special physical abilities, knowledge or attention (cf. Purcell, Lamb, Person and Falchero, 1994; Hartig a Staats, 2006). To analyze the environmental

preferences of individuals stated in response to the photographs displaying the particular forest type and question *"How attractive would it be for you to walk one hour on the pathway in this forest"*, we assume that the stated preference reflects its visual characteristics and preferences of individual with certain experience and socio-demographic characteristics. Environmental preference was measured on a 5-point scale ranging from – 2 (not at all attractive) to 2 (very attractive).

Data

In order to evaluate the effect of characteristics of forest growths on environmental preferences, a survey was used (N=773). To be able to control for familiarity with forests growing in a post-mining landscape, respondents were quota sampled to 4 strata: i) urban population on the edge of dumps (from cities of Sokolov, Chodov and Nové Sedlo), ii) rural population on the edge of dumps, iii) remaining rural population of Karlovy Vary region and iv) Central Bohemian region (except for Prague). The resulting sample comprises 307 inhabitants of Sokolov county, 231 inhabitants from counties Cheb and Karlovy Vary and a control group (N = 235) of inhabitants of Central Bohemia region. The data were collected in 2016 by survey agency SC&C. Since there were no significant differences between urban and rural population of Sokolov county, both sub-samples were collapsed into one in the subsequent analysis.

The survey involved: i) an evaluation of selected 6 forest growths typical for Sokolov post-mining landscape with respect to five visual characteristics (permeability, naturalness, care, familiarity and danger), ii) a rating scenario where attractiveness of the same types of forest growth for a short walk were evaluated, iii) Discrete Choice Experiment with 8 binary choices of localities for hypothetical leisure visit (not described in this study), iv) socio-demographics and v) scale measuring place attachment to Sokolov region.

Results

The environmental preference stated by respondents vary according to the type of forest growth and the place of respondent's residence. As can be seen in Table 1, the attractiveness does not differ systematically between reclaimed and spontaneously growing succession forests, but depends largely on the type of reclamation or succession and the age of forest growths. Whereas pine reclamation is considered attractive (positive rating $M_{pine} = 0.39$), the alder reclamation is rated most negatively ($M_{alder} = -0.81$) from all the valued forest types. The attractiveness of the spontaneously growing succession forest significantly increases with the age of the growth. It's rating is negative ($M_{wave1} = -0.02$) for 15 years old succession on the original waves, positive ($M_{wave2} = 0.17$) and significantly higher in 35 year ($t(750.96) = -4.513$, $p < .000$) and even more attractive in the age of 55 years, when mixed forest with birches spontaneously come into existence ($M_{birch} = 0.49$; $t(403) = -4{,}968$, $p < .000$). This type of most mature succession forest (55 years) is even more attractive for recreation than pine reclamation in the age of 35 years ($t(772) = 2.12$, $p = .034$). However, none of the evaluated forest in the Sokolov post-mining landscape is as attractive as the reference spruce planted forest in the reference locality Libavske valley ($M_{spruce} = 1$; $t(772) = 9.436$, $p < .000$).

Tab. 1: Forest types, their characteristics and average attractiveness rating in the survey

Label	Characteristics	Age of growth of visual representation	Average attractiveness (St. Dev.)
Spruce	Common forest in a locality not affected by surface coal mining	75 years	***1.00 (0.041)***
Birch	Spontaneous forest grown on a dump (not straighten out)	55 years	***0.49 (0.038)***
Alder	Reclaimed forest growths on a dump	35 years	***-0.81 (0.043)***
Pine	Reclaimed forest growths on a dump	35 years	***0.39 (0.039)***
Wave 1	Spontaneous forest grown on a dump (not straighten out)	15 years	***-0.02 (0.044)***
Wave 2	Spontaneous forest grown on a dump (not straighten out)	35 years	***0.17 (0.058)***

How the most affected population of Sokolov evaluates the forests to be found in its proximity?

Environmental preferences of the affected population (from Sokolov county) significantly differ for three types of forests to be found on dumps, namely pine (in the age of 35 years) and two younger age categories of succession forest (15 and 35 year old) from the control sample of Central Bohemia. People from Sokolov find pine forest reclamation significantly less attractive than the control population from Central Bohemia ($M_{Sokolov}$ = 0.36; $M_{C.Boh.}$ = 0.57; F (2,770) = 5.228, p = 0.006). Interestingly, the pine reclamation valued by the population of Karlovy Vary region that is not directly affected by mining is even less attractive ($M_{K.Vary}$ = 0.26). Also the attractiveness of two younger succession forests (Wave 1 and Wave 2) is significantly lower in Sokolov population than in the control population (for wave 1: $M_{Sokolov}$ = -0.17; $M_{C.Boh.}$ = 0.06, $M_{K.Vary}$ = 0.09; F(2, 770) = 3.77, p.0.023; for wave 2: $M_{Sokolov}$ = 0.00; $M_{C.Boh.}$ = 0.23, $M_{K.Vary}$ = 0.29; F(2, 401) = 2.438, p=0.089). The population of Karlovy Vary region values both younger age categories of succession forests even higher than population of Central Bohemia. Importantly, the Sokolov population differ neither in preferences towards the planted spruce forest, or generally positively valued the 55 year old succession forest (birch) and alder reclamation that is generally little attractive.

The s*ocio-demographic* characteristics of respondents did not significantly affect the stated attractiveness of the evaluated forests. One of the variables that explains the observed lower attractiveness of reclaimed and succession forest in Sokolov population is the employment in mining and reclamation sector; however, this effect is not consistent over all evaluated forest types.

Discussion

The results indicate a rather complex relationship between visual characteristics of reclaimed forest and their attractiveness for both people living in their proximity and both control populations. People from the immediate vicinity of the dumps evaluate some (not all) types of forest that are typically to be found there as less attractive

than people in the Central Bohemia region. However, the average ranking of the evaluated forest types remains in all investigated population more or less the same; the planted spruce forest being the most attractive and the alder reclamation the least attractive forest type. In any case, higher familiarity, measured here for simplicity by the county of residence, does not contribute to a higher attractiveness of the environment as is suggested by literature (e.g. Kaplan & Kaplan, 1989). It indicates that the positive effect of familiarity of the environment on its attractiveness might be limited to nature resembling forests. The relationship of the familiarity of environment deeply affected by anthropogenic changes and its attractiveness requires further investigation.

Conclusion

The results have shown that environmental preferences towards forest growth in post-mining landscape considerably differ according to the type of forest growth, i.e. the type of tree species either planted or spontaneously growing on the reclaimed site and the age of the forest. The attractiveness of succession forest considerably increases with its age, being comparably attractive with generally popular coniferous forest in the age of 55 years. The environmental preferences differ also according to the place of residence of the respondent. People living in the vicinity of the dumps where the evaluated reclaimed and succession forest exist find them more familiar but less attractive than people from the control population of Central Bohemia region. This difference cannot be explained by differences in socio-demographic structure of the affected population since no socio-demographic indicators have significant effect on the perceived attractiveness of the reclaimed forest.

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Souhrn
V článku prezentujeme první výsledky studie preferencí k vizuálním aspektům porostů nacházejících se na rekultivovaných výsypkách na Sokolovsku. Analýza zahrnuje šest typů porostu včetně řízené lesnické rekultivace, spontánní sukcese různého věku a kontrolního porostu (vzrostlý smrkový les). Výsledky prokazují, že atraktivita sukcesního porostu se zvyšuje s věkem porostu, a také, že preference respondentů se liší podle jejich bydliště - lidé žijící v blízkosti výsypek vnímají sukcesní porosty jako relativně známější, avšak méně atraktivní než jak jsou tyto porosty vnímány kontrolní populací Středočeského kraje.

Contact:
Mgr. Markéta Braun Kohlová, PhD.
E-mail: marketa.braun.kohlova@czp.cuni.cz

ASSESMENTS OF STREAMFLOW CONDITIONS IN FOREST WATERSHED

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

Abstract
Microwatershed coud be characterized as highlands forest catchement area showing relatively identical morphology and different dominant tree species in the forest stands. There are presented three forest microwatersheds: dominated by oak, spruce (the proportion of listed trees is above 40%) and mixed.
Low ability to maintain a balanced flow occurs in the watershed Ušákov. The flow decreased the lowest of all measured in May when the precipitations are weak. The value of the average flow rate is 0,52 l/s. Microwatershed Křtiny (spruce) and Kanice (mixed) are relatively stable. Their effectiveness varies in response to increased precipitation at the end of May and mid-July, when spruce watershed reacts with the highest flow. Both watersheds have higher water management efficiency in the weaker precipitations period than Ušákov.

Key words: streamflow, microwatershed, forest, catchment area, recipient

Introduction

The experiments in forest microwatershed have been a long-term use research method to evaluate the impact of forest management on run-off from the watershed (Brown et al., 2005). For evaluate changes mentioned below comparative watershed with similar natural conditions and dimensions are used, but the vegetation cover. Experiments were performed previously under different types of forestry interventions - afforestation, deforestation, rengeneration and transfers (Brown et al., 2005). Flow assessment in the beds of small streams is an important method for assessing the overall state of the watershed and assessment of climate change impacts on these ecosystems (Arthington et al. 2010). In the Czech Republic these experiments are traditionally concentrated mainly in mountainous regions in the Krkonoše Mountains, Beskydy, Šumava etc. These observations are often long-term (20+ years), enabling evaluation of the impact of forestry interventions in the stands for the total amount of runoff and a prediction of precisely the impact of climate change on the hydrology of the area eventually the dynamics occurrence of critical elements such as sulfur and nitrogen (Fottová, 2003). Beyond mountain areas that have compared with highlands specific hydrology are rather rare published results (Deutscher a Kupec, 2014; Deutscher et al., 2016). In Central Europe, this includes the work from Hungary (Szilagyi et al., 2008).

Materials and methods

The experiment was carried out at three forested microwatersheds: Křtiny, Kanice, a Ušákov. The critical factors for microwatersheds selection were size, relatively equal geomorphology and various dominant tree species represented in forests. The aim of a study was to stabilize the microwatershed always dominated by a different tree species (limited by natural conditions of Uplands). The following classification was used for the description of the dominance of trees in species composition: the main tree species (relatively represented by more than 40%), mixed (10% - 30%) and and disseminated (up to 10%). Thus, microwatershed Křtiny is dominated by spruce,

Útěchov is dominated by beech, Ušákov is dominated by oak and finally Kanice as a reference microwatershed dominated by mixed forest stands (Kupec, 2015). The studied sites are briefly described below.

Materials

Microwatershed Křtiny

It is the third largest watershed with area of 57 ha and with the largest maximum altitude of 563 m above sea level. The average altitude is 521 m above sea level. Watershed is oriented towards the east and the slope is 21%. Spruce is the most common tree species there. There are four wards and with 52 forest stands. 50 years old stands are represented with 30.8%. Stands up to seven years of age are 7. Thicket and small pole stand with the necessity of thinning, they contained most i.e. 55.8%. There are stands with full tree species representation of a perfect canopy The watershed is represented by more than 10 different tree species in various mixed forms.

Microwatershed Kanice

This is a watershed with the area of 65 hectares and with a fan-shape (0.32). The average altitude is 341 m above sea level. The length of the main stream is 640 m. The density of afforestation is 98%. There is represented by 53 forest stands divided into 4 sections. Stands the age of 50 years or more represented 22.6%. stands of to seven years (inclusive) are only 3. Thicket and small pole stand with the necessity of thinning are on 72%. The watershed is represented by more than 10 different tree species in various mixed forms.

Microwatershed Ušákov

It is the largest microwatershed with an area of 82 ha. The length of the main stream is 1850 m. Located at the southernmost territory of ŠLP. The main tree species is pedunculate oak on 38% of area. The most represented are stands over 50 years. Stands of first age class are represented 8%. Thicket and small pole stand with the necessity of thinning, they contained 19%. The watershed is represented by more than 10 different tree species in various mixed forms.

Methods

Flow Measurement

A continuous flow determination in forest recipient watersheds was carried out using the system for measuring heights levels in the closing profile of the recipient Each system includes mask of Thompson-type weir and immersion level pressure sensor. Current flows were recorded at 15 min intervals based on level heights measurements every 15 minutes and automatic data logging. Correlation between the height of the overflow jet above and streamflow in basin above the overflow is exponential. Comparison of stream flow trends, especially its diameters is partial result of this study. Flow rates are calculated by modified equations for calculating the flow above the Thomson-type weir:

$$Q = 1.4252 * h^{2.48515} * 0.01 \quad (1)$$

Q - flow rate (l/s)

h - height of the above overflow jet (cm)

Sensor calibration was necessary during installation or maintenance of measuring devices. The verifications of data record and manual measurements of level above the overflow was carried out every 14 days. The current measured values have to

be entered using the software MOST in case that the data are different from the actual level above the overflow. Hydro Logger H40D (Fiedler-Magr) measures with an accuracy of 1%.

Climatological data measurement

For the measurement of basic climatic variables (temperature [° C], and total precipitation [mm]) were used semiprofessional climatic stations from AMET company. Temperature measurement was carried out 2 m above the ground. Temperature data were recorded at 15 minute intervals. Only the rain precipitation were recorded in climatic station. Watershed are located within a radius of max. 5 km from the meteorological station The measured values were used as input climatic characteristics for all surveyed watersheds.

Data processing

Data collection was followed by the creation of a database of low rates, precipitation and temperature at one time series. This time series describes the period from 1 April 2016 to 30 August 2016. Further, elimination of systematic errors was carried out (i.e. continuous increase of material caused by the clogging of the mask). Thus, from the modified data average flows in the recipients were determined by using pivot tables.

Results

Climatic characteristics

The mean temperatures measured at stations Dykova školka, Bílovice and Arboretum Řícmanice in 15 minutes intervals during the period from 4. 4. 2016- 30. 8. 2016 are in the range between 15-16 ° C. In the Czech Republic, the daily average value of the period is 14,79°C according ČHMU(portal.chmi.cz). The average daily temperature for the South Moravia region in this period is 16.24 °C (portal.chmi.cz). The temperature in the JHK and ŠLP Křtiny is slightly above average in the Czech Republic.

The total amount of precipitation in ŠLP Křtiny is 319.74 mm and in JHK 308 mm. In comparison with the average throughout the Czech Republic (336 mm), the measured values are slightly below the average. More than 1/3 of all precipitation in the period appears in July.

The representation of temperature and precipitation development throughout the period is illustrated in the graph Fig. no. 2 and 3. Klimadiagram was created as daily averages of all three test sites on the territory of ŠLP Křtinyperiods for a closer description of the trends of flow rates can be identified More precisely by using the klimadiagram. The largest daily total precipitation was mesasured in Bílovice 31stof July with a value of 59 mm. Fig. no. 3 and no. 4 shows that the largest total precipitation were recorded in July.

Flow characteristics 4. 4. 2016 – 30. 8. 2016

Data modified according to the methodology are presented in daily averages. Characteristics within each watershed are shown in Fig. no. 5. The average flow of watersheds in Křtiny and Ušákov are even. The highest daily average value is recorded in Ušákov, almost twice as higher than the other. This may be caused by the shape of watershed or tree species representation. The largest flow fluctuation is recorded in Ušákov, where sand clogging of recipient frequently occurs. On the contrary maximum stability in the reporting period has Kanice watershed.

Discussion

The data will be evaluated as daily averages in two selected months. In terms of precipitation, May is the weakest month compared with July as the wealthiest. Trends in comparison with the average flow for the period will be analyzed. The table below describes the flow characteristics in a given period. Flow fluctuation in Ušákov i salso apparent in the table.

Figure 6 and 7 presents course of average daily flow in each wateshed recepients. There is a noticeable decrease in the flows in the season with weaker precipitations especially in Ušákov watershed. The fastest decreased flow is in Křtiny when the flow rate value decreased of 1.8 l / sec to 0.5 l / s over 4 days. Křtiny watershed reacted to precipitation the most in the end of month when the flow increased up to more than twice the daily average.

The course of the daily flow value is in July influenced by precipitation which were for this month the highest in total for the period. More abundant precipitations were recorded 12th July (21,8 mm). Flow response showed the most in Křtiny when the average daily flow reached 6,24 l/s. The greatest precipitation were recorded on the last day of the month, when their value reached 35.8 mm.

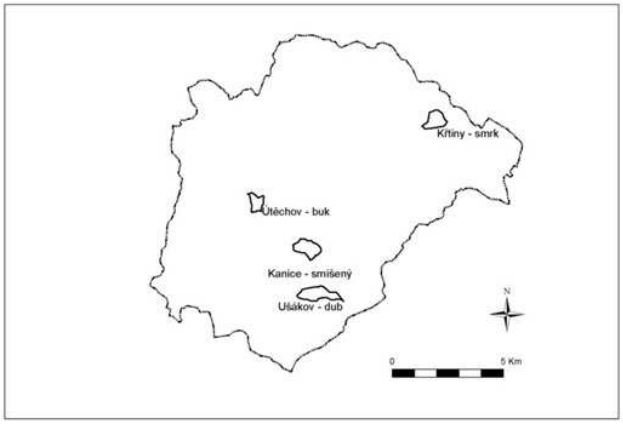

Fig. 1: Location of measurement watershed in the SLP Krtiny

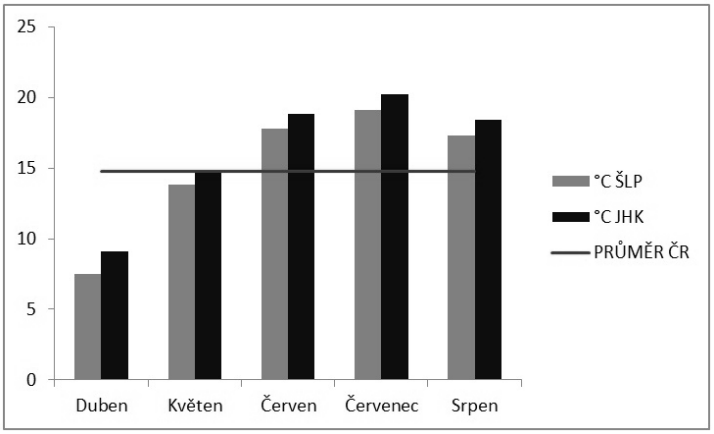

Fig. 2: Comparing temperatures averaged three meteorological stations located on the territory of SLP diameters at JHK and CR

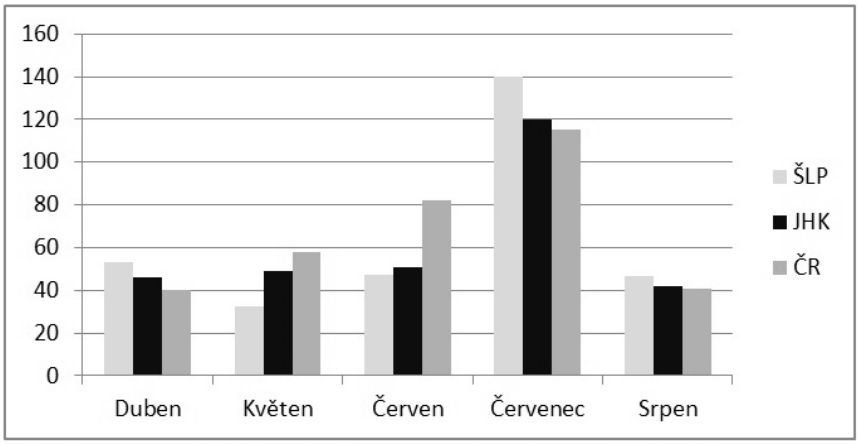

Fig. 3: Summary of rainfall (mm) for the measured period April 4, 2016 – 31.8.2016; average of three weather stations on SLP/JHK/CR

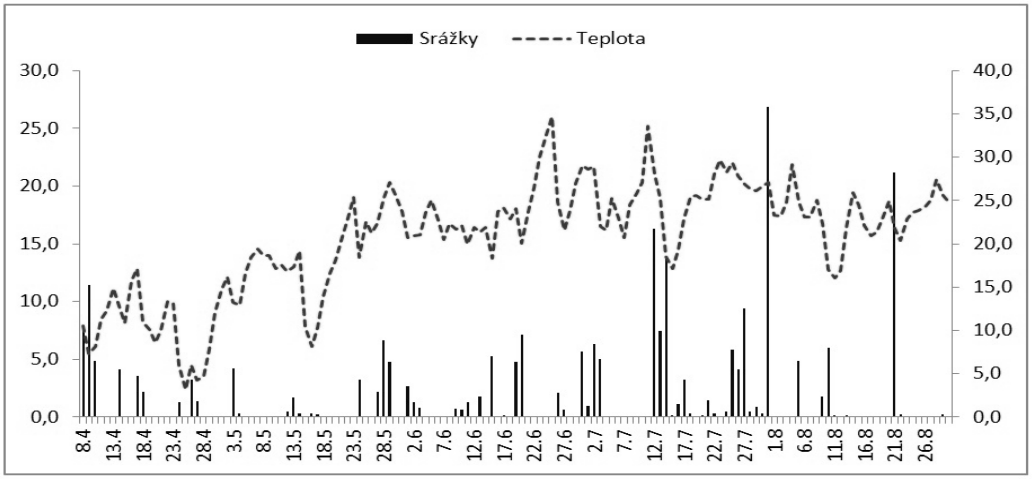

Fig. 4: Klimadiagram created from data obtained from meteorological stations (BÍLOVICE, Dykovy školky, arboretum Řícmanice; Major axis shows (°C), the by the rainfall (mm)

Charakteristiky průtoku		Křtiny		Ušákov		Kanice	
		l/s	datum	l/s	datum	l/s	datum
Minimální průtok	denní	0	více	0	více	0	více
Maximální průtok	denní	13,29	8.7	35,3	31.7	11,02	31.7
Průměrný průtok	denní	0,78		0,77		0,48	

Fig. 5: Flow characteristics at particular micro catchment, described are daily averages of the values of l/s

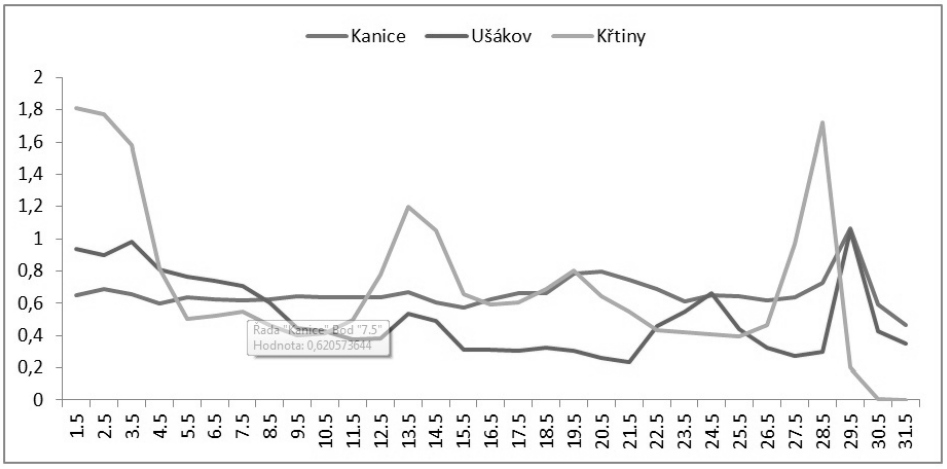

Fig. 6: Compared flow weakest rainfall in the period May 2016

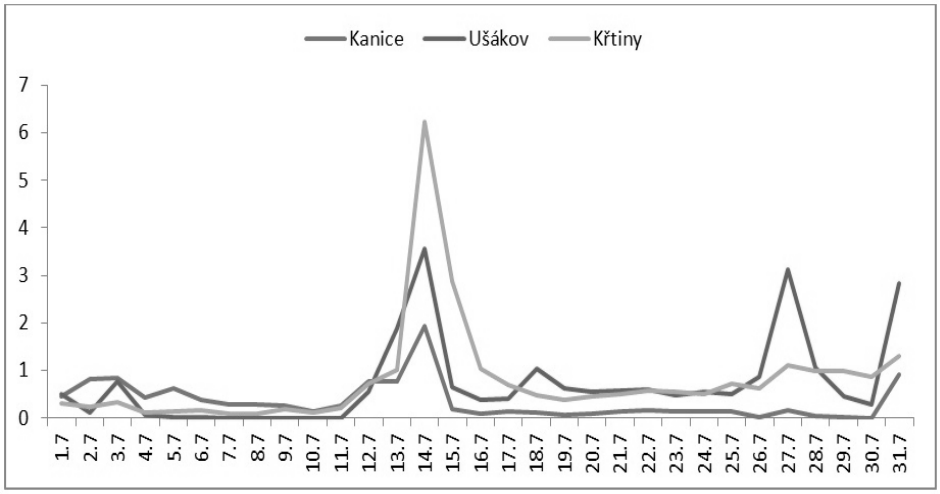

Fig. 7: Compared flow in July 2016 when total precipitation is greatest

Conclusion

Microwatershed coud be characterized as highlands forest catchement area showing relatively identical morphology and different dominant tree species in the forest stands. There are presented three forest microwatersheds: dominated by oak, spruce (the proportion of listed trees is above 40%) and mixed.

Low ability to maintain a balanced flow occurs in the watershed Ušákov. The flow decreased the lowest of all measured in May when the precipitations are weak. The value of the average flow rate is 0,52 l/s. Microwatershed Křtiny (spruce) and Kanice (mixed) are relatively stable. Their effectiveness varies in response to increased precipitation at the end of May and mid-July, when spruce watershed reacts with the highest flow. Both watersheds have higher water management efficiency in the weaker precipitations period than Ušákov.

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Souhrn
Závěry jsou popisovány na vlastních datech průměrných denních průtoků odvozených z měření v recipientech příslušných lesních mikropovodí. Jsou zde uvedeny tři lesní mikropovodí, dubové, smrkové (se zastoupením uvedených dřevin nad 40%) a smíšené. Nízkou schopnost udržet vyrovnaný průtok vykazuje povodí v Ušákově. Ve srážkově slabém měsíci květnu klesl průtok nejníže ze všech měřených. Hodnota průměrného průtoku je 0,52 l/s. Povodí Křtiny (smrk) a Kanice (smíšené) jsou relativně stabilní. Jejich účinnost se liší v reakci na zvýšené srážky na konci května a v půli července, kdy smrkové povodí reaguje nejvyšším průtokem. Obě povodí však vykazují vyšší vodohospodářskou účinnost ve srážkově slabším období než je tomu v povodí Ušákov.

Contact:
Ing. Libor Školoud
E-mail: skoloud.libor@gmail.com

BANK PROTECTION BY MEANS OF ACTIVE ANTI-ABRASIVE STRUCTURES

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

Abstract
The article deals with problems of bank stability that are affected by bank abrasion in context of the protection of riparian habitat and protection of banks in terms of their recreational use. The issue of bank stability is demonstrated on the example of Brno reservoir (Osada area) the developed abrasion activity is manifested in from of abrasion caverns. This area as whole reservoir is used for recreational purposes and it's for this part of reservoir announced special protection statute under which the banks are not allowed to alter (protection of kingfisher nests). As a compromise solution it is possible to use elements of active bank protection which does not interfere with the character abraded banks and to some extent prevent their further abrasion.

Key words: Brno dam reservoir, recreation, abrasion cavern, waving of water level, granulometry

Introduction

The abrasion is one of the basic elements that changing water reservoir's banks. Other forms are landslides and other mass movements, accumulation and washing out of banks (Spanilá, 1975, Vuglinskiy, 1991). Abrasion is a process of grinding the bottom and banks caused by movement of water level, followed by transporting and depositing of eroded material into the reservoir (Šlezingr, 2011). Abrasion itself is defined as the process mechanical destruction of rocks due to waving and fowing. This results in prolonged liquid water level in the reservoir to create a high steep abrasive cavern. When the toes of abrasive caverns further exposet of water motion, leaching to the washing out of fine fraction and subsequently to the formation of cavities extending into the slope. This resulting overhang may fall (Spanilá, 1975). This process, however, does not show on all the reservoirs, but only in places that are prone to abrasion (Šlezingr, 2011).

The influence of bank abrasion is also evident in the Brno dam reservoir, particularly in recreation area Osada that lies on the left bank of the reservoir. Osada area is most affected by bank abrasion. There were formed up to 5 m high abrasion caverns. Thus disturbed coast occupies a length of about 250 m.

Such sing of water erosion can have a negative impact on the stability of various objects located close to the shore, such as cottages and other recreational facilities including roads, but also can lead to danger to visitors and vacationers who are moving throughout the year. Next the soil washes into reservoir leads to clogging of reservoir and loss of the soil at the same time (Šlezingr, 2004, 2007).

Due to restrictions (building enclosure) is prevented in any way interfere with or somehow modify the resulting abrasion caverns. One solution to stabilize the abraded shorelines, protect recreational facilities while preventing the natural state of the caverns is the ability to use active anti-abrasive protection of banks.

Materials and Methods

In the Osada area were built-up several offshore experimental structures for which examined the effectiveness of reduction of waves due to the effects of wind and boat traffic, mitigation of abrasive development and prevent of washes out of eroded material into reservoir. Low-cost offshore technical, biotechnical and biological solutions on the principle of breakwaters were preferred. The experimental measurements were realized on the short gabion wall, simple and double willow wattling and willow stand. This structures are built-up from local natural material as stones, gravel, living willow poles and stams (*Salix sp.)* from coast of reservoir.

The following description of constructions, analyzes and results of the experiment are related to the double willow wattling which was established in spring 2014. This struction was built-up on abrasion platform in distance of 5 m from the toe of abrasion cavern (height of approximately 4 – 5 m). The works were accomplished during spring season when the water level in Brno reservoir is usually still operated 4 m below its standard conditions (water level in months April – September). The dimensions of structure are 0.6 x 0.3 x 7.0 m (height x width x length). The material for structure is represented by 3 – 4 cm thick willow poles with length 1.2 m. The next 1–2 cm thick willow stems with minimal length of 1.5 m and local rock aggregate were used. The poles were rammed into the abrasion platform with mutual distance of 0.5 m and interlaced by willow stems. Two rows of wattling (built-up in parallel 0.3 m apart) were fulfilled by local rock aggregate from abrasion platform with various sizes (consumption of 0.18 m^3 per meter). The final structure represents the combination of biological and technical elements. The structure was situated in the distance of 5 m from the cavern toe in parallel to the shoreline. The altitudinal emplacement was adjusted with respect to the most occuring water level in reservoir during the period of April to September. The value of 228.80 m.a.s.l. was derived by means of statistics (data of water level from years 2010-2014). The top of structure lies in the elevation of 228.70 m.a.s.l. In the main season, the structure is usually swamped and the top edge is approximately 5-10 cm below the water surface (periodic fluctuation of water surface due to the reservoir operation). Hence the structure behaves as submerged breakwaters.

In case of Brno dam reservoir, Osada area, the waves or water level motion caused by wind has the biggest impact on development of bank abrasion. Although the prevailing wind direction on Brno reservoir is north-west, the wind that has the biggest impact on development of abrasion is rather opposite: south-south-east. This is mainly due to the length and wind speed on the surface of the reservoir. In our case it is 2050 m (Gernešová, Pelikán, Šlezingr et al., 2017). At this locality, the experiments were conducted: measuring of the waves and detecting the effects of waves and their deformation due active anti-abrasive structures. Detached breakwaters protect the shore by modifying wave action, thereby promoting sediment deposition shoreward of the structure and resulting in development of offshore salient. Detached breakwater locally reduce incient wave energy and alter wave direction to create a „shadow zone“, where sediment transported alongshore or placed as beach-fill is retained (Dally et Pope, 1986).

There were also conducted sampling of abraded material seized behind the anti-abrasive construction. The effects of waves were investigated by statistical data process. Evaluation of the effect of waves is not part of this article (it was presented in articles: Šlezingr, Marková, Gernešová, 2016; Gernešová, Pelikán, Blahuta, 2016 a Gernešová, Pelikán, 2015). There is, however, assess changes in particle size of sediment composition seized behind anti-abrasive structure. Since 2014, the establishment of anti-abrasive structure were each subsequent year taking trapped

sediment. The samplings were conduced in the spring season (February – March in years 2014, 2015, 2016 and 2017) at the time when it was the water level below normal state in reservoir and the sediment wasn't frozen. Subsequently the analysis of granulometry was conduced in the laboratory of soil mechanic at Department of Landscape Management of Mendel university in Brno. When analyzing the determination of particle size composition was performed according to CSN 72 1007.

Results and Discussion

Removed material retained by construction of active anti-abrasive protection (by double willow wattling), was analyzed in a laboratory of soil mechanics and classification according to the applicable standard CSN 72 1007.

In the spring of 2014 it was built-up double willow wattling. Because this structure was established before the summer season when the water level in reservoir is at a height of 228.80 m.a.s.l., could not trapped any abraded material from previous year. The taken sediment was removed from the abrasive platform without the influence of the active anti-abrasive structure and its granulometric curve characterizes the grain size composition of abrasive platform.

The following graphs (see Fig. 1 – 4) show that the sediment retained by double willow wattling contain increasing volume of finer fractions.

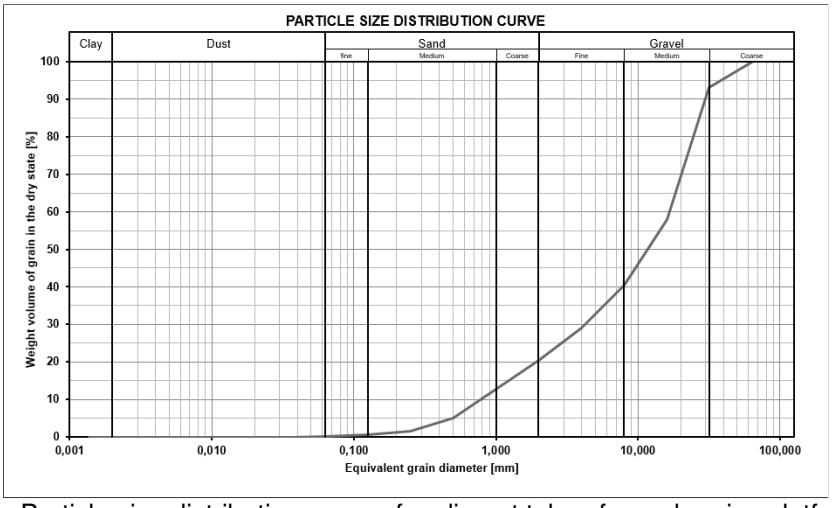

Fig. 1: Particle size distribution curve of sediment taken from abrasive platform in 2014

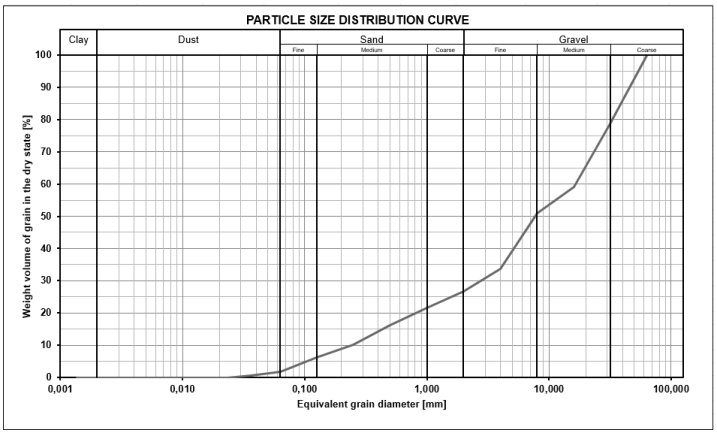

Fig. 2: Particle size distribution curve of sediment taken from abrasive platform in 2015

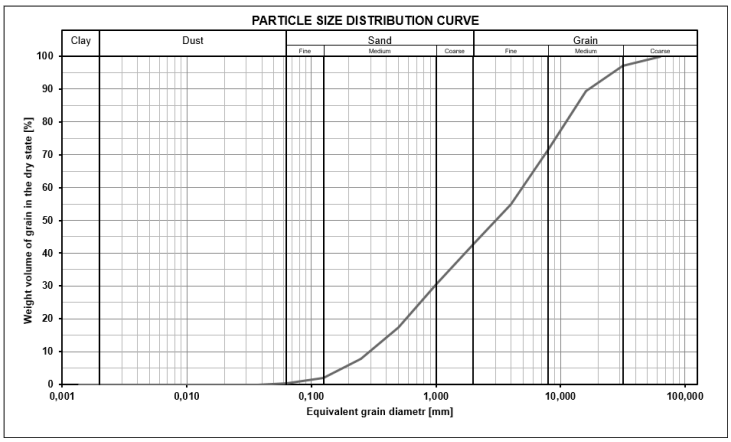

Fig. 3: Particle size distribution curve of sediment taken from abrasive platform in 2016

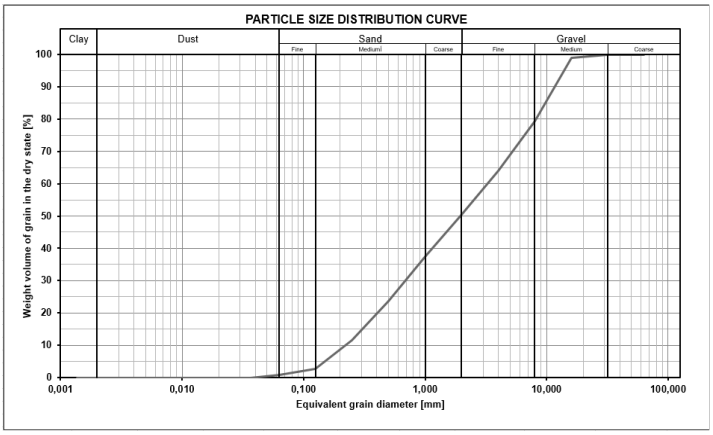

Fig. 4: Particle size distribution curve of sediment taken from abrasive platform in 2017

Compared to the original sample (2014) was the rise if fine sand from 0.5 % to less than 1.5 %; in case of medium-grained sand it was increase in the fraction of 12.5 % to 35 %. Percentage volume in coarse sand in year 2014 was 7.5 % of the total volume, this volume increased by 2017 up to 13.5 %; fine gravel fraction increased by 8 % from 20 % to 28 %. For medium-grained gravel decreased volume of 53 % (2014) to 21 % (2017). In 2017 no longer share coarse gravel in sample noticeable in contrast to 2014, when this fraction occupied 6.5 %. The percentage volume of fractions (dust, fine-sand, medium-grained sand, coarse-grained sand, fine gravel, medium-grained gravel and coarse-grained gravel) is summarizes in Tab. 1.

Tab. 1: The volume of soil class in total volume of the analyzed sample

Year	Dust (%)	Sand (%)			Gravel (%)		
		fine	medium	coarse	fine	medium	coarse
2014	0.0	0.5	12.5	7.5	20.0	53.0	6.5
2015	2.0	4.5	15.0	5.5	24.0	28.0	21.0
2016	0.5	1.5	28.0	13.5	28.5	25.5	2.5
2017	1.0	1.5	35.0	13.5	28.0	21.0	0.0

The largest increase was in fraction of medium-grained sand from original 12.5 % to 35 % (an increase of 22.5 %) and the largest decline was recorded for fraction of medium-grained gravel which had in 2014 53 % in all volume of sampling and in 2017 only 21 %, an overall decrease of 32 % of the total volume.
The process of gradual silting of the space behind the breakwater is known. This is a natural process. In case when this depositional feature becomes connected to the structure of active anti-abrasive protection, it is called a tombolo (Dally et Pope, 1986). The gradual silting of the space behind the structure, we can expect the situation where the object of anti-abrasive protection will become part of the new bank, will forms his toe. Very much depends on the used material. The most stable component of an structure is made of stone (for example: hanging dam) or gabions. In case of double willow wattling, this construction is a short-lived. Gradually degrades willow stams and subsequent disintegration and spillge inner lining.

Conclusion

The process of abrasion is evident in various parts of the mainland shore – seas, oceans, but also lakes and reservoirs. Abrasion, however, does not show at all banks, but the banks susceptible to abrasion. One example may be the Brno reservoir - Osada area, where arose several meters high abrasive caverns. In the experiment there were built-up elements of active anti-abrasive protection: short gabion wall, simple and double willow wattling and willow stand. This structures fulfill the function of breakwaters.
This article was focused on construction of a double willow wattling which has built-up in the spring of 2014 in parallel with the shoreline about 5 m from the toe of abrasive cavern. Height placement of structure is 5 to 10 cm below the most frequent level in reservoir (228.80 m.a.s.l.). These structures have two functions: namely to dampen the effects of waves while preventing erosion of abraded material into the reservoir. The deposited material was taken and subsequently analyzed in the laboratory of soil mechanics. Samples were taken in spring season when the water level was lower about 4 m than the normal state. The sampling from year

2014 contain the granulometric composition from abraded platform without effect of anti-abrasive construction. For the years 2014, 2015, 2016 and 2017 grain size composition change in the growth of finer fractions (the largest increase was in fraction of medium-grained sand which was in 2014 represented 12.5 % of the total volume and in 2017 it was 35 % of the total volume), while the decline in coarse fractions (the largest decline was recorded in case of medium-grained gravel, which decreased by 32 % in the total volume).

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Souhrn

Článek řeší problematiku stability břehů s rozvinutou břehovou abrazí v kontextu ochrany břehových biotopů a ochrany břehů z hlediska jejich rekreačního využití. Problematika stability břehů je demonstrována na příkladu Vodního díla Brno –

oblast Osada. Zejména právě v této části nádrže se nejvíce projevila rozvinutá abrazní činnost a to v podobě rozvinutých abrazních srubů. Tato část, stejně jako celá nádrž je využívána i k rekreačním účelům a navíc je pro zájmovou část nádrže vyhlášena stavební uzávěra (jako ochrana hnízdiště ledňáčka říčního). Jako kompromisní řešení je možné použít prvky aktivní ochrany břehů, které nenaruší charakter abradovaných břehů a v určité míře zabrání jejich další abrazi.

Contact:
Ing. Lenka Gernešová
E-mail: xgerneso@node.mendelu.cz

BARRIER - FREE OR UNIVERSAL DESIGN OF TOURIST TRAILS IN THE FOREST LANDSCAPE?

Mariana Jakubisová[1], Lea Rollová[2]
[1] The Borova hora Arboretum, Technical University in Zvolen, Borovianska cesta 2171/ 66, 960 53 Zvolen, Slovakia
[2] CEDA - Centre of Design for All, Faculty of Architecture, Slovak University of Technology in Bratislava, Námestie Slobody 19, 812 45 Bratislava, Slovakia

Abstract
The article deals with the topic "Tourism for All", which requires comprehensive planning and design with the potential accessibility for all without discrimination. Here are specified the differences in perception of terms „the Barrier-free Design“ and „the Universal design“. Here is an overview of current Slovak legislation in the field of Barrier-free and Universal Design. Designing of hiking trails and educational paths in the forest landscape for people with disabilities is a specific. Harmonize the technical demands with the requirements to protect the country in the area and with Universal Design, it requires knowledge and expertise of designers. Harmonization of requirements for optimum design is demanding, individual for each specific environment. Barrier free and Universal design has close relation to "inclusive design" with the aim enriched society for the benefit of all. They are also being applied to the design of technologies, guidelines, services, and other products in environments at all.

Key words: disability, hiking trails, accessibility, universal design, technical requirements

Introduction

Many disabled people are limited in their possibilities for tourism and traveling in general. They either have no possibility of access or limited access to outdoor tourism. Very important document, which deals with the rights of people with disabilities is the UN Convention on the Rights of Persons with Disabilities (UN Convention). Article 30 "Participation in cultural life, recreation, leisure and sport" of UN Convention states that persons with disabilities have the right to take part on an equal basis with others in cultural life, sport and recreational activities and tourism. They enhance through physical activity your physical condition and mental health, endurance and courage. In order to fulfil one of the objectives of the UN Convention, all spaces (both indoors and outdoors) should be accessible (Article 9), including hiking trails in forest landscape. There are many interesting recreational places in Slovakia forest landscape which have potential to be accessible to all. Accessible tourism and related services are an important step towards meeting the requirements of anti-discrimination law on equal treatment. Humanitarian approach in any form are good examples for the partial solution to the problem, but systemic solutions are the key to accomplish the objectives set out

Materials and methods

The paper aims to create a space for discussion and systemic solutions to creation of accessible hiking and nature trails with principle of universal solutions in forest country for all people including people with disabilities. The terms “Universal design” and “Barrier-free design” are often used interchangeably. However, these terms

aren't synonymous and each refers to different approaches in creating environments. In Table1 the comparison of the differences between Barrier-free and Universal Design is shown (see Table 1).

Barrier-free Design is an *„approach to planning and designing living environments that emphasizes accessibility by persons with functional limitations*" (http://medical-dictionary.thefreedictionary.com/barrier-free+design). Often it focuses on creating environments for people with reduced mobility (wheelchairs users). But Universal design is a broader concept that is defined by The Center for Universal Design at North Carolina State University as "*the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design*." Universal Design seeks to take into account the demands of a wide range of users, not just people with limited mobility, for example the needs of people with sensory or intellectual disorders, parents with young children, the elderly, travellers with heavy luggage and so on. In order to apply Universal Design in the creation forest landscape or hiking trails, it is necessary to understand „The Seven Principles of the Universal Design", which were developed in 1997 by a working group of architects, product designers, engineers and environmental design researchers, led by the late Ronald Mace in the North Carolina State University: (1) EQUITABLE USE (the design is useful and marketable to people with diverse abilities), (2) FLEXIBILITY IN USE (the design accommodates a wide range of individual preferences and abilities), (3) SIMPLE AND INTUITIVE USE (use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level), (4) PERCEPTIBLE INFORMATION (the design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities), (5) TOLERANCE FOR ERROR (the design minimizes hazards and the adverse consequences of accidental or unintended actions), (6) LOW PHYSICAL EFFORT (the design can be used efficiently and comfortably and with a minimum of fatigue), (7) SIZE AND SPACE FOR APPROACH AND USE (appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility). The proposals of hiking trails and educational paths in the forest country must be comply with UN Convention and therefore they must be designed according to the principles of Universal Design and Article 9 Accessibility. In order to develop international tourism and to uniform labeling of universal accessible hiking trails, it is necessary to harmonize international standards.

Legislative issues of making available of the forest landscape (outside built-up areas, in the forests and free landscape) and the accessibility for disabled persons are not systematically addressed in Slovakia. The accessibility of forest complex through the network of forest roads is dealt only does not resolve the issue of accessibility for all in a natural setting. In Slovakia, it is also necessary to subsequently modify the following legal regulations and standards for example: Law on Urban Planning and Building Code No. 50/1976 Coll., Decree of the Ministry of Interior (MV) of the Slovak Republic No. 9/2009 Coll. implementing the Act on Road Traffic and amending and supplementing certain acts, as amended; Decree of the Ministry of Environment (MŽP) of the Slovak Republic No. 532/2002 Coll. specifying details of general technical requirements for construction and general technical requirements for structures utilized by persons with limited movement and orientation abilities; STN 73 6101 Design of Roads and Motorways; STN 73 6110 Design of Local Roads; TP 10/2011 Technical Conditions – Design of debarrierization measures for persons with reduced mobility and orientation on roads, MDVRR SR: 2011.

Tab. 1: Comparison of principles Barrier free and Universal design

Barrier-free design	Universal Design/Design for All
Special adaptations designed especially for wheelchair users, often need assistance or assistive devices	Solutions to enhance the quality of environment and services for the entire population, regardless of health status
Creating of individual forms, suggestions and solutions with a focus on a certain type of disability (especially on handicapped in a wheelchair)	Creation environment and services that reflects of the diversity of users in all areas of life - so that special equipment was minimized
Creation of special products and lifting devices for a selected group of people (e.g. staircase platform for those with mobility problems)	Formation of the universal products that are intended for larger populations (e.g. ramp instead of staircase platforms)
Social consequence: segregation and discrimination of persons with disabilities	Social consequence: inclusion of persons with reduced mobility and orientation into society
Design features: a unique, fixed - rigid, isolated - segregated, intolerant to all	Design features: versatile, flexible, fair, diverse, tolerant for all

Results

Creation of thoughtful hiking trails in forest environment must be characterized of tolerance for human diversity, among others for the disabled and older person, if possible. In areas for recreation with landscape protection is important to create accessible hiking trails with respect on cultural heritage, natural attractions, places with a view of countryside, birdwatching, wildlife, plants, trees etc. This does not mean that all tourist routes must be with wheelchair accessible, but It is often possible to choose the route with adequate slope of the terrain, which may be adapted to the needs of a wide range of users. For purposes of the survey of the claims of disabled users were conducted the analyses about accessible tourism /Tourism for All (Rollová, 2010, Jakubisová in Fialová et al. 2015) where together 384 respondents answered. The intention of these studies was to obtain information about opinions of target group of disabled people and about accessibility to hiking trails and accomodations. The research results are published in books "Trails for disabled people in the V4 countries" (Fialová et al. 2015) and "Accessible Tourism. Demands of disabled people for accommodation and services" (Rollová, 2010). Specifically research and outputs has been reflected in the preparation of Slovak building regulations (not yet approved). Recommended principles of Universal Design for implementation of accessible hiking trails (hereinafter the “AHT”) in forest landscape of Slovak Republic are: unobstructed width of the AHT is at least 1,600 mm; unobstructed width of the AHT may be narrowed to a width of 900 mm only where justified, for example because of adverse terrain configuration or installation of elements of technical equipment; longitudinal slope of a AHT section is at most 1:21 (4.8%) and the section with such slope should not be longer than 20 meters; if longer, it should be interrupted by a horizontal plane with relaxing bench; if the longitudinal slope of a AHT section exceeds 1:21, it must be designed and equipped as a ramp with handrails within the meaning of construction laws; cross slope of the AHT may be at most 1:50 (2%); head clearance on the AHT must be at least 2,200 mm; the AHT surface must be even and hardened to be negotiable for a person with

a wheelchair, walking aids, stroller and the like; if the AHT surface is made of a metal grid, the grid holes must have a maximum size of 20 mm x 20 mm; if the AHT surface is made of balks, they must be placed transversely to the direction of movement and the joints between them may not be wider than 10 mm; If the AHT surface is made of natural stone tiles, the joints may not be wider than 10 mm; the AHT surface must be non-slip; the AHT sections with the risk of falling must have a fixed barrier with filler at a height from 100 mm to 1,100 mm; any bridge or footbridge on the AHT in a height not more than 500 mm above the ground must have an elevated rim on both edges up to a height of 100 mm or a guiding rod at a height of 300 mm; any bridge or footbridge on the AHT in a height exceeding 500 mm above the ground must have an unobstructed width of at least 900 mm; fixed barriers with filler must be installed on both edges of the bridge at a height from 100 mm to 1,100 mm; rest areas must be situated along the AHT (recommended is one rest area after each 200 m) outside the main course of the route, with benches and areas for parking wheelchairs or strollers; benches for taking a rest must have a backrest and armrests; there must be a hardened surface area beside the bench to park a wheelchair or stroller; information and orientation systems of the AHT must be presented in a multi-sensory form using relief tactile maps, plans, labels with inscriptions, or audio comments etc. (see Figures 1 – 3); wheelchair accessible toilets should be situated along the hiking trail.

Fig. 1: Tactile map for blind people (source: marketing journal.cz)

Fig. 2: Tactile plan should be positioned so that it is accessible and readable by all users (source: authors)

Fig. 3a, 3b: Labels with inscriptions in Braille (source: rajce.net)

Discussion

Tourist activities have significant ecological, environmental, economic, social and cultural impacts or responses (Price et al. in: Messerli, Ives 1997). The many aspects and broad contexts of ecotourism in protected territories were dealt with in the key works of Ceballos-Lascuráin (1996), Eagles et al. (2002) and others. Accessible hiking trails and educational paths in forest landscape are designed for locations with favourable terrain configuration, with moderate slope and formed as a closed circuit with different length routes, due to the variety of choice and demands of users with different abilities. Their design is related to the current legislation that is not from the perspective of various disciplines compatible, is not united in Slovakia. For example, in Slovakia in terms of directional routing from the perspective of people with physical disabilities, no are limits are defined regarding the path curvature (minimum curve radius), tangential curvature path between curves of opposite direction, or the length of straight lines and sight distance. Design elements must be selected to allowed smooth and safe movement of both hikers and wheelchair users. Usually, such trails are not separately designated for only one type of movement or users, but are also used by others, such as cyclists and the like. For cyclists, is defined the minimum curve radius as 5 metres (at concentric cross slope p = 6%) and a uniform stopping sight distance 15 m (at speed 40 km per hour, the downward longitudinal slope of 8%). While a longer route, at a section longer than 200 m there must be with the resting place for physically handicapped people with a longitudinal and cross slope not higher than 1:50 (2%). Information on hiking trails and attractions on the route must be mediated multisensory to be

perceptible by sight, touch or even hearing. It should be created for everybody to enjoy the range of forest values.

Conclusion

Accessible hiking trails in forest landscape designed according to the principles of „Universal design“ are mainly for locations with favorable terrain configuration, with moderate slope and formed as a closed circuit with different length routes, due to the variety of choice and demands of user. Positives of Universal design proposals are associated with solutions to enhance the quality of environment and services for the entire population, regardless of health status, creation of environment and services that reflects of the diversity of users in all areas of life - so that special equipments were minimized. Formation of the universal products that are intended for larger populations possesses social consequence: especially, their inclusion to society and increase mobility. Universal design supports the features as are: versatile, flexible, fair, diverse, tolerant for all. It is therefore necessary to revise Slovak legislation and legal standards in accordance with established "Principles of Universal Design" and with Article 9 Accesibility of UN Convention of the Rights of Persons with Disabilities.

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Souhrn
Článek se zabývá problematikou “turismu pro všechny” v lesním prostředí, která vyžaduje komplexní plánování a navrhování s potenciální přístupností „pro všechny“. Uvádíme zde rozdíly při vnímání pojmů „bezbariérovost“ a „univerzální navrhování“ a uvádíme souvislosti s platnou legislativou Slovenska (SR). Prezentujeme pohled současné legislativy SR v oblasti bezbariérového a univerzálního navrhování. Navrhování turistických tras v lesním prostředí pro osoby se zdravotním postižením je specifické. Uvedení do souladu technických požadavků s požadavky na ochranu krajiny v oblasti navrhování přístupných turistických tras a naučných stezek vyžaduje znalosti a zkušenosti odborníků. Na základě výzkumu jsme sumarizovali požadavky pro aplikaci univerzálního navrhování turistických tras pro podmínky SR. Harmonizace požadavků a optimální návrh je náročný a individuální pro každé konkrétní prostředí. Univerzální navrhování má úzký vztah k „otevřené koncepci“ návrhů. Zkušenosti jsou využitelné v praxi i při navrhování technologií, pokynů, služeb a dalších produktů v prostředí vůbec.

Contact:
Ing. Mariana Jakubisová, PhD.
E-mail: jakubisová@tuzvo.sk

BIOCLIMATIC ANALYSIS AND TOURISM ANALYSIS IN ROMANIA

Ana-Maria Ciobotaru, Ion Andronache, Daniel Peptenatu, Daniel Constantin Diaconu, Mircea Cristian Vişan

Research Center for Integrated Analysis and Territorial Management , University of Bucharest, 4-12 Regina Elisabeta Avenue, 030018 Bucharest, Romania

Abstract

Bioclimatic research is in a strog interconnection with tourism activity in Romania. For this research weconsidered to analyse some bioclimatic index (Temperature-Humidity Index - THI, SSI Simmer Summer Index – SSI) in Constanţa, Focşani and Sinaia in the period 2000-2012. Also, were made connections with tourism activity (accommodations occupancy rate and length of stayings) and the number of arrivals and overnight stayings in the analyzed period. We observed that exist variations from year to year in the number of overnight stayings and arrivals in function with bioclimatic conditions.

The results illustrate the links between the number of arrivals and overnight stays and bioclimatic comfort in Constanţa, Sinaia and the presence of a bioclimatic discomofort in urban areas especially in and Constanţa.

Key words: Tourism Climate Index, Temperature-Humidity Index, tourism analysis

Introduction

Bioclimatic analysis is a relatively new part of climatology that has developed gradually recent year in climatological studies. In a wide range of scientific papers about the environmental requirements in agricultural crops taking into account bioclimatic regions (Letunov et al. 1960)and tourism and development of territorial systems (Peptenatu et al. 2015; Draghici et al. 2016; Draghici et al. 2016). In the recent decades, the quantitative studies of bioclimatic analysis have been raised based on physiological reactions of temperature and relative humidity in touristic sites (Matzarakis et al. 2013, Bleta et al. 2014, Rutty and Scott 2015). Therefore, the study of bioclimatic conditions was applied in residential areas (Fikfak et al. 2017). Recent studies have taken into account a combined analysis of bioclimatic indices: heat index and wind chill index (Shitzer 2008), Physiologically Equivalent Temperature (Mansouri Daneshvar et al. 2013) that are well documented and include important meteorological and thermo–physiological parameters (Matzarakis 2007, Mansouri Daneshvar et al. 2013).

In this regard, the bioclimatic analysis of THI and SSI have a main role in the interpretations of bioclimatic discomfort and comfort of urban environments. Also, the variation fo air temperature and relative humidity and implicit the variation of bioclimatic index and tourism activity (accomodations occupancy and lengh of stayings).

Material and methods

We used in this analysis, climatic data from Sinaia, Focsani, Constanta in the period 2000-2012. The climatic parameters used were air temperature adn relative humidity for the indexes according to the formulas (Kyle, 1994; Pepi 1987):

$$THI\ (°C) = T_x - (0.55 - 0.0055 \times U) \times (T_x - 14.5) \quad (1)$$

$$SSI = 1.98 \times (T_x - (0.55 - 0.0055 \times (UR)) \times (T_x - 58)) - 56.83^* \quad (2)$$

where Tx is air temperature (°C) and U is relative humidity (%).
Taking into account applicable rules of bioclimatic indicators THI and SSI to analyze specific climate types of environments cities THI index can be calculated for all bioclimatic, both hot and cold. This index could be calculated for all cities taken for analysis. SSI index was calculated for Focsani and Constanta as air temperature values exceeded 22 °C. For Sinaia, the values of the air temperature are between 13-15 °C for July to September. To calculate these index, the formulas (1) and (2) were introduced in Microsoft Excel to provide tables and graphics according these index.
For the analysis of tourism activity we take into account the number of nights spend and arrivals in accomodations from TempoOnline (INS) in the period 2000-2012.

Results

1. Bioclimatic analysis in Focsani

THI index is noted that in June-August fall within the area of discomfort bioclimatic heating, hot type with minimum values of 20.76 °C in August and maximum of 23.64 °C in July. Also in early June is noted the presence of a bioclimatic comfort in 2000-2006. May and September are characterized by bioclimatic comfort, these months are moving towards bio climate cool cooling from October to April. In the period from October to April bioclimatic discomfort was observed predominantly by cooling, cold type (values between -4.77 °C and 12.90 °C in December to April. These values of THI index in this range of temperature values is interdependent air and air humidity variation. in January of 2000, 2004, 2005, 2010 and 2011 noted the presence of a cold bioclimatic excessive human body resimţtit increased discomfort (Table 1).
SSI index was calculated for the months from July to August met because the corresponding calculation values, namely air temperature between 22 ° C and 53 ° C. It is noted that in the period, according to the index SSI, to Focsani Bioclimat is characterized by the presence of quite warm and the rapid changes from one to another to welfare of the bioclimatic. In July 2012 it has been a hot Bioclimat the discomfort is accentuated by heating at 32.62 ° C.

2. Bioclimatic analysis in Sinaia

The bioclimatic analysis at Sinaia revealed in the analysis of THI that the cold bioclimat with negative values in January-March and values over 10°C-13°C in May-June.Is Predominate the cold bioclimate in January-February in 2003-2006 and 2009-2012. Also, in December predominate the very cold bioclimate due to negative values of air temperature. July and August are the months when were registered chilly bioclimate and bioclimatic comfort (Table 2).

3. Bioclimatic analysis in Constanta

THI index reveals in October-aprilieun bioclimatic discomfort by cooling, and in May, June and September comfort bioclimatic and in July and August mild discomfort bioclimatic by heating.
Summer Simmer Index describing the conditions of heat stress for warm half of the year. SSI index values show that was under the influence of bioclimatic comfort and bioclimatic discomfort but alternating between periods of comfort and the quite warm. So for the analyzed period bioclimatic comfort prevails.

4. Touristic analysis in Focsani, Sinaia and Constanta

Analyzing the monthly number of nights from period 2000-2012 for cities Focsani, Constanta, Sinaia was observed several relevant aspects. For all three cities, most

overnight stays in accommodations are in the summer season when weather conditions are favorable for all forms of tourism singularity is especially resorts Sinaia and Constanta. Focsani stands present a transit tourism, business travel, but increases in the period from September to October is due to cultural events due unie oenological specific geographical areas with large vine crops. Constanta stands for an increase in the number of overnight stays and the length of stay in high season characterized by comfort bioclimatic bioclimatic and mild discomfort in the months from July to August. Also, Constanta stands summer tourism, tourism turnover, cultural tourism, beach tourism. Sinaia is distinguished by a range of types of tourism, winter sports tourism, spa tourism, and tourism warm semester (June-August) trekking, mountain biking. Also, Sinaia is based on the existence of a favorable natural environment: ski slopes, hiking trails. THI index for June and August remark bioclimatic bioclimatic cool and comfort which supports and the high number of night spends and arrivals from Sinaia.

Discussion

1. Assessment of touristic analysis in Romania

Our results revealed important differentiations on touristic activity in Romania. By using bioclimatic index and touristic activity, we provide informations about touristic activity based on bioclimatic analysisin 2000-2012.

Romania have a high touristic potential and relevant resources to be used. From the mountains and to the sea, Romania have an unicity and specificity that make among the relevant touristic destinations from Europe. The specific of Romania is taken by the unique landscapes from Carpathian mountains (Sinaia, Brasov, Rasnov) and Delta of Danube. The touristic activity is in a strong correlation with the legislation in Romania and after the post-socialism period.

2. Usage of bioclimatic analysis in touristic analysis

We have evaluated the bioclimatic analysis and touristic activity. Our results revealed new insights in tourism analysis in Romania (citare) compared to previous studies based on bioclimatic analysis (citare). The findings of this study clearly confirmed the hypothesis that is a link between air temperature, relative humidity and number of nights spend in accomodations and the flux of tourists.

Conclusion

Bioclimatic analysis in the period 2000-2012 reveals that the index values are dependent variation bioclimatic meteorological parameters measured at observation times of climatological (air temperature, air humidity). In the stations Sinaia and Constanta was revealed a bioclimatic confort in the summer period and significant touristic activity.

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Tab 1: THI values at Focsani (2000-2012)

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
I	-2.60	1.25	-1.45	-1.47	-1.92	-1.89	4.74	5.45	-0.73	0.99	-2.87	-1.85	0.44
II	3.20	3.46	7.04	-1.86	2.76	2.53	0.08	4.39	4.73	3.34	0.43	-0.81	-5.49
III	7.36	8.14	9.07	3.49	7.78	7.67	5.90	8.97	9.92	7.25	6.80	6.26	6.83
IV	14.18	11.81	11.16	10.78	12.29	12.37	12.36	12.51	12.75	12.90	12.52	11.67	13.86
V	17.25	16.45	17.81	19.21	15.82	16.23	16.25	18.19	16.14	17.19	17.38	16.61	17.61
VI	19.79	19.04	20.64	20.75	19.18	19.88	19.79	21.42	20.27	20.31	20.35	20.00	21.57
VII	21.82	23.33	22.52	21.30	20.92	21.63	21.24	22.40	20.91	22.25	22.55	21.82	23.64
VIII	21.70	22.60	20.76	21.70	20.27	21.08	20.97	21.88	21.82	21.02	22.88	20.66	21.91
IX	15.66	17.33	16.78	15.96	16.31	17.66	17.69	16.28	16.15	17.85	16.78	18.71	18.43
X	11.25	13.02	11.69	10.45	12.23	11.85	13.16	12.09	12.70	12.63	9.43	10.47	13.64
XI	8.92	5.29	7.11	7.16	6.80	4.81	8.11	4.57	7.29	6.61	10.00	4.35	7.62
XII	3.27	-4.77	-4.22	1.43	3.24	2.34	2.76	0.49	3.65	0.33	-1.28	3.24	-1.38

Tab. 2: THI values in Sinaia (2000-2012)

Month	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
I	-6.64	-0.75	-0.41	-3.71	-5.71	-2.94	-3.60	1.05	-0.70	-0.94	-4.58	-2.34	-4.43
II	-1.70	-1.44	4.12	-6.03	-2.62	-4.37	-2.98	-1.45	-0.27	-4.05	-3.28	-1.97	-6.15
III	-0.12	4.39	3.96	-0.48	0.97	-1.68	0.09	3.03	2.63	-0.33	0.37	1.65	1.86
IV	7.22	5.50	3.67	3.90	5.98	5.72	4.95	6.09	6.07	7.04	4.64	4.73	6.82
V	10.97	9.44	10.94	13.28	7.69	9.74	8.78	11.69	9.46	9.91	9.46	9.02	10.19
VI	12.80	10.67	12.71	13.56	11.22	10.68	11.60	13.69	12.87	12.90	12.52	12.34	14.50
VII	13.80	14.67	15.09	13.47	13.92	13.28	13.91	16.19	13.58	14.42	14.32	14.41	17.36
VIII	14.80	14.66	12.22	15.07	12.93	13.36	13.29	14.83	15.19	13.88	15.92	14.17	15.68
IX	8.97	9.61	9.07	8.81	10.35	11.03	10.02	9.61	8.97	10.88	9.61	12.86	13.38
X	8.52	8.57	6.55	3.57	8.11	6.26	8.61	6.82	7.78	6.20	3.42	5.32	9.43
XI	7.23	0.97	5.25	5.07	2.74	1.65	3.06	0.96	3.57	3.78	7.19	1.81	5.24
XII	2.64	-4.29	-3.17	1.26	1.23	-1.86	1.72	-0.10	-1.08	-1.85	-2.03	0.08	-2.18

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Souhrn
Bioklimatický výzkum je propojení turistických aktivit v Rumunsku. V rámci výzkumu jsme analyzovali některé bioklimatické parametry (teplotně-vlhkostní parametr – THI, SSI – simer letní index) v Constanţa, Focşani a Sinaia během let 2000 – 2012. Vezmeme-li v úvahu platné předpisy o bioklimatických ukazatelích THI a SSI, pak je možné analyzovat konkrétní typy klimatu v prostředí měst. THI index lze vypočítat pro všechny bioklimatické ukazatele jak pro studené tak pro teplé oblasti. Dále byly pozorovány ukazatele spojené s turistickou činností jako: ubytování, obsazenost dané lokality, délka pobytu, počty příjezdů a zůstání přes noc v daném období. Bylo vypozorováno, že existuje návaznost mezi jednotlivými po sobě následujícími roky, v počtu jednodenních pobytů v kontextu bioklimatických podmínek.
Výsledky ukazují závislost mezi počtem příjezdů a přenocování a bioklimatickým komfortem v Constanţa a Sinaia v porovnání s diskomfortem v městských oblastech zejména v Constanţa. Bioklimatická analýza z let 2000 – 2012 ukazuje, že hodnoty

indexu jsou závislé na variaci bioklimatických meteorologických naměřených parametrech (teplota a vlhkost vzduchu).

Contact:
Ciobotaru Ana-Maria
E-mail: ana-maria.ciobotaru@geo.unibuc.ro

BIODIVERSITY ACTION PLAN AS A MEANS OF SUSTAINING ECOLOGICAL STABILITY OF OPENCAST GRAVEL MINING SITES

Jan Deutscher[1], Petr Kupec[1], Aleš Bajer[2]
[1]Department of Landscape Management, [2]Department of Pedology and Geology, Faculty of Forestry and Wood Technology, Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic

Abstract
The Biodiversity Action Plan (BAP) is a specific approach adopted by the Cemex mining company to ensure ecological stability of their post-mining sites. In this paper we present an original way of preparing the BAP on the example of the Northern Lake locality in Spytihněv. The lake is a result of opencast gravel mining in the floodplains of river Morava were changes to water regime and soil structure created very valuable biotopes. The aim of the BAP was to offer support to the management and decision making in order to promote biodiversity of the locality. To achieve this, the locality was divided into homogenous segments where we defined valuable target biotopes by assessing their current state, ecological potential and interests of local authorities. Specific long-term management for each target biotope was described by defining annual management practices together with their expected time and financial costs. These actions were all aimed at supporting the development and conservation of target biotopes and most importantly to minimize potential risks to their existence such as spontaneous succession, overgrowing by ruderal or destruction by invasive species.

Key words: biotope management, invasive species, ruderalization

Introduction

The Biodiversity Action Plan (BAP) is a specific approach adopted by the Cemex mining company to ensure ecological stability of their post-mining sites. In this paper we present an original way of preparing the BAP on the example of the Northern Lake locality in Spytihněv. This paper is focused on the methodological aspects of its creation.

The mining site is situated on the northern border between South-Moravian floodplain and Carpathian uplands. The area is characterized by wide floodplain of River Morava in one of the hottest parts of Czech Republic with slightly increased annual precipitation caused by the vicinity of Vizovice uplands. Winds blow mostly in northern or west northern orientation that carry dry air and cause desiccation. A typical mosaic of floodplain fluvisols is characterized by the occurrence of different soil types (from coherent clay to permeable sands and gravel) (Bajer et al., 2015). The evolution of biotopes is highly dependable on the water table level. The active mining of sandy gravel in close vicinity to the river channel and its natural deepening considerably decrease the water table level on the study area. Consequently, the current natural biotopes can be described mostly as woody steppe and dry oligotrophic grassland both of which are threatened by overgrowing by invasive ruderal species such as acacia (*Robinia pseudoacacia*) and bushgrass (*Calamagrostis epigejos*). The highest biological value can be assigned to spatially minor biotopes along the ragged shore line of post-mining lakes and waterlogged depressions formed either by flat sandy littoral zones or by steep vertical abrasion cliff sides. These kinds of biotopes have almost disappeared from Czech landscape

due to river straightening and stabilization (Gremlica et al., 2013; Řehounek et al., 2015).
The aim of the BAP was to deliver support for the decision making process and the realization of effective management measures aimed at conserving and enhancing biodiversity of the study area while maintaining other landscape uses as well (recreation, extensive agronomy etc.) while also taking into account the ongoing technical restoration imposed by the mining law (Sádlo and Tichý, 2002). This BAP was conceived mostly from the restoration ecology point of view. As such, proposed management measures pursue environmental friendly practices preferring natural processes like spontaneous succession – mildly controlled (initial seeding or planting of autochthonous species etc.) or blocked (removal of invasive species, periodical mowing etc.) whenever possible. The aim of the BAP was to propose specific management measures to create a harmonic balance between the management demands (both temporal and financial) and the conservation of their ecological value (biodiversity).

Materials and methods
In order to come up with the most effective methodology, the first step was the definition of specific goals of the BAP. These were defined as follows:
- Delineation of target biotopes
- Identification of biotopes with highest natural values (biodiversity)
- Proposal of effective management measures aimed at enhancing long-term sustainable development of target biotopes and at sustaining their ecological stability
- Monitoring of realized management measures including measurable and comparable parameters

To fulfill the above described goals, the elaboration of the BAP leaned on several key steps:
1. Study of relevant available information – This included mainly project documentations of both technical and biological restoration. The aim was to not interfere with those documents if possible.
2. The communication with the investor and landowners – To truly help with sustainable development of the locality and the poly-functional landuse, the future visions of stakeholders concerned was implemented if possible.
3. Field work – During the summer and autumn of 2016 several terrain trips were carried out in order to evaluate the current state of the locality and to identify the potentially valuable areas and biotopes. This resulted in a segmentation of the locality into homogenous segments were similar management measures could be implemented.
4. The identification of “target biotopes” – Within above described segments, a description of “target biotopes” was elaborated. The basic idea was to reach sustainable status of valuable target biotopes within the segments. Given the fact that most of target biotopes could be characterized by early succession, it was clear that they would require specific management measures throughout their whole life span.
5. The harmonization of target biotopes towards the NATURA 2000 (Chytrý et al., 2010) – this was done mainly to enable a wider usage of the approach used in this BAP, potentially across the country.
6. The proposal of specific management measures – To enable best possible implementation of proposed practices in the field, the specific measures were

described in an annual time frame incorporating ecological and ethological demands of expected important species expected to inhabit the newly created biotopes and an yearly timetable was constructed. The total financial costs were calculated for a square meter of each segment so that the financial costs could be used even if some changes to the areal extent of individual segments.

Results

The resulting BAP identified 6 target biotopes of very different sizes. Specific management measures were proposed for each of these biotopes including the estimation of their financial costs. The comparison of spatial financial costs can be used for future planning and decision making.

Tab. 1: Target biotopes and the annual financial costs of the specific management as proposed by this BAP

	CZK/year	Area (m^2)	CZK/year/m^2	%
Rich mesotrophic meadow	59544	4200	14.2	4%
Extensive orchard	5675	1250	4.5	1%
Recreation zone	378930	21000	18.0	20%
Exposed sandy banks	20191	7100	2.8	7%
Woody steppe	294890	71200	4.1	68%
Exposed vertical banks*	-	-	-	-
Total	**759230**	**104750**	**7.2**	**100%**

- Exposed sandy banks were identified as maintenance-free biotopes

Conclusions

This BAP used an original approach towards finding a harmonic balance between the management demands of target biotopes (both temporal and financial) and the conservation and enhancement of their ecological value (biodiversity). From the ecological point of view, the most valuable biotopes (with highest potential biodiversity) of the restored area were rich mesotrophic meadows and exposed sandy banks and exposed vertical banks. The most of important and protected species are expected to inhabit these areas. Therefore these types of biotopes should receive special care. To conserve and enhance the ecological stability and value of target biotopes, periodical management measures are required each year. To sustain long-term stability which inherently means yearly financial costs from land managers, finding a balance between the demands of nature and man is essential.

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Souhrn
Předkládaný BAP vylišil na rekultivovaném území 6 cílových stanovišť velmi rozlišné velikosti. Ke každému stanovišti byl zpracován návrh managementu včetně finanční rozvahy. Z pohledu zachování či zvýšení biodiversity a biologické hodnoty rekultivovaného území jsou nejcennější stanoviště: Obnažené vlhké písčiny, Obnažené vlhké svahy prudké a Ovsíková louka. Na tato stanoviště je vázána převážná většina ohrožených a chráněných druhů rostlin a živočichů, a proto by na ně měl být v rámci managementu kladen největší důraz. Z dlouhodobého pohledu je provádění managementových zásahů nezbytné pro udržení nejcennějších stanovišť, tedy vysoké biologické hodnoty rekultivovaného území.

Contact:
Ing. Jan Deutscher, Ph.D.
E-mail: jan.deutscher@mendelu.cz

BUILDING OF INDIVIDUAL HIKING TRAILS IN THE NORTHERN NEGROS FOLLOWING THE METHODOLOGY OF THE CZECH TOURIST CLUB AS A POSSIBLE SUPPORT OF LOCAL COMMUNITIES AND NATURE PROTECTION

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

Abstract
The article presents the project focused on the creation of a network of hiking trails in the attractive destination of Northern Negros, Philippines following the methodology of the Czech Tourist Club. The new hiking trails were marked out in the terrain by classic Czech painted signs on trees and especially on marking bamboo posts and were leaded in the areas with high or extraordinary nature protection importance to show the nature protection consequences of passed localities to the visitors. Moreover, the trails were equipped with signposts and other marking necessities and a small maps of their location were produced using the GPS and GIS. The project was carried out by students from MENDELU in Brno with in cooperation with the local experts. Because the trails were formed for the individual hiking it supposes that their influence to the nature will is lower than in case of guided group hiking. This fact can help to save the unique nature of Northern Negros.

Key words: Czech Tourist Club, hiking trails, nature protection, Northern Negros

Introduction

Individual recreation in the nature is one of the oldest way how to recharge one´s energy. Among others kinds of individual recreation in the nature just hiking holds specific place. From goalless roaming to the specific forms of hiking (such us Nordic walking etc.) all of them need the hiking paths. Ability to recognize where the hiking paths could be divided into two extremes (with many transitive forms of course); complete knowledge of passed by locality or reaching of marked touristic (hiking) trails.

The article presents the project focused on the creation of a network of hiking trails in the attractive destination of Northern Negros, Philippines following the methodology of the Czech Tourist Club. The project was conducted by the group of students of Mendel University in Brno in the autumn 2016 in frame of their practical stay in Philippines. People from local community were also involved into the project solution. The principal idea of the project was to form the trails for the individual hiking (instead of in locality traditional guided group hiking) and by that reduce the influence of hiking to the. As for the author's opinion, this approach can help to save the unique nature of Northern Negros.

Materials and methods

Negros island is with the area of 13 328 km² the third biggest island of the Philippines. It´s length is approximately 185 km and average width is approximately 55 km. Negros is located in the centre of Visayas part of Philippines and is surrounded by Panay and Guimaras islands on the northwest and Cebu island on the southeast. Mentioned islands are separated from Negros by the Sulus Sea (southwest), Bohol Sea (southeast) and Visayas Sea (north). The morphology of the

island is relatively flat only on the west are situated volcanic mountains with several hills which influences the surrounding areas - Silay (1535 m asl.), Mandalagan (1885 m asl.) and the highest Mt. Kanlaon (2465 m asl.).
Negros island is politically divided into two parts; western Negros occidental and eastern Negros oriental. Bacolod is the capital city of the Negros island and of the Negros province too.
The locality where was presented student project carried out is situated to the northern part of Negros, o National Park Mount Kanlaon or more precisely to its part called Rafael M. Salas Nature Park. NP Mount Kanlaon was established in 1934 in the area of Mt. Kanlaon volcano. Its area is approximately 25 000 ha where forest cover reaches 47%, rest of the area is covered by open meadows, pastures and cultivated arable lands settled by local communities (Mallari a kol., 2001).
Rafael M. Salas Nature Park is located in the east part of NP Mount Kanlaon at the altitude of approximately 800 meters above sea level. It has an area of 300 hectares. The Bagacay river springing in Mt. Kanlaon massive is the main water recipient in the area. Guintubdan village is located within the park and the management authority of the park is situated there (so called DENR - Department of Environment and Natural Resources). The administrative authority of the park is located in Bago city.
Methodologically the processing of the project could be divided into two steps. The first one was focused on terrain marking of touristic trails (in many cases leaded through existing paths) the second one solved the touristic map of the trails carrying on. As for the first step, as was mentioned above, the touristic trails were marked in terrain mostly following existing path. Each of them was routed to the some interesting point and back. In terrain were marked using the standard Czech Tourist Club signs (two white strips bordering the colored one - yellow, green, red or blue). The parameters of the signs were obtained from the reference book Basic Rules for Marking Touristic Trails and for establishing Touristic Signs (Czech Tourist Club, 1999). Finally the starting point of the trails was marked by the guidepost construction.
As for the map carrying out, the GPS technology was utilized for data collection). The coordinates as well as the altitude of each important point of the trails were recorded. Then the data were incorporated to the map using ArcGIS. The Google Maps data were used as basic map layer for final expression of the touristic trails.

Results

Using methodology described above, finally three touristic trails were marked.
First trail – future short nature trail traversing the roster farms – A concrete path has already been constructed on this trail (see figure 1). At some parts there are also several jambs (ready for a creation of a rope railing). These sections were measured and it is estimated that 110 meters of rope is needed for the railing. This nature trail is 0.8 km long and it was marked with a blue color. The hiking marks were, due to good visibility, drawn on those jambs – always in both directions as is usual. On the trail, several points were recorded using GPS – these places were assessed as suitable for the emplacement of instructive signs or to create recreation zones in future.

Fig. 1: Marking the blue colored trail tracking on the concrete path

The other two trails are leading to the waterfalls . The shorter one, a 1.4 km long trail leading to the Oro Falls, was marked by yellow color; the longer and more difficult trail almost 4km long leading to the Buslugan Falls was marked by a red color. Due to the fact that there is a strict prohibition of any tree damage (including marking), bamboo sticks were used for the marking of these routes. They were provided by local inhabitants. The usage of bamboo was chosen for several reasons – exceptional durability, natural abundance and furthermore the natural character of trails was not compromised. All bamboo sticks were more or less uniform, each was approximately 150 cm long and 15 cm wide in diameter (see figure 2). After drawing hiking marks, all the bamboo sticks were stationed in the terrain with the help of local guides.

Fig. 2: Bamboo sticks used for marking the trails where using another ones is forbidden

The Guidepost construction consists of wooden boards (*Philippine mahogany*) and bamboo pilots and roof. It was situated at a busy part of Guintubdan village, on the starting point of all three trails. On the November 2016 the trails were visited by the rector of MENDEL University in Brno Prof. Havel and by the representative of the Czech Embassy in Manila Ing. Vytopil (see figure 3).

Fig. 3: Guideposts of the trails with delegation of MENDELU in Brno and the Czech Embassy in Manila

Finally the map of marked touristic trails was carried out. In the Google Maps layer were set particular points measured in terrain by GPS. Particular trails were in map marked by their coloring in the terrain. Spatial expression of touristic trail is shown on the figure 4.

Fig. 4: Reprint of the spatial map of the trails

Discussion

Presented results of the practical student project support not only the development of the area of the Rafael M. Salas Nature Park, but by leading the visitors only on well defined paths will also inhibit the use of unauthorized hiking trails in the locality. This is in coincidence with Philippines policy of nature protection (eg. Revilla 1997). The trails, leading through the protected Nature Park are intended to show the importance of nature preservation, protection of local species as well as the consequences of nature damage to the visitors. This fact is very important for biodiversity conservation understanding (Catibog and Heaney 2006). All the trails are marked as the foot paths with respect to surrounding environment also the areas requiring higher care from the natural and nature protection point of view were identified close to the trails. These localities of natural importance where for example

new reforestation is intensively needed are searched for and solved by Philippines National Reforestation Program (Forest Development Center 1987).
Partial goals of the project was also to assess the possibility of the transfer and implementation of the unique technology of marking hiking trails used by the Czech Tourist Club to the conditions of Philippines (Czech Tourist Club 1999) and it seemed to be definitely without any problem.

Conclusion

The article presents the results of the project focused on the creation of a network of hiking trails in the attractive destination of Northern Negros, Philippines following the methodology of the Czech Tourist Club. In the locality of Rafael M. Salas Park three touristic trails were identified, marked in terrain and also the map of the trails was carried out. The initial guideposts as the mark of the trails starting point was constructed and situated to the Gintubdan village. All the trails were formed for the way of individual hiking so their influence to the nature is expected to be lower than in case of guided group hiking. It can help to save the unique nature of Northern Negros, Philippines.
The trails were marked by the students of the study programme “Natural Resource Management in the Tropics and Subtropics” of Mendel University in Brno. Also local inhabitants were involved into the project solution and they are expected to take part in the identification of individual hiking trails and to use the newly created hiking trails not only to their own relax and vacation, but also as a way to support tourism in the region.

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Souhrn

Článek prezentuje výsledky projektu zaměřeného na vyznačení několika turistických tras podle metodiky Klubu českých turistů na Filipínách, konkrétně v severní části ostrova Negros. Práce byly soustředěny do lokality Přírodního parku Rafaela M. Salase. Celkově byly vyznačeny tři turistické trasy, každá vždy k nějakému významnému turistickému cíli. Východisko tras je situováno do obce Gintubdan a je opatřeno výchozím rozcestníkem tras. Smyslem značení tras jakožto individuálních turistických tras pro pěší bylo, mimo jiné, snížit zátěž na přírodní prostředí, kterou generuje v současné době skupinová pěší turistika s průvodci.
Projekt byl řešen v rámci praktického výjezdu studentů LDF MENDELU v Brně, studijního programu Hospodaření se zdroji trapů a subtropů. Do řešení projektu byly

zapojeni rovněž místní obyvatelé, kdy se předpokládá, že se s problematikou značených turistických tras ztotožní, budou značené stezky využívat pro svoji vlastní rekreaci, ale zejména využijí jejich potenciál pro turistický rozvoj regionu.

Contact:
Doc. Ing. Petr Kupec, Ph.D.
E-mail: petr.kupec@mendelu.cz

CHRISTMAS DECORATION FROM FOREST MATERIALS

Jiří Kadlec, Alžběta Hejduková
Department of Forest and Forest Products Technology, Faculty of Forestry and Wood Technology, Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic

Abstract
Non-wood forests products (NWFPs) are large group of products which are used in different fields of human life. Decorating materials are very popular NWFPs with utilisation in floristic compositions and have long tradition use in Christmas time. The aim of this article is presentation of popularity of wreath from greenery in Christmas time. There are differences in origin of wreath which were observed in survey. 13 % of respondents are buying wreaths, 49 % are making their wreath at home, 13 % obtain wreath as present, 21 % of respondents have no wreath as decoration and 4 % gained wreath otherwise.

Key words: greenery, wreath, Christmas, survey

Introduction

Greenery is material which is possible to obtain from silvicultural or final felling. We divide it to greenery from coniferous or broadleaves trees. Greenery utilisation is one of NWFPs (Kuchtík 1988).
Wreath became a symbol of all cultures and of accompanying him all sorts of meanings. Egyptians saw in the rim cyclicality of the sun's path across the sky. Buddhists perceive the rim wheel of life and rebirth. Greeks and Germans considered wreaths of evergreen plant as a symbol of eternal life. Romans Round washers yarns bound green plant material, this technique to preserve today (Vaňková 2007).
Of vegetable materials for the formation of wreaths they are usually used blossoms, leaves, stems, fruits, mosses, cones and twigs. Bound ring formed by tying the plant material to the pad (Haake 2014).

Material and methods

Market interest in wreaths was detected using a questionnaire during February 2017. The questionnaire was created by service companies Survio Ltd., which provides a free online version of the questionnaire. It was compiled a list of 10 questions that best describe the structure and market interest in decoration of evergreens. Link the question mark was shared via social networks, specifically on www.facebook.com.

Results and Discussion

The questionnaire within a month of 200 respondents answered. The most interesting results from questionnaire are connected with way of obtaining of wreaths and materials which are use for making of wreaths.
Figure 1 shows portion of answers on way how respondents obtained their wreaths. The highest portion of respondents (49 %) manufacture their wreaths at home, 13 % are buying wreaths, 13 % obtain wreath as present, 21 % of respondents have no wreath as decoration and 4 % gained wreath otherwise.

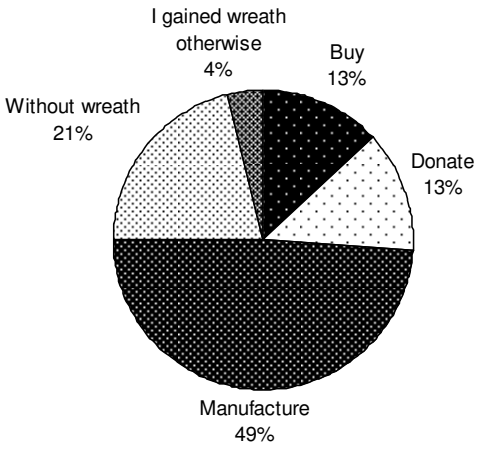

Fig. 1: How did you gained in this year a wreath?

Interesting results are connected with materials which are used in making of wreaths (see Figure 2). 66 % of respondents use greenery, 7 % other materials, 5 % wickery, 1 % mosses and 21 % of respondents has no wreath during Christmas time.
Our result from pilot study is impossible to compare with another research. When we are looking for high portion home made wreath we can assume that material for making of wreath is collected during touristic visits in forest.

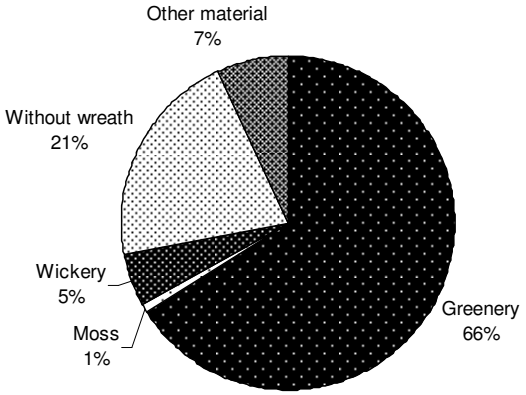

Fig. 2: From what material was a wreath?

Conclusion
Wreaths are typical Christmas decoration in many families in the Czech Republic. It became very popular and just 21 % of families have no wreath as decoration. On the other hand high portion of home made wreaths show that a lot of people are looking for material in forest because greenery is major material used for wreath making. It seems that greenery is picked during recreational visits in forests.
It will be useful to continue in research on forest material preferences of forest visitors during their recreational activities.

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The research was financially supported by the Research programme of the Faculty of Forestry and Wood Technology, Mendel University in Brno, IGA LDF_PSV_2016008.

Souhrn
Nedřevní produkty lesa jsou významnou skupinou produktů, které jsou lidmi vyhledávány a často jsou součástí turistických aktivit v lese. V předvánočním čase jsou oblíbenou dekorací v domovech věnce, které jsou většinou tvořeny větvemi jehličnatých dřevin. Cílem příspěvku je prezentovat popularitu věnců v předvánočním čase a preference materiálu pro jejich tvorbu. Z výsledků dotazníkového šetření je zřejmé, že dominuje vlastní výroba věnců v jednotlivých domácnostech, při které je využíváno jehličnatých větví. Lze předpokládat, že většina větví je získávána v lesích při rekreačních aktivitách a následně využita při tvorbě dekorací. Do budoucna bude vhodné se zaměřit na zjištění, které druhy dřevin jsou v lese vyhledávány pro tvorbu dekorací.

Contact:
Ing. Jiří Kadlec, Ph.D.
E-mail: jiri.kadlec@mendelu.cz

CLIMATE AND RECREATIONAL HUNTING, A CASE STUDY FROM THE LIPTOV REGION, SLOVAKIA

Jana Špiaková, Martin Jančo
Department of Natural Enviroment, Faculty of Forestry, Technical Univerzity in Zvolen, T. G. Masaryka 24, 960 53 Zvolen, Slovakia

Abstract
Hunting function is one of the forest ecosystem services. Recreational hunters show primary interest for trophy game, due to attractiveness of the game hunting itself and due to trophies kept as permanent memories. A special experience is roe deer hunting. The roe deer, as an autochthonous species in Slovakia, meets favourable living conditions over the entire Slovak territory. One of the most north-situated occurrence localities for this species is the Liptov region. This work studies the statistical dependence of roe deer (*Capreolus capreolus* L.) trophy score on bio-meteorological variables. The correlation analysis resulted in finding that the roe deer trophy quality in the III-rd age class was mainly influenced by snow cover duration. This dependence was high statistically significant.

Key words: roe deer, trophy quality, game management

Introduction

Ecosystem services may be defined as out-of-production goods and services supplied by the nature to sustain the people community living over the Earth. Their assessment is usually quite complicated. E.g. Vilček a Bujnovský (2014) reflect ecosystem service Slovak soils by points, but also their price. The Millenium Ecosystem Assessment (MEA, 2005) has diversified the ecosystem services into the following four groups: supporting, provisioning, regulating and cultural (Korbeľová a Kohnová, 2017). The cultural services represent non-material offerings and profits for the man from ecosystems; such as recreational possibilities, aesthetic experiences in the nature and ecological tourism

A very wanted recreational activity is hunting, in many localities performed as charged hunting, with primary focus on trophy game. In these cases, the trophy quality of the hunted game is imperative.

We focussed on the region Horný Liptov, one of the most northern-situated occurrence localities for the roe deer (*Capreolus capreolus* L.) in Slovakia. Horný Liptov means the Liptovská kotlina basin with the longest Slovak river Váh. The whole basin circumference is bordered with high mountain ranges. The region comprises several hunting grounds, assembled under the unique Regional Game Commission in Liptovský Mikuláš.

Recreational hunters using charged hunting services show primary interest in the game trophy quality over the locality. Improved services and experiences guarantee more visits to the locality repeated later.

The harsh climatic conditions in the Horný Liptov region imply harsh living conditions for the game. The game trophies, however, exhibit a high quality. This is evident during game-breeding exhibitions organised yearly by the Regional Game Commission in Liptovský Mikuláš. In the game management, there is very common to over-value the genetic-associated factors as determining development of high scored antlers, while the correct development equally depends on other external factors. Beside trophic conditions and genetic-associated factors, the antler

development in the roe deer (*Capreolus capreolus* L.) is influenced by the local climate, diseases and other factors Rajský et al. (2016).

Materials and Methods

The study site is an area in north-central Slovakia in the Liptovská valley (495 to 1000 m above sea level). Climate is with mild summers (the average temperature in July 10/16 °C) and cold winters (–5/–9 °C in January), in winter, the valley is characterized by temperature inversions, when it is colder at lower altitudes than at higher ones. The average annual rainfall for the 1961-1990 periods in the Liptov valley was 710 - 1550 mm. In the Liptov valley snow falls in 100 to 150 days. The share of snow increases with height. (Skvarenina et al. 2004; Skvarenina 2009b; Gaal et al. 2014; Vilcek et al. 2016; Szolgay et al. 2016)

The influence of bio-meteorological factors on the roe deer (*Capreolus capreolus* L.) trophy quality in Horný Liptov was analysed based on the following variables: number of snow cover days, overall snow cover depth, and mean and minimum air temperature during the antler growing period, roe deer of the age class III. The processed data and individual roe deer scores were compared by correlation analysis. From the comparisons between the obtained correlation coefficients and the critical values reported by Šmelko, Wolf (1977), we inferred the accumulated effects of all the factors on the antlers quality score.

The roe deer scores were assembled form the Catalogues of the trophy game hunted down during the hunting seasons 1987 – 2015, published yearly by the Regional Game Chamber in Liptovský Mikuláš. We decided to restrain to the age class III, representing six- and more year-old individuals. In this age class, the hunting-down is allowed based on the age assessed, so there is a little impact of the subjective choice of the hunter. In this class, no selective shooting is allowed. Then, the mean score values for the roe deer trophies from the III. age class were compared by simple correlation analysis with selected meteorological data provided by the Slovak Hydrometeorological Institute (SHMI) in Liptovský Hrádok.

Results and Discussion

The roe deer trophy scores in the III-rd age class seem influenced by the overall snow cover depth. The values of this variable were obtained by summing all the monthly snow cover values form November to March, this means the growing period of antlers. The overall snow cover depth exhibits a considerable variability over the Liptov region, and there are also big inter-annual differences. The relation between the trophy quality and climate was explored through correlation analysis, the results are in Fig.1.

The simple correlation analysis gave a correlation coefficient value of 0.279 indicating a very low statistical significance. We may judge about a very low impact of snow cover depth on the trophy scores in the roe deer related. Similar conclusions were derived by Jurík (2013) evaluating this dependence in 1987-2011 and by Pjatek (2015) studying the issue in 1987-2015.

The next factor supposed to influence the trophy quality in roe deer was the number of days with continuous snow cover during the period of antlers development.

The results of simple correlation analysis revealed that the trophy scores were strongly dependent on the number of days with snow cover in the antlers growing period. This correlation was very significant. The regression coefficient value was 0.702, at a 99.99 % confidence level. The negative dependence means that the trophy quality decreased with increasing snow cover days. The regression equations related shows a decrease by 0.1314 per one snow cover day more.

The decisive fact for antlers development in the roe deer was not the snow cover depth but the continuity of this cover over the day. This meteorological variable can influence the food accessibility for animals, as the snow cover is formed and kept on frozen surface only.
The last meteorological characteristic examined as influencing the roe deer trophy quality was the mean monthly air temperature over the region. There is a considerable inter-annual variability ranging from -3.1 °C recorded in 1987 to the maxima obtained in the recent years.
There has been identified a positive correlation between the trophy scores and mean monthly air temperature. The regression coefficient value was 0.287, so the dependence was low significant, indicating effects for about 29 % individuals only.
Fig. 4 displays the correlation between the roe deer trophy scores over the Horný Liptov region and the minimum monthly air temperature over this area. We can see a slight positive correlation. The correlation coefficient value of 0.346 indicates this meteorological parameter could affect about one third of the animals.

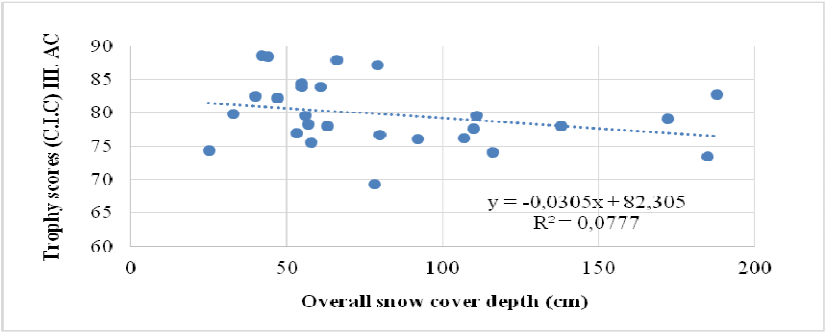

Fig. 1: Dependence of roe deer trophy scores on the overall snow cover depth (r=0.279, degrees of freedom n=29, probability α=0,10, *low significant)

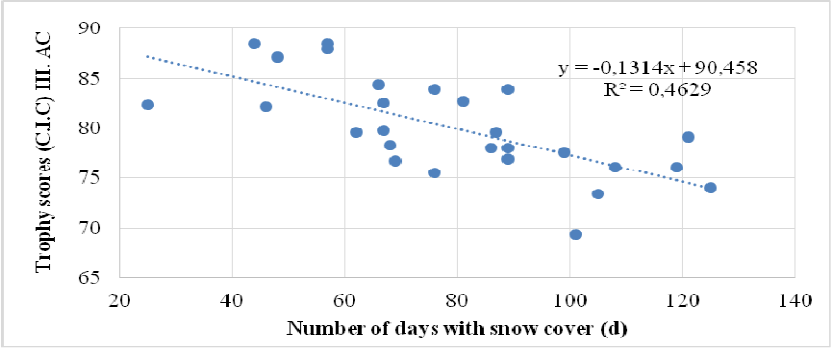

Fig. 2: Dependence of roe deer trophy scores on the number of days with snow cover (r=0.702, degrees of freedom n=29, probability α=0,01, ****high significant)

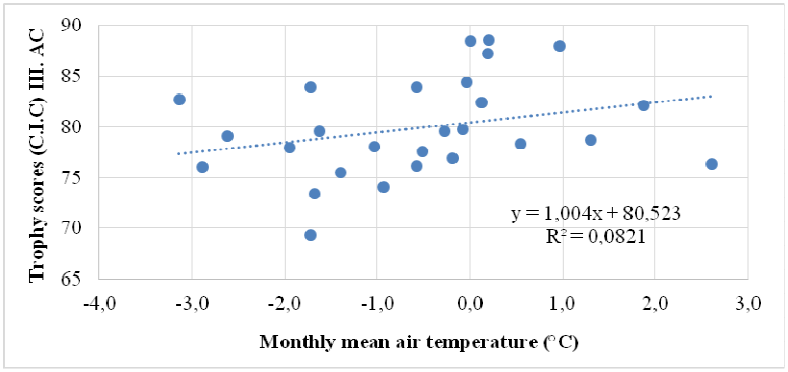

Fig. 3: Dependence of roe deer trophy scores on the monthly mean air temperature (r=0.287, degrees of freedom n=29, probability α=0.10, *low significant)

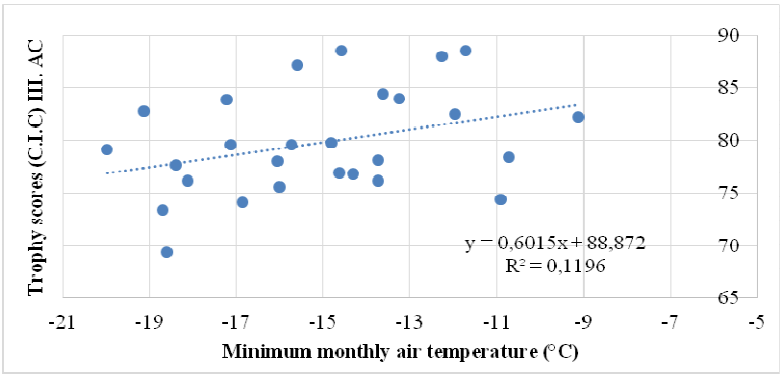

Fig. 4: Dependence of roe deer trophy scores on the minimum monthly air temperature (r=0.346, degrees of freedom n=29, probability α=0.05, ** significant)

Conclusion

The performed correlation analysis revealed statistical that the roe deer trophy quality was dependent on climatic conditions in the species occurrence area. There has been confirmed our expectations according to which the number of days with snow cover is the leading bio-meteorological factor influencing the trophy scores in roe deer in Horný Liptov. For this variable, we identified a very strong negative statistical dependence. The regression equation indicated an antler score reduction by 0.1314 points for one snow cover day extra. The other bio-meteorological factors did not show such significant influence on the roe deer trophy quality.

This finding is novel for the game management practice. The knowledge of the winter weather history facilitates predicting the antler strength for the roe deer in the next season, and planning hosted hunting events in accord. At assessment of the trophy quality, the medal position often depends on decimal fractions only. A medal holding, however, is one of the commonest requirements expressed by the hosting hunters.

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Souhrn
Korelační analýzou jsme dokázali, že mezi trofejovou kvalitou srnčí zvěře a klimatickými podmínkami prostředí, ve kterém se vyskytuje, existují statistické závislosti. Tak, jak jsme předpokládali, biometeorologický faktor, který nejvíce ovlivňuje bodovou hodnotu trofejí srnčí zvěře na Horním Liptově je počet dní se sněhovou pokrývkou. Zjistili jsme, že mezi těmito veličinami je vysoce významná, negativní statistická závislost. Podle regresní rovnice víme, že každým dalším dnem se sněhovou pokrývkou klesá bodová hodnota paroží o 0,1314 bodu. Vliv ostatních zkoumaných meteorologických faktorů na kvalitu trofejí srnčí zvěře už nebyl tak významný.
Toto zjištění dává nový poznatek myslivecké praxi. Na základě průběhu zimy bude možné předpokládat, jaké silné paroží bude mít zvěř v následující sezóně a následně tomu přizpůsobit i plány honů. Při hodnocení kvalitních trofejí často rozhodují desetiny bodů o tom, zda bude jedinec ohodnocen jednou z medailí. Což je často jeden z požadavků hostujících myslivců.

Contact:
Ing. Jana Špiaková
E-mail: jankaspiakova@gmail.com

CONDITIONS OF DEVELOPMENT OF VOLCANIC ATTRACTIONS IN THE PLANNED COLCA AND ANDAGUA VOLCANOES GEOPARK IN SOUTHERN PERU

Andrzej Gałaś, Slávka Gałaś
Faculty of Geology, Geophysics and Environmental Protection, AGH University of Science and Technology, Poland

Abstract
The analysed area is located in the Western Cordillera in the department of Arequipa. The results of the investigation carried out by the Polish Scientific Expedition Peru, which goal was to prepare the scientific background for establishing a national park in the area of the Colca Canyon and the Valley of Volcanoes, have been used for the study. At present, the Peruvian Institute INGEMMET is endeavouring to establish there a protected area in the form of a geopark under the auspices of UNESCO. Establishment of the Geopark Colca and Andagua Volcanoes will create new opportunities for touristic development. Among the numerous geosites described in this area, those related to volcanic activity deserve special attention. There are numerous: stratovolcanoes, lava domes, pyroclastic cones, lava flows, geysers and hot springs in the area. Also layers of tuff, ingimbrites, lahars and other volcanic rocks occur there. Indication of possibilities to make volcanic forms accessible will be an important step in their touristic development. Conditions and restrictions in making the objects accessible in the light of protection of other environmental values have been analysed during the study. Apart from tourism, highly developed mining industry, farming, hydrotechnical and power investments of supra-local scale occur in the area. Therefore, indicating necessity to establish zones of limited access to protect the area against improper land development is also an important aspect.

Key words: volcanic geosites, geoturism, conditions, Colca Canyon, Peru

Introduction

geoparks. For more than a dozen years, the number of approved areas and applying projects has been growing. The major goal of the UNESCO geopark network is to promote geo-diversity through promotion of geotourism, geolandscape and geosites in the context of natural, cultural and human resources. Geoparks in volcanic areas play a special role in the international arena. A chance to observe spectacular natural forces released during volcanic activities attracts thousands of tourists. However, active volcanoes such as Stromboli (Aeolian Islands-Italy), Kilauea (Hawaii, USA), Arenal (Costa Rica) are quite difficult to access. Hence, many geoparks where dormant volcanoes and effects of their recent activity can be observed are very popular. When the Global Geoparks Network was commenced in 2004, Vulkaneifel (Germany) and Wudalianchi (China) were put on the first list. They are both the areas representing intra-plate volcanism. In the Vulkaneifel area, 340 eruption centres have been identified, including pyroclastic cones and maares. The Wudalianchi area is known for about 1,500 pyroclastic cones and lava fissures of various ages and stages of preservation (Dowling & Newsome 2006).
Designation of a geopark involves interest, cooperation and consent of the local community. Educational aspect is of particular importance. It is to provide opportunity not only to study phenomena and processes that result in formation of

the relief of our planet but above all to trigger changes in human behaviour (UNESCO 2016). Economic activities consistent with the idea of sustainable development should be exposed and promoted in the area of a geopark. Putting Wudalianchi on the list of Global Geoparks has increased the number of travel agencies from 5 up to 22 ones (Unesco.org.com 2017). Making environmental values accessible to a wide range of tourists, apart from economic benefits, brings also the danger of losing the values. It is usually the role of scientific centres and state geological services to determine the limits of access and protection of particularly sensitive values. Such situation occurs in the above mentioned Wudalianchi geopark, Muskau Arch (Germany-Poland) and others.

Inventory and valorization of geosites

The accession dossier of the Cola Geopark and Andagua volcano project in southern Peru was submitted to the UNESCO Global Geoparks network in November 2016. The INGEMMET Institute for Inventory Documentation carried out inventory and valorization of geosites in the area (Zavala 2015, Zavala et al. 2016). 119 sites were identified and divided into 8 thematic groups: geomorphology, hydrogeology, volcanology, neotectonics, geodynamics, paleontology, stratigraphy, structural geology. The sites were also qualified for future use by division into the following functions: tourist, educational and scientific. Most of the volcanic sites are located in the Valley of the Volcanoes, which complement the scattered sites connected with stratovolcanoes located on both sides of the Colca Canyon (Fig.1). The volcanic sites are distinguished in terms of quantitative, scientific and didactic qualities. A significant amount of them - 31 is concentrated in the Valley of the Volcanoes. The remaining ones -19 are located along the Colca Canyon and the Colca Valley. A large number of objects means increased opportunity to observe intermediate forms, partly transformed by geological processes. It creates excellent conditions for preparation of educational pathways related to volcanology which enable tourists to access the sites and scientists to carry out research studies.

Volcanic geosites management in the Valley of the Volcanoes

The Valley of the Volcanoes is about 90 km long and it generally runs longitudinally. In its middle part, about 30 km long, the axis of the valley turns NW-SE. In the upper northern part where a mining town Orcopampa is located, the bottom of the Valley of the Volcanoes lies at the altitude of 3800 m a.s.l. The outlet of the valley into the Colca Canyon in the southern part is at the altitude of 1300-1360 m a.s.l. The mountains surrounding the valley are 3500 – 5000 m high. Approximately at the border of the middle and the upper part of Valley of the Volcanoes, following the extension of its axis towards NW-SE, there is a side valley Sora, also filled with Andahua lava (Gałaś 2008). Lavas form a dense cover, tightly filling the Valley of the Volcanoes between Misahuanca and the mouth of the Rio Ayo, at the length of about 50 km. The cover is divided into lava fields with clearly defined boundaries (Gałaś 2014). The town of Andagua is surrounded by the most interesting volcanic forms belonging to the Quaternary Andahua group. Pyroclastic cones and small lava domes with lava flows are the biggest attractions there. Three cones: Ticsho (2- see Fig.1), Yanamauras Norte and Yanamauras Sur (also called Jemellos, 3), occur on the outskirts of the town. North of Andagua, on the eastern edge of the valley, near the abandoned Santa Rosa antimony ore mine, Puca Mauras (1), the largest cone in the valley (340 m) and a small lava dome complex occur. At the top of the volcano and on the lava flows, there are remnants of pre-Hispanic buildings. The lava cover, and the subordinately tephra, is about 100-150 m thick and the surface of the

covered area is about 100 km^2 (Gałaś 2008). The middle and southern parts of the Valley of the Volcanoes, from the line marked by Jenchaña (5) cone and Pumajallo Lagoon to the place where it joins the Colca Canyon, are covered by lavas of the youngest – third generation, forming the lava fields of Accopampa, Chilcayoc and Sucna. Jechapita volcano, which is an example of an "ideal" pyroclastic cone, is located on the edge of the Chilcayoc field. In the immediate vicinity there are two further cones: Chico (6) and Chilcayoc (7). They were opened by lava flows that flowed out of them and surrounded Jechapita (8). At the centre of the lava field, there is Chilcayoc Grande (9) cone. In the area, ten lava flows, which pile up and intersect, can be found. Near Laguna Chachas, along the Rio Andagua, interesting structures of lava flows such as: aa lava flows, block lava flows and flow banding can be observed (Gałaś 2014). From the slope located above, there is a great view of the lava covering the entire width of the Valley of the Volcanoes in that place. Such large concentration of sites should be used to mark out an educational path: Andagua volcanoes – pyroclastic cones and lava flows. At present, most of the proposed sites in the area are accessible via comfortable but unmarked paths used by Andagua, Chachas and Sopporo residents. Along the western border of the Valley of the Volcanoes, there is also a dirt road which is accessible by car and even by a small bus travelling to Ayo and Chachas.

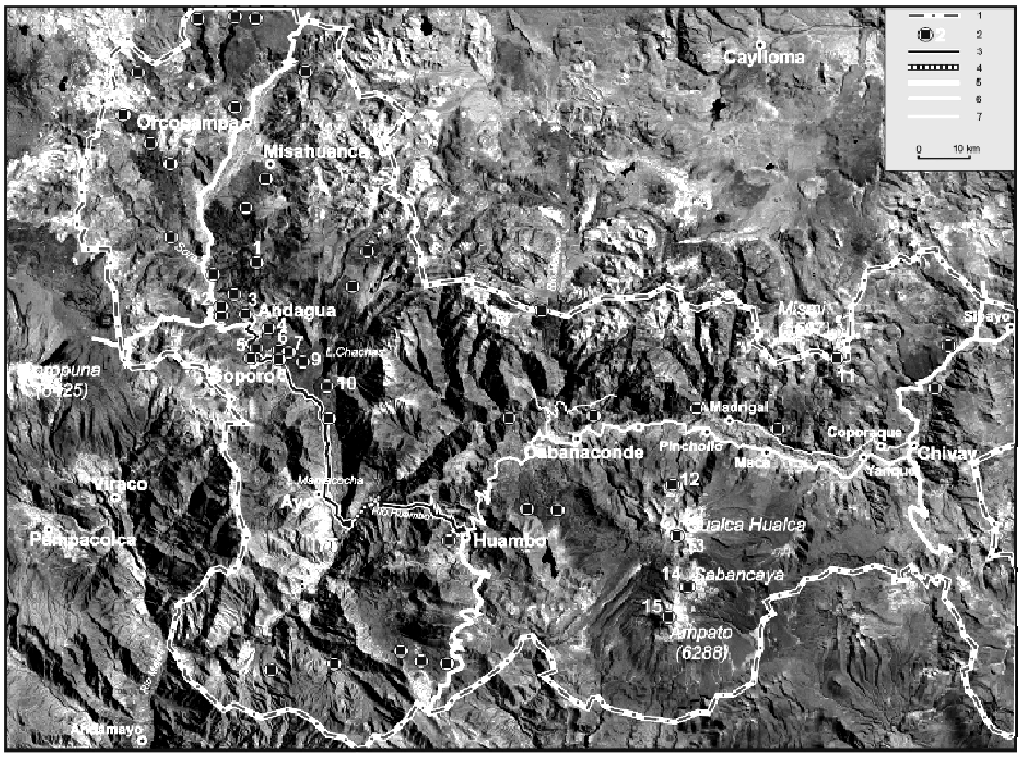

Fig.1: Map of project Geopark Colca and Volcanoes the Andagua (Landsat 7). 1 – borders of territory of the Project Geopark, 2 – volcanic geosities (number use in text), 3 – Andagua – Huambo road ready, 4 - Andagua – Huambo road in construction, 5 – regional roads, 6 – local roads, 7 – small local roads.

Using the existing dirt roads running along the Valley of the Volcanoes, it is easy to get close to the described forms, but it is harder to reach the top of a cone or the surface of a lava flow.

Stratovolcanoes as geosites

There are stratovolcanoes among the proposed sites: Mismi (11), Hualca Hualca (13), Ampato (15), Sabancaya (14, Fig.2) and forms related to them such as exposures of lava with a columnar joint (e.g. Cabanaconde), ignimbrite (Collunas) or diatomite (Maca). Most of those exposures are located in the Colca Valley where there is a well developed communication network and services for tourists. Chivay is the centre as there are entities that cater for virtually all needs of tourism there. Thermal pools which guarantee relaxation are also available in the vicinity of Chivay.

Fig. 2: Active Sabancaya volcano from the Colca Valley (July, 2015).

A significant part of the area of the planned geopark is occupied by the Volcanoes Complex Hualca Hualca (6025 m a.s.l.) - Sabancaya (5976 m a.s.l.) - Ampato (6288 m a.s.l.). Andesite lava flows and andesite basalt from the Pliocene Hualca Hualca volcano, which total thickness exceeds 100 m, form the walls of the Colca Canyon at the level of Cabancaonde. A huge niche was formed on the northern slope of the volcano as a result of a landslide. The colluvium of the landslide is hundreds of meters thick and solfatara fields and an active geyser (12) occur in its area. The youngest volcano in Peru – Sabancaya is located between Hualca-Hualca volcanoes and Ampato. Pumice, block-ash and scoria flows, up to 7 km long, have been documented in the volcano surroundings. Activity of subplinian type is characteristic for the volcano. There is a unique panoramic view of the Western Cordillera from the top. At present, activity of the volcano makes tourist access impossible. Mismi (5597 m a.s.l) is a multi-top stratovolcano of the Neogene age located on a watershed between the Atlantic Ocean and the Pacific Ocean. Since 2010, there has been no glacier on the summit. The described stratovolcanoes, which are proposed as geosites, have unique and outstanding research values, both for tourism and scientific purposes (Gałaś et al. 2014). They cannot be the object of mass tourism due to their limited accessibility, although, there are roads providing access to the base, which might be used as a starting point for trips to the slopes and the crater. Altitude of the base is often about 5000 m a.s.l. As it is very well known, staying at high altitudes is connected with numerous threats. One of the major problems in high mountains is the so-called altitude sickness. A serious

problem with the availability of water is another difficulty encountered when setting up a camp in that part of the Andes. Limited consumption of water may precipitate occurrence of the altitude sickness. Furthermore, protected species such as vikuna, guanaco and puma can be found on the slopes of the volcano. Frequent presence of large groups of tourists can be a serious threat and may interfere with that unique ecosystem.

Conclusion

The middle part of the Valley of the Volcanoes between the Jenchaña-Niñamama fault line in the north and the lava dome area near Sucna is a true pearl in terms of tourism and educational attractiveness. There are easily accessible volcanic forms there, such as: lava domes, pyroclastic cones, block lavas, aa lavas, furrows in lava flows. It is possible to see a perfect cone Jechapita and less regular Chilcayoc Chico broken by the lava flowing out of it.

Stratovolcanoes, which are characteristic for that part of the Andes, highlight the alpine nature of the terrain. They can be a place of climbing or tourist exploration only for people properly equipped and physically fit. The large size of the stratovolcanoes makes them also visible from the Colca Valley or the Valley of the Volcanoes. Apparently, the planned Geopark Colca and Andagua Volcanoes fit in the unique geological diversity of our planet.

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Souhrn

Oblast kaňonu Colca a Údolí sopek se vyznačují pestrou geologickou stavbou. Jedná se o oblast s aktivní seismickou zónou, která patří do SVZ – střední vulkanické zóny. Láva zde vytvořila pevný pokryv v celkové délce asi 50 km. Město Andagua je obklopeno právě nejzajímavějšími formami sopečné činnosti: pyroplastickými kužely a dómy s malými proudy lávy, které jsou v této oblasti největší turistickou atrakcí a také jsou zajímavé z hlediska vzdělávání. K dispozici jsou tak snadno přístupné různé sopečné formy. Stratovulkány, které jsou

charakteristické pro část And tak zvýrazňují charakter terénu. Mohou být tedy využity jako místo k lezení nebo pro turistické nadšence, ale jen takové, kteří jsou fyzicky zdatní. Tato oblast se nemůže stát předmětem masové turistiky už jen z pohledu omezené dostupnosti.

Contact:
Slávka Gałaś
E-mail: sgalas@geol.agh.edu.pl

DEER BROWSING IS ONE OF THE LIMITING FACTORS OF CONVERSION TO UNEVEN AGED FOREST

Robert Knott, Kateřina Novosadová, Lukáš Opravil
Department of Silviculture, Mendel University in Brno, Zemědelská 3, 61300 Brno, Czech Republic

Abstract
We can see distinct growing importance of non-wood-producing functions in forestry recently. Selection uneven aged system is one of the alternatives in which these functions are on the high level. Selection systems are generally considered to be more challenging to implement and maintain than even-aged silviculture. For the proper functioning of selection system or conversion to this system is essential to have natural regeneration. We focused on the progress and growth of the natural regeneration of fir, spruce and beech in different light conditions in selected stands in the conversion to a selection forest at Training Forest Enterprise Masaryk Forest Křtiny. Based on the statistically evaluated data we found a negative impact of ungulates on growth of main tree species from natural regeneration. Deer browsing is one of the main limiting factors of natural regeneration in the transformation to selection system at this locality.

Key words: selection forest, light conditions, natural regeneration

Introduction

Forest landowners are interested in management alternatives which do not use clear cutting and planting (Pukkala 2016). Uneven-aged management is one of the current trends in forest management (O'Hara et al. 2007). This type of management aims at a certain steady-state forest structure and often assumes that exactly similar cuttings can be repeated at regular intervals to infinity (Schütz 2001a).
The conversion of even-aged monocultures into mixed uneven-aged forest stands is an important topic of forest management in many countries also with the increasing importance of other non-wood-producing roles of the forest (Reininger 1992, Korpeľ, Saniga 1993, Poleno 1999, Schütz 2001b, O'Hara 2001, Souček 2002, Tesař et al. 2004, Remeš, Kozel 2006). Among the biggest risks and the most common reasons for the failure of the conversion into uneven-aged forest is a low presence of regeneration (Schütz 2001a). Some results show that ungulates play a very important part on the structure and dynamics of the regeneration of forests (Ammer 1996) and browsing could be the major factor of decline of particular tree species – for example silver fir (Heuze et al. 2005, Senn, Suter 2003).
For the proper functioning of uneven-aged forest (selection system) is essential to have natural regeneration. In this contribution we focused on the progress and growth of the natural regeneration of main tree species (fir, spruce and beech) in different light conditions in selected stands in the conversion to a selection forest because of lack of trees in thinner girth classes.

Materials and methods

Our research was carried out in Training Forest Enterprise „Masarykův les" Křtiny (Czech republic) at locality Klepačov (49°20'43"N, 16°40'14"E) where a long term conversion experiment from uneven-aged forest to uneven-aged forest (selection system) has been running (1973). The mean elevation in the study site is 300 – 420

m a.s.l.. The soil type is Cambisol (typical, mesotrophic and oligotrophic) on the granodiorite bedrock. The annual mean temperature in the area is approximately 7.9°C, with annual rainfall of 596 mm (375 mm in vegetation season). In the stand, the tree species from inventory in 2003 were as follows: Norway spruce 32.42 %, silver fir 25.83 %, Scots pine 21.83 %, European beech 15.28 %, European larch 3.61 %, sessile oak 0.31 %, European hornbeam 0.10 %, other broadleaves 0.57 % and other coniferous species 0.05 %.

To clarify the reason of the lack of natural regeneration, we have established a total of 90 plots, in different light conditions (each area having a radius of 1 m had an area of 3.14 m^2). In the stand, the main tree species which were studied were European beech (*Fagus sylvatica* L.), silver fir (*Abies alba* Mill.) and Norway spruce (*Picea abies* L.). We also evaluated the stand structure of parent stand on all research plots. We measured height, number and damage of seedlings and we determined their age. Measurements took place in two periods - in the fall of 2015 and spring of 2016. To assess the influence of animals on the natural regeneration, half of the plots were protected by fencing. All data were analysed in STATISTICA 12 (StatSoft 2013).

Results and discussion

Conversion to a selection forest at Klepačov began in 1973. From repeated inventories for the period 1973-2013 it was found that the stands are not in production loss. The problem is maintaining the appropriate species composition, because the natural regeneration of forest stands is inadequate. For the proper functioning of forest selection system (and for conversion to this system) is essential to have a permanent natural regeneration. Longer stagnation of natural regeneration or crisis caused by various factors seriously limit the success of selection system (Schütz 2001a).

From the obtained results we can say that on most plots fir seedlings were 1 year old. One of the problems of natural regeneration shows age and height differentiation of fir seedlings at particular plots, when there is no or only a very small extent of seedlings older than 3 years and not higher than 20 cm (Fig. 1).

From the third year of age of seedlings there is a stagnation in the number of older seedlings and the slowdown in natural regeneration.

One of the main reasons for this unfavorable condition may be particularly animals grazing, when in repeated selective browsing seedlings occurs delay of natural regeneration or increased mortality of seedlings (Senn, Suter, 2003). In 2016 it was damaged by winter grazing even 26 % of fir individuals. Winter grazing was also noticeable in contrast to the summer with at beech seedlings (31 %) and Norway spruce (19 %).

Effect of grazing is illustrated by the average height of seedlings by age in fencing and outside the fenced area (Fig. 2). Seedlings of all species in the fence were higher than in open non protected areas. Beech was most damaged by deer browsing at the age of 4 and 6 years and fir at age of 5 years. Norway spruce seedlings were most damaged at the age of three years.

The numbers of seedlings in the fence on all plots significantly exceeded the number of seedlings outside the fence. This difference was even up to 119 % for silver fir seedlings (Fig. 1) in 2015. This difference was statistically significant in the different levels of the crown canopy. The number of spruce seedlings in 2016 was 93 % higher among individuals in the fence than outside the fence. In the fenced areas it was also possible to also record seedlings older than 3 years, which did not occur outside the fence

The average initial numbers of seedlings correspond to the numbers in the virgin and the managed forest (Diaci et al. 2003, Rozenbergar et al. 2007), as well as model curve frequency of trees in the selection system forest for our conditions (diameter class 2 cm - 320 pcs per hectare). Alarming, however, is the difference between protected and unprotected plots.

The results show that one of the main reasons for the lack of trees in the weakest diameter classes is evident impact of grazing on natural regeneration of main tree species. Natural regeneration is insufficient, which is one of the most common reasons for failure in the conversion to the selection system (Schütz 2001a). Expected non-production and production functions of forests can be adversely affected if the specific structure of selective forest with vertical crown canopy and corresponding species composition will not be created.

To improve the current state of natural regeneration of fir, as well as other tree species natural regeneration in the object of conversion to selection forest in Klepačov, it will be necessary to increase protection against browsing. Primary must also be reduction of game (Korpeľ, Vinš 1965, Korpeľ, Saniga 1993).

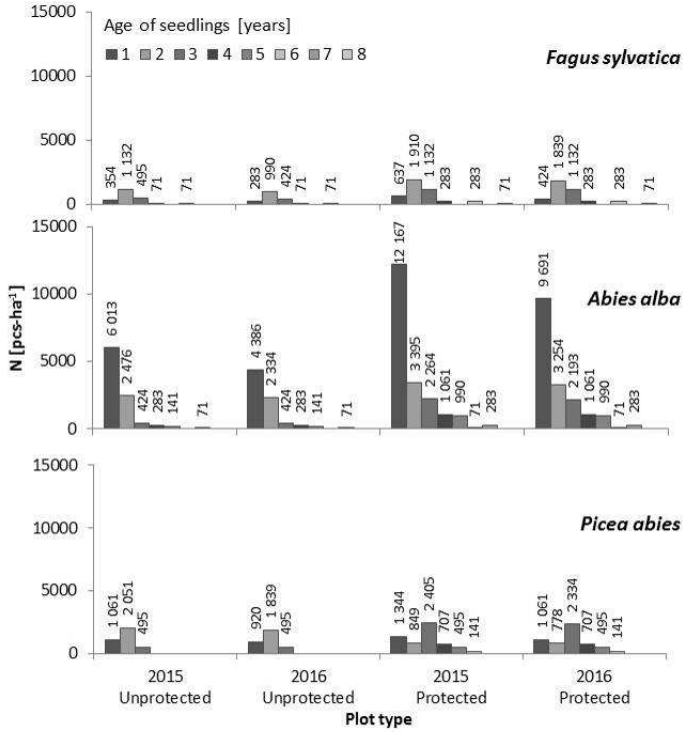

Fig. 1: Average number of seedlings per hectare by plot type and age

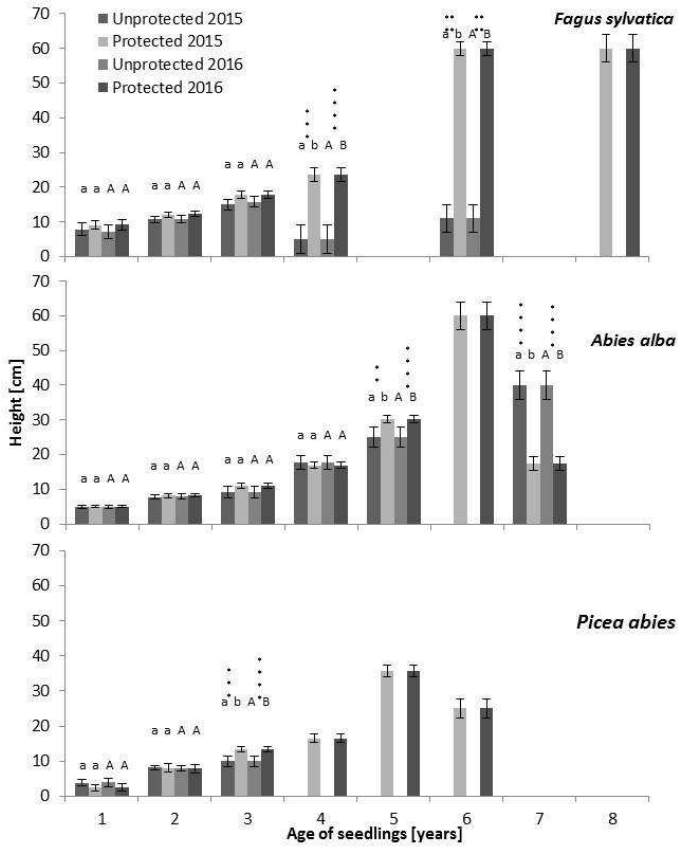

Fig. 2: Mean height of seedlings. (Error bars represent standard deviation of the mean value. Letters a, b - homogenous groups of trees in 2015. Letters A,B - homogenous groups of trees in 2016. The statistical significance of differences represent characters * = p ≤ 0.05; ** = p ≤ 0.01; *** = p ≤ 0.001; ***** = p ≤ 0.0001)

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Acknowledgement
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Souhrn
Pro správné fungování výběrného lesa nebo převodu na tento pěstební systém je nezbytná fungující přirozená obnova. Příspěvek se zabývá přirozenou obnovou hlavních lesních dřevin v objektu dlouhodobého převodu na výběrný les na Školním lesním podniku „Masarykův les“ Křtiny z důvodu nedostatku stromů ve slabších tloušťkových třídách (tzv. dorostu).
Pro objasnění příčin nedostatečné přirozené obnovy bylo vyznačeno celkem 90 zkusných ploch v různých světelných podmínkách, na kterých se zaznamenávalo přirozené zmlazení hlavních dřevin (JD, BK, SM) a zároveň se hodnotila i porostní struktura mateřského porostu. Pro posouzení vlivu zvěře na přirozené zmlazení, byla polovina zkusných ploch chráněna oplocením.
Na základě vyhodnocení byly zjištěny statisticky významné rozdíly mezi stavem porostu z přirozené obnovy v oplocení a mimo něj. V oplocené variantě byly semenáčky všech dřevin vyšší oproti plochám neoploceným. Počty semenáčků v oplocení na všech plochách evidentně převyšovaly počty semenáčků mimo

oplocení, a to až dvojnásobně. Z výsledků vyplývá, že jednou z hlavních příčin nedostatečného počtu stromů v nejslabších tloušťkových stupních je evidentní vliv zvěře na přirozené zmlazení všech hlavních dřevin, což může způsobit neúspěch převodu na výběrný les v zájmové lokalitě. Zároveň může být ohroženo plnění očekávaných mimoprodukčních funkcí i funkce produkční, pokud nebude vytvořena specifická struktura výběrného lesa s vertikálním zápojem a odpovídající druhovou skladbou.
Pro zlepšení současného stavu přirozeného zmlazení hlavních dřevin z přirozené obnovy v objektu převodu na výběrný les v lokalitě Klepačov, bude třeba zvýšit ochranu proti zvěři a snížit její stavy.

Contact:
Ing. Robert Knott, Ph.D.
E-mail: knott@mendelu.cz

DEFINITION OF THE FOREST ROAD ACCORDING TO ACT NO. 13/1997 COLL., ON ROADS AND ITS PUBLIC ACCESS IN THE CZECH REPUBLIC

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

Abstract
The act on roads considers both reinforced and unreinforced forest roads to be specific-purpose roads. It has been a subject of long-term professional discussion to define which of the transport lines within the forest transport network meet the conditions of the act on roads and can be regarded specific-purpose roads in compliance with the act, and which are only technological corridors, used for the purposes of forest management solely. New standard ČSN 73 6108, Forest road network, divides forest roads into two classes - class 1L and class 2L, which is used to transport timber from the roadside stack. These classes can be in compliance with the act on roads referred to as special-purpose roads; by their nature, they meet the requirements for the operation of road vehicles on roads. Forest road classes 3L and 4L used to skid or transport timber to roadside stacks are currently referred to as skid roads (3L) and technological lines (4L). A forest road can be defined, based on the above, as follows: A forest road is any reinforced and unreinforced specific-purpose road in the forest of class 1L and 2L. Primarily, the use of forest roads as specific-purpose roads is regulated in the act on roads, giving also the conditions for their public access.

Key words: access to forests, forest road network, forest road

Introduction

One of them is Act no. 13/1997 Coll., on roads. This act defines the infrastructure four categories, one of them being the specific-purpose road (§ 7). Generally speaking, they are roads used for the connection of individual properties for the needs of their owners or their connection with other roads, and for land management in agriculture and forestry. This category includes forest roads.
According to this regulation, forest roads fall into the mode of free-of-charge general use in a usual manner and for usual purposes, as is stipulated in §19, section 1, unless the act stipulates otherwise in specific cases. The act further distinguishes between publicly accessible and publicly inaccessible specific-purpose roads. A specific-purpose road accessible to the public must be a transport road, permanent, recognisable in the field and not changing its track (Motejl 2011). It becomes public by being dedicated to the general use or if it is so "from time immemorial", this term indicates a general use, for which it is difficult to prove the owner's will to make the road publicly accessible, especially as these roads have existed for many years and their original owners do not live any longer. The consent then follows from the very existence of the road and its existing use. Court decisions (e.g. Decision of the Supreme Administrative Court, doc. no. 5 As 20/2003 or 9 As 55/2011) gave rise to additional assessment criteria. One of them is the road owner’s consent with the public use. The owner may grant the consent expressly or tacitly, i.e. by other than oral or written expression, which however, raises no doubt as to what their will is. The “other expression” includes nodding or not protesting, etc. (Harvánek 2013) An important aspect is also the binding character of such consent for the legal

successors. From a potential purchaser cannot be released from this obligation even in cases that they didn't know about it as it is their responsibility to find out about the legal and de facto status of the property (Decision of the Constitutional Court, doc. no. II. ÚS 268/06). This avoids property transfers with the purpose of being released from the obligation to tolerate this use as well as the situations when the owners of connected properties cannot use the road. Another specific feature is the irreplaceable need of linking, which is met if there is no other way to ensure the connection of properties than to restrict ownership rights. If this exists, it has to be given precedence (Decision of the Constitutional Court, doc. no. II. ÚS 268/06).
A publicly inaccessible road is located in an enclosed space or an estate that is used for the needs of its owners or administrators. It is accessible only to the extent and in the manner that these people have laid down. However, a road in the forest cannot be considered publicly inaccessible. It is therefore not possible, for example, to put a gate on it, which is in fact an obstacle to the road use.
Act no. 13/1997 Coll., on roads, §19, stipulates that under the conditions laid down in this Act and special regulations everybody can use roads free of charge in the usual manner and for the purposes they are intended for, unless provided otherwise by law. The users must adapt to the structural and technical conditions of the road concerned. This fact is illustrated by the judicature (Decision of the Supreme Administrative Court, doc. no. 5 As 3/2009).
It is also significant for the legal regime of the specific-purpose roads to determine whether the road is a construction or if it is only a piece of land serving as a road. To determine what a construction is, the legislation specifies the important aspect which is whether we can define where the land ends and the construction begins. If this is not clear, it is usually a part of the land. If we come to the conclusion that the specific-purpose road is a construction, there is the obligation stipulated in Act no. 183/2006 Coll., on territorial planning and building code, to maintain it as a construction.

Forest road according to Act no. 13/1997 Coll.
It is thus clear that Act no. 13/1997 Coll., on roads, considers both reinforced and unreinforced forest roads to be specific-purpose roads. The forest act does not provide any definition of a forest road. This causes considerable confusion. The forest act understands the forest as a stand with its environment and lands that are intended to fulfil the forest functions. The category of lands intended to fulfil the forest functions includes forest roads that are unreinforced and are up to 4 metres wide (Decree No. 84/1996 Coll.). The category of other lands includes reinforced forest roads related to a forest or serving for its management, and which at the same time do not belong to agricultural lands.
Another definition of a forest road contained in § 2 section 1a) and in the Decree No. 433/2001 stipulating technical requirements for constructions performing forest functions, says that it is: "a specific-purpose road which is part of the forest road network, designed for the transport of timber, people and material only in the interests of the forest owner and for the passage of special vehicles."
Czech State Standard ČSN 73 6108 divides forest roads into class 1L and 2L used to transport timber from the roadside stacks. These classes can be in accordance with the standard marked as specific-purpose roads.
The general use of roads can be restricted in several ways. The limitations to the general use of roads by law are given in the form of the rules of the road. However, the general use is more restricted by the Act No. 114/1992 Coll., on the nature and

landscape protection, which for example limits the movement of motor vehicles in the territory of national parks, the Act No. 254/2001 Coll., on water
banning the entrance and access to protected zones of water sources, and also the already mentioned forest act.
At this point it is appropriate to clarify the relationship of Act no. 13/1997 Coll., on roads, and Act no. 289/1995 Coll., on forests. There are several legal opinions. The judicature shows that the two acts stand side by side, as each adjusts a different area (Decision of the Supreme Administrative Court, doc. no. 33 Odo 449/2005). Primarily, forest roads use is governed by the act on roads.
The forest act bans entrance and parking of motor vehicles on forest roads, which does not prohibit the public use of roads. It is based on the legal regime of these roads. The ban of traffic of motor vehicles does not apply to the forest owner and administrator (or lessee) for activities related to the forest management. The owner is also authorized to grant exemptions from this ban. A forest road is a specific-purpose road under the act on roads, but it is also the land intended for the performance of forest functions. The violation of the mentioned prohibition is an offence, and is sanctioned by the authorities of the state administration of forests with a fine based on the forest act.
A forest road can be equipped with the traffic sign banning entrance of motor vehicles. It is preceded by a request for the location of the traffic sign at the local competent municipal authority, who under delegated powers executes the road administration. The municipal authority convenes local investigation and then makes the decision, also on the basis of the written opinion of the Czech Republic Police competent authority. It should be noted that there is no legal claim concerning the location of the sign, so it cannot be claimed in legal ways. It is also prohibited to ride horses, bicycles, ski or sledge off forest roads and marked paths.

Definition of the forest road
The definition of a forest road can be inferred from the above listed documents as: A forest road is any forest reinforced and unreinforced specific-purpose road of class 1L and 2L.

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Act No. 13/1997 Coll., on roads
Act No. 114/1992 Coll., on nature and landscape protection
Act No. 183/2006 Coll., on territorial planning and building regulations
Act No. 254/2001 Coll., on water
Act No. 289/1995 Coll., on forests
Decree No. 85/1996 Coll., on forest management planning
Decree No. 433/2001, stipulating technical requirements for constructions for the performance of forest functions
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The Czech State standard ČSN 73 6108 – Forest road network

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Souhrn
Zákon č. 13/1997 Sb., o pozemních komunikacích vymezuje kategorie pozemních komunikací, mezi nimiž je i kategorie účelové komunikace (§7). Obecně lze říci, že je komunikací pozemní, sloužící ke spojení jednotlivých nemovitostí pro potřeby jejich vlastníků nebo k jejich spojení s ostatními komunikacemi a obhospodařování pozemků v zemědělství a lesnictví. Do této kategorie je zařazena i lesní cesta.
Je tedy zřejmé, že zákon č. 13/1997 Sb, o pozemních komunikacích považuje zpevněnou i nezpevněnou lesní cestu za účelovou komunikaci. Lesní zákon žádnou definici lesní cesty neposkytuje. To vyvolává značné nejasnosti.
Další definice lesní cesty obsažená v § 2 odst. 1 písm. a) ve vyhlášce č. 433/2001, kterou se stanoví technické požadavky pro stavby pro plnění funkcí lesa, říká, že se jedná o: „účelovou komunikaci, která je součástí lesní dopravní sítě, určená k odvozu dříví, dopravě osob a materiálu pouze v zájmu vlastníka lesa a pro průjezd speciálních vozidel.“ Česká státní norma ČSN 73 6108 dělí lesní cesty na třídy 1L a 2L sloužící k odvozu dřeva z odvozního místa (lesní odvozní cesty). Tyto třídy lze v souladu s normou označit za účelové komunikace.
Definici lesní cesty si lze z výše uvedených dokumentů dovodit takto: Za lesní cestu lze považovat všechny lesní zpevněné i nezpevněné účelové komunikace třídy 1L a 2L.
Obecné užívání účelových komunikací je možné několika způsoby omezit. Na tomto místě je vhodné vyjasnit vztah zákona č. 13/1997 Sb., o pozemních komunikacích a zákona č. 289/1995 Sb., o lesích. Existuje zde více právních názorů. Z judikatury vyplývá, že oba zákony stojí vedle sebe, protože každý upravuje jinou oblast (rozsudek NSS sp. zn. 33 Odo 449/2005). Primárně se na její užívání vztahuje zákon o pozemních komunikacích.

Contact:
doc. Ing. Petr Hrůza, Ph.D.
E-mail: petr.hruza@mendelu.cz

DEVELOPMENT OF FATAL ACCIDENTS DURING THE LEISURE ACTIVITIES IN THE HIGH TATRAS (SLOVAKIA) IN TWENTIETH CENTURY

Matúš Jakubis
Department of Forest Harvesting, Logistics and Amelioration, Faculty of Forestry, Technical University in Zvolen, T. G. Masaryka 24, 960 53 Zvolen, Slovakia

Abstract
In the Slovak Republic as in many other developed countries, the recreation, sport and various leisure activities in mountain areas are more and more popular and coveted. The High Tatras, which are the highest and most visited mountain area in the Slovak Republic, they are also one of the most popular area for various year-round leisure activities. The article deals with statistical analysis of fatal accidents during leisure activities caused by various reasons in twentieth century in the High Tatras. The data were obtained from Mountain Rescue Service Headquarters in Horný Smokovec. From 1901 to 2015 were during the leisure activities in the High Tatras 1062 fatalities that are in the article by the causes of death, decades, months and according to season of the year analyzed.

Key words: mountain regions, recreation, sports, disasters

Introduction

The High Tatras are the highest, most famous and most visited mountain in Slovakia. They are part of the Tatra National Park, the oldest national park on the territory of our country. The High Tatras were from January 1, 1949 declared as an protected area – Tatra National Park with an area of 738 km^2, and the buffer zone around the park covers an area of 307 km^2; it is 1045 km^2 together. Along with Polish part of High Tatras was on these area estabilished in 1993 the UNESCO Biosphere Reserve. In the High Tatras it is also the highest peak of Slovakia – Gerlachovský štít (2,654.4 m) and symbol of Slovakia – Kriváň (2,494.7 m), too. The High Tatras are the most popular area for leisure activities in our country. There´s a very wide range of leisure activities throughout the year, especially in sommer and in winter (Composite Authors 2014). In these leisure activities include primarily: downhill skiing, cross-counry skiing, skialpinism, snowboarding, freeride snowboarding, snowturbing, hiking, mountain hiking, family hiking, mountaineering, cycling and mountain biking, paragliding and various other activities. In the Tatra National Park exists about 600 km of marked hiking trails and about 16 marked and maintained bike trails. In the High Tatras is located more than 30 km of hiking trails for disabled people in wheelchair, too (Jakubisová 2016, Janeczko et al. 2016). The number and types of mountain actvities pursued by tourists have increased dramatically in recent years. This range of options continues to increase as new technologies emerge and destinations compete in global and regional markets (Price et al. 1997). The number of visitors of high mountains is increasing dangerously. It is so even in the High Tatras. In 1834, the High Tatras visited per year by 186 visitors, in 1927 by 19,250 visitors, in 1945 by 20,000, in 1947 by 32,160, in 1948 by 200,000, in 1950 by 450,000, in 1959 by 200,000, in the eighties it was 4.000,000 visitors, in the ninieties it was already 5.000,000 visitors (Composite authors 2005). On the other hand, the High Tatras, like other high mountains, can also mean great danger for visitors.

The issue of deaths during recreational and other leisure activities is engaged in the world of so many authors. Many articles of foreign authors dealt with fatal accidents caused by avalanches: Boyd et al. (2009) in Canada, McIntosh et al. (2007) in USA, Würtl, Bilek (2011) in Austria etc.

Materials and methods

The article deals with the statistical analysis of fatal accidents in the High Tatras caused by various reasons during leisure activities according to the records which are taken from the data of the Mountain Rescue Service Headquarters in Horný Smokovec (http://www.hzs.sk/horska-zachranna-sluzba/smrtelne-nehody-vysoke-tatry/). From 1901 to 2015 were in the High Tatras 1062 fatalities which are in the article by the causes of death, decades, months and according to season analyzed.

Results

In the years 1901 – 2015 during the leisure activities in the High Tatras died 1062 people. This means that, during leisure activities here have died each year on average more than 9 people. Evaluation by decades proved largely upward trend from decade 1901-1910 until decade 1971 – 1980. In this decade, the number of fatalities was 181, that is 18.2% off all accidents from years 1901 – 2010. From decade 1981 – 1990 we recorded a downward trend in fatalities until decade 2001 – 2010. A graphical representation of the development of these data is shown in Fig. 1.

Evaluation by months proved that most fatal accidents between the years 1901 – 2010 happened in August (194, it is 18.3%) and July (161, it is 15.2%). The least of accidents happened in months May (23, it is 2.2%) and November (26, it is 2.4%). A graphical representation of these data is shown in Fig. 2.

Evaluation by cause of death proved that most fatalities were caused by fall (386, it is 36.3%), then slip and fall (146, it it 13.7%) and further snow avalanche (143 it is 13.5%). Graphical representation of these data is shown in Fig. 3.

Evaluation by season of the year showed that the most fatal accidents happened in sommer season (months VI. – VIII.) – 421 (39.6%), further in winter season (months XII. – II.) – 220 (20.7%), in autumn season (months IX. – XI.) 201 (18.9%) and in spring season (months III. – V.) – 193 (18.2%).

Downward trend of fatal accidents during leisure activities in the High Tatras in the last three decades (since 1981) can be mainly explained by several factors, notably a comprehensive awareness of visitors about the dangers of staying in the mountains, better transfer of informations, versatile and extremely selfless actions of mountain rescue service, better equipage and technical elements of visitors, compliance with safety instructions etc.

Discussion

Hewit (1997) notes that the world´s mountain lands include regions of exeptional risk for various human activities and some unique dangers. These dangers can be caused by unespected natural processes, but often cause their own man. Among various hazards of high mountains, in the HighTatras is for example the largest number of snow avalanche paths in the Slovak Republic (1749 with an area of 3121 ha). Avalanches are the third leading cause of death for visitors in the High Tatras. Techel, Zweifel (2013) dealt with recreational avalanche accidents in Switzerland. The authors report that during the last 20 years (1992/93 to 2011/12) more than 90% avalanche fatalities in Switzerland occured in uncontrolled avalanche terrain

(recreational winter sport activities). Although the recreational activities have increased, the number of fatalities did not increase in recent decades. This positive trend can be atributed to improved prevention measures and faster and more efficient rescues.

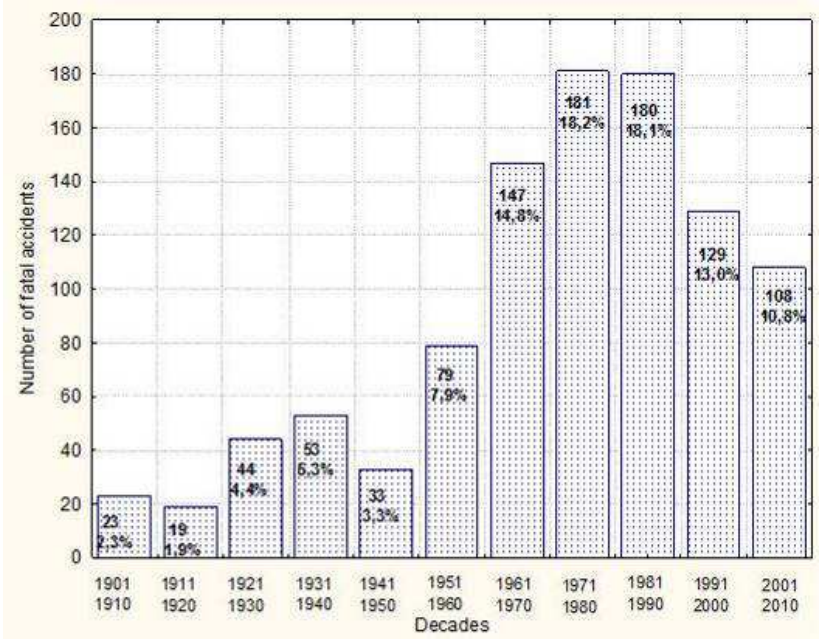

Fig. 1: Evaluation of fatal accidents by decades (1900-2010)

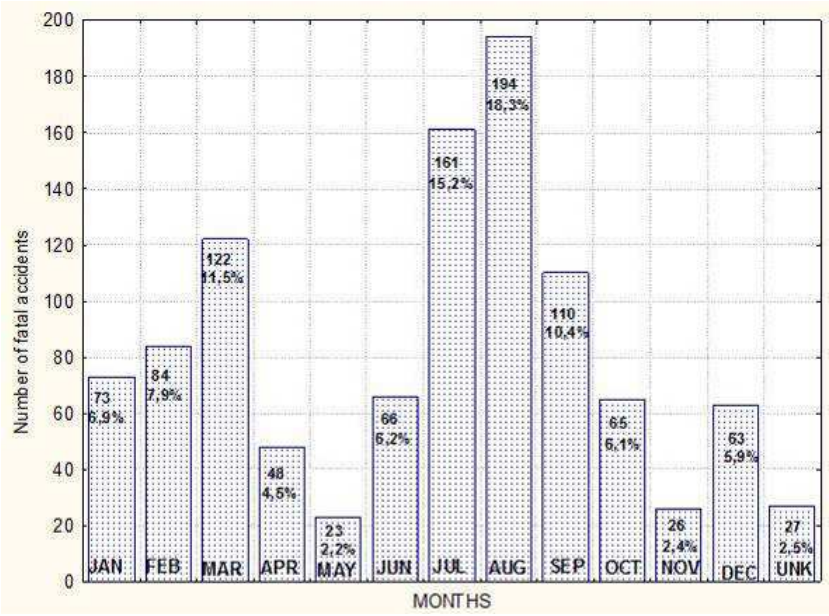

Fig. 2: Evaluation of fatal accidents by months (1900-2015)

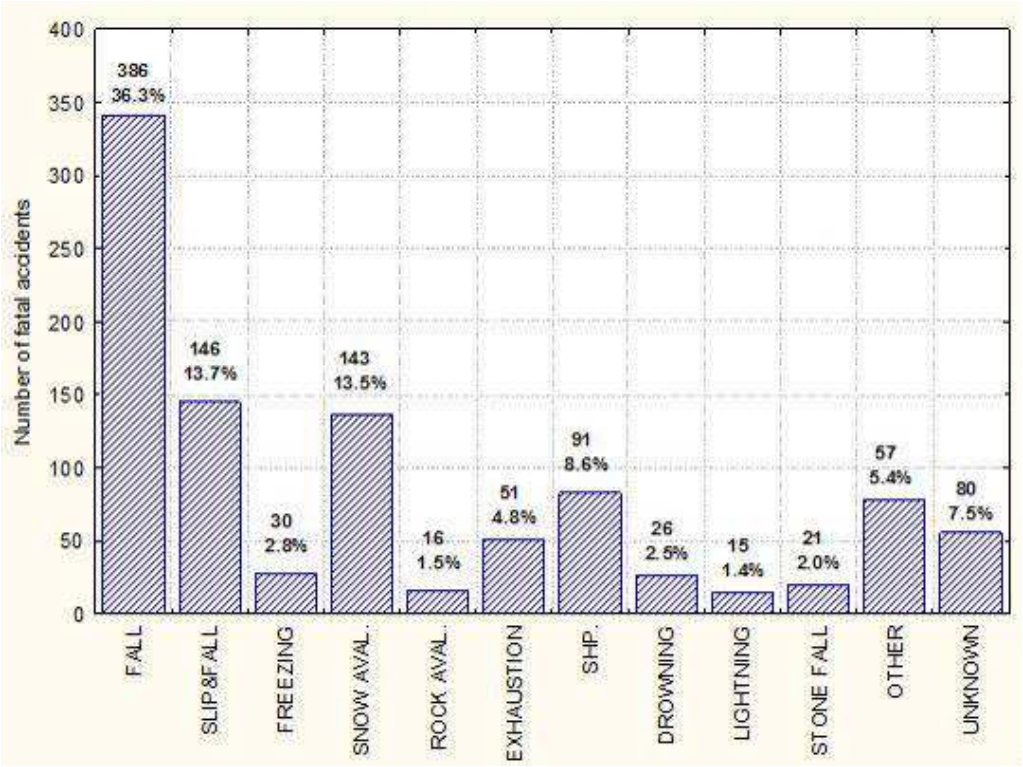

Fig. 3: Evaluation of fatal accidents by cause of death (1900-2015)
(SHP – sudden health problem)

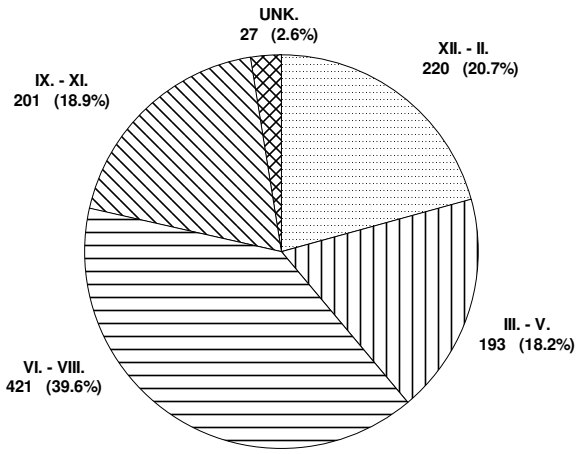

Fig. 4: Evaluation of fatal accidents according to season (1900-2015)

Conclusion

Despite the positive trends in the number of fatal accidents during leisure activities in the High Tatras, this number is still high. The results of this article can be a source of lessons from these accidents and a warning for all of the visitors in high mountains in Slovakia. The most important possibilities for prevention of fatal disasters consider the compliance with safety instructions, realistic assessment of our real capabilities and the degree of terrain danger, all-round quality equipment and taking into account possible weather development.

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Souhrn

Příspěvek se zabývá hodnocením smrtelných nehod, které se udály během různých volnočasových aktivit návštěvníků Vysokých Tater především v dvacátém století. Od roku 1901 do roku 2010 se stalo 996 smrtelných nehod, od roku 1901 do roku 2015 až 1062 smrtelných nehod, to znamená v průměru více než 9 těchto nehod ročně. Smrtelné nehody jsou v příspěvku analyzovány podle příčin, četnosti v jednotlivých měsících v roce, sezóny, ve které se nehody staly. V rámci hodnocení vývoje nehod podle jednotlivých desetiletí jsme zjistily převážně vzestupný trend od deseti 1901-1910 až do let 1971 - 1980. V tomto desetiletí byl počet obětí 181, což je 18,2%

všech nehod z let 1901 - 2010. Od deseti 1981-1990 jsme zaznamenali klesající trend úmrtí až do desetiletí 2001 - 2010. Grafické znázornění vývoje těchto údajů je na obr. 1. Vyhodnocení podle měsíců ukázalo, že většina smrtelných nehod mezi roky 1901 - 2010 se stala v srpnu (194, to je 18,3%) a červenci (161, to je 15,2%). Nejméně nehod se stalo v měsících květnu (23, to je 2,2%) a listopadu (26, to je 2,4%). Grafické znázornění těchto údajů je na obr. 2. Vyhodnocení podle příčin smrti ukázalo, že většina úmrtí byla způsobena pádem (386, to je 36,3%) a po uklouznutí a pádu (146, to je 13,7%). Grafické znázornění těchto dat je na obr. 3. Vyhodnocením podle ročního období ukázaly, že většina smrtelných nehod se stala v letním období (měsíce VI. - VIII.) - 421 (39,6%), dále v zimním období (měsíce XII. – II.) - 220 (20,7%), podzimním období (měsíce IX. - XI.) - 201 (18,9%) a nakonec v jarním období (měsíce III. - V.) - 193 (18,2%). Grafické znázornění tohoto hodnocení je na obr. 4. Klesající trend výskytu smrtelných nehod během volnočasových aktivit ve Vysokých Tatrách v posledních třech desetiletích (od roku 1981) je podle nás možné vysvětlit zejména několika skutečnostmi, zejména komplexní informovanosti návštěvníků o nebezpečí při pobytu v horách, lepším přenosem potřebných informací, všestranní a mimořádně obětavé činností horské záchranné služby, lepší výstrojí a technickým vybavením návštěvníků, dodržováním bezpečnostních pokynů atd.

Contact:
Prof. Ing. Matúš Jakubis, PhD.
E-mail: jakubis@tuzvo.sk

DOMESTIC TIMBER MARKET AND ILLEGAL LOGGING: THE CASE OF SELECTED LUMBER MARKETS IN ACCRA, GHANA

Kofi Ampadu Boateng, Petra Hlaváčková
Department of Forest and Wood Products Economics and Policy (FFWT), Faculty of Forestry and Wood Technology, Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic

Abstract
Illegal logging has gained prominence at both local and international forestry discussions globally over the past decade. This paper analyses four main lumber markets in the capital city of Ghana based on the monitoring of vehicles conveying lumber to market sites. Trading of the lumber are mainly for domestic consumption. Nonetheless, a fraction of the product is exported to nearby countries. Bearing in mind markets together with sales which is not covered by the study and permitting inter-market exchanges, this paper estimates the annual sale of domestic and export consumption to be in the order of 0.5 million m^3. In addition to formal export sale of 0.5 million m^3 , the total annual sale of wood is approximately 1 million m^3 which is equivalent to about 3.2 million m^3 of raw wood. This is in excess of the yearly allowable cut. This paper therefore, confirms that constant monitoring of vehicles transporting wood is a reliable and feasible technique for estimating the domestic market size which could uncover further applications. The effectiveness of the Forest Law Enforcement, Governance and Trade (FLEGT) initiative is therefore questioned by the larger formal sector and therefore there is an urgent need for reinforcements and policy reforms.

Key words: FLEGT, law enforcement, vehicle observation

Introduction

The rich forests that once secured half of the surface of the earth are being substituted by landscapes of forest fragments, agrarian products, tree plantations and fields. A significant part of the forest that still remains is being degraded. Tropical forest are being depleted at a rapid rate, somewhere in the range of 5% in the recent decade, with grave impacts for the environment globally. Deforestation is a major cause of habitat destruction prompting irreversible decline of biodiversity. Responsible for at least one-fifth of greenhouse emissions, it also deprives governments of billions of dollars in lost revenue. This in turn has debilitating effect on rural livelihoods. There are however illegalities associated with the forestry sector and its various stages of production. Sawn wood or a variety of wood-based panels such as plywood, veneers and fibreboard are obtained from the industrial processing of round wood. These industrial products can be traded in the domestic or international markets. Illegalities can occur in almost any of these phases of production, transport and trade (see Fig. 1 below) (Contreras-Hermosilla et al. 2008).

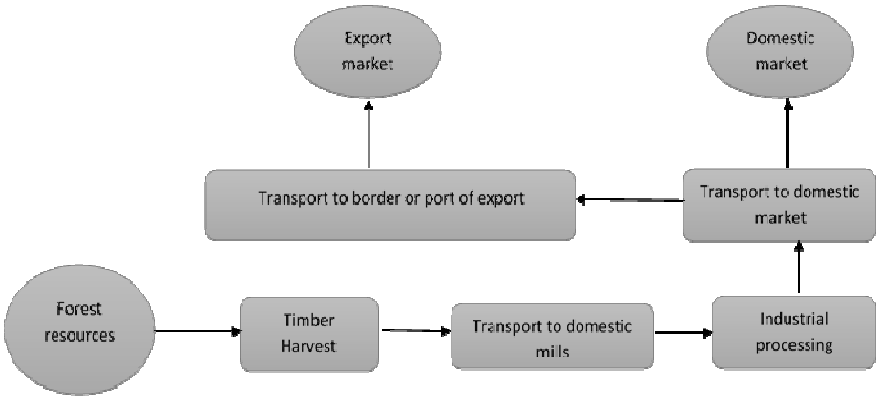

Fig: 1: Flow path of log
Source: Seneca Creek, 2004

According to Miller et al. (2006), defining illegal logging can be remarkably difficult. Various definitions lead to very different assumptions on the magnitude of the problem. It is not just a technical issue but rather one that has far reaching political implications. It is usually associated with unsustainable forest practices.
According to Brack (2003) and Smith (2002), illegal logging occurs when timber is harvested, transported, traded in violation of national laws. This broad definition is applied by many as the determinant of illegality. As an umbrella term, illegal logging is frequently used interchangeably with illegal forest activities. It is however unsuitable for analytical purposes due to its multiplicity of dimensions included in the term.
Quantification of illegality by definition is difficult. Given its covert nature and the methodological issues required in processing reliable and comparable assessments, published figures of illicit logging are often inaccurate. The size of illegal wood which enter the market is hard to calculate in regions that have inadequate monitoring and statistical systems (Contreras-Hermosilla et al. 2008).

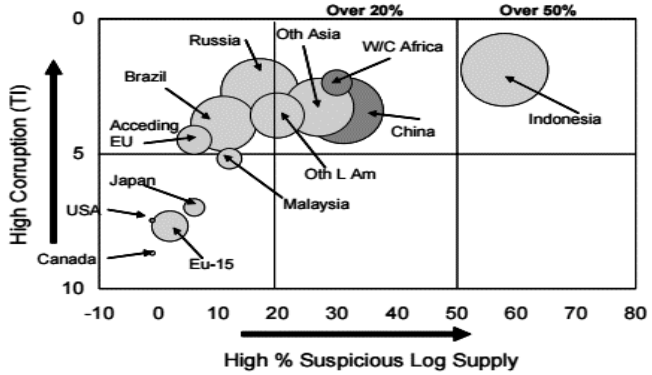

Fig. 2: Corruption and Illegal Forest Activity
Source: Transparency International; WRI/SCA estimates of illegal logging
* Size of bubbles represents volume of suspect round wood, including imports

Effects of illegal logging
As emphasised by Contreras-Hermosilla (2002) and Richards et al. (2003), illegal logging has severe negative environmental, economic and social consequences.

There are visible threats of forest degradation or complete deforestation are as a result of illegal logging. This in effect according Curran et al. (2004) to reduce environmental services and biodiversity as well as recreational purposes. Illegal logging impacts negatively on revenue generation. The World Bank (2004) estimates about US$ 5 billion of government revenue is lost globally each year as a result of illegal forest activities. Brack (2007) also estimates market value of products resulting from illegal logging to exceed US$ 15 billion annually. Smith et al. (2003) also affirms that it weakens democratic processes through the characteristic disrespect for the rule of law and associated corruption (Fig. 2). It may prompt an increase in poverty levels, either indirectly or directly. Indirectly as a result of decreased government revenues available for development programmes (Tacconi, 2007). More also, illegal logging decreases domestic and international forest product prices (Turner et al. 2007). Finally, in many scenarios illegal logging has been a key funding source for most armed conflicts (Kaimowitz 2003, Renner 2005, Brack 2003).

According to FAO (2001), lots of activities affect forest resource change and dynamics in Ghana. Notable among these factors include: illegal or excessive logging, bush burning, poor agricultural practices, mining and quarrying, and settlement and connected infrastructure construction. Though, increases in population growth together with migration, particularly in the forest areas, also account for a high degree of deforestation. Between 1990 and 2005, Ghana lost about 1.9 million hectares of forest which represented about 26% of total forest cover (FAO, 2000). According to IUCN (2006), the annual deforestation rate of Ghana is about 2.0% even though there has been measures like the Ghana National Plantation Project to plant 20,000 hectares annually.

Material and methods

By direct observation, the volume of traded wood in the four selected domestic markets were assessed. A total period of one month was assigned for the direct observations. Two weeks was devoted for monitoring during the dry season and the later for monitoring in the wet season (Tab. 1). Field workers entering the data were strategically positioned either within the market or at the peripherals. Data was recorded on the type of vehicle and source of supply; whether sawmill or chainsaw processed. For accuracy on supply, there was the need for field workers to work round the clock therefore, they worked on 12 hour shifts. This enabled daily accurate record of lumber inflow. Due to the sensitive nature of the data collection, enumerators needed to blend-in so they will not be easily noticed. For this reason they were in one way or the other associated with the markets. The field workers, usually employees of the various markets were given training on observation techniques and data entering.

There was a pre-testing period of a couple of days in order to test the methodology. This gave the opportunity to record various types of vehicles used for the transportation of lumber to the markets. The most common vehicles included Articulator, Cargo 207, Double axle-full load, Kia, Long trailer and Single axle-full load. Dealers of these markets were also asked to provide information relating to the load of the vehicles; information such as the typical number of pieces of lumber and dimension for the various vehicle types. This information helped in transforming the estimates to cubic metres (m^3).

Although the sample region is not a high forest zone, it has a very high demand for lumber because of its urban and populous nature hence its selection for this study. The dry season is regarded as the peak period because transportation of lumber

from sites by road is easier and faster. Monitoring of this period was carried out from January – April 2016. The wet season on the other hand is considered the lean period due to the constraints in transportation. Monitoring of this season was between July – August 2016. The obtained data was entered into a spreadsheet and monthly mean, low and high estimates were deduced by the use of relevant vehicle type as well as summation.

Results

Aproximately 39,000 m^3 of lumber was supplied monthly for the four surveyed lumber markets, recording a low estimate of about 25,000 m^3 and a high of approximately 52,000 m^3. Agbogbloshie and Muus Timber markets recorded the highest supply during the dry season (Tab. 2) representing 85% of volume recorded. The main source of lumber for these markets are from chainsaw operations, representing about 76% in total volume.

The wet season recorded approximately 15,000 m^3 monthly with low and high estimates of 9,000 m^3 and 20,000 m^3 respectively (Tab. 3). The leading supplier of lumber for this lean period again was recorded from Agbogbloshie and Muus Timber Markets representing 73% of total volume for the period.

Although there was a slight decline in supply volume, chainsaw remains the major source of supply for the lean period. It is interesting to note however, that in the lean period Agbogbloshie and Muus Timber Markets recorded higher sawmill supply than chainsaw (Tab. 3).

Tab. 1: Survey markets and season monitoring

Market	Dry season monitoring	Wet season monitoring
Agbogbloshie	x	x
Ashaiman	x	x
Muus Timber	x	x
Ofankor	x	x

Tab. 2: Monthly inflow of lumber during dry season of surveyed markets (m^3)

Market	Mean estimate				High estimate			Low estimate		
	Chainsaw	Sawmill	Total	% Chainsaw	Chainsaw	Sawmill	Total	Chainsaw	Sawmill	Total
Agbogbloshie	6275	2689	8964	70	8825	3951	12776	3724	1427	5151
Ashaiman	1474	698	2172	68	2036	994	3030	912	402	1314
Muus Timber	18531	202	18733	99	25377	308	25685	11684	96	11780
Ofankor	3038	5752	8790	35	4109	6521	10630	1967	4983	6950
Total	**29317**	**9341**	**38658**	**76**	**40347**	**11774**	**52121**	**18287**	**6908**	**25195**

Tab. 3: Monthly inflow of lumber during wet season of surveyed markets (m^3)

Market	Mean estimate				High estimate			Low estimate		
	Chainsaw	Sawmill	Total	% Chainsaw	Chainsaw	Sawmill	Total	Chainsaw	Sawmill	Total
Agbogbloshie	1617	2723	4340	37	2239	4023	6262	995	1422	2417
Ashaiman	1128	630	1758	64	1561	848	2409	695	412	1107
Muus Timber	4601	1925	6526	71	6234	2542	8776	2968	1308	4276
Ofankor	789	1433	2222	36	1096	1984	3080	482	881	1363
Total	**8135**	**6710**	**14845**	**55**	**11130**	**9397**	**20527**	**5140**	**4023**	**9163**

The dry season monitoring repeatedly recorded high lumber inflow as compared to the wet season (Tab. 4). On the average, supply was about 40% of dry season supply although there were variations at the Ahsaiman market.
An activity calendar was deduced from the data obtained from the survey (Tab. 5). Although there were recorded variations in markets, there were repeated high volume of lumber inflow between November to March. June and July were relatively lower whilst April – May and August – September were regarded as intermediate inflow period.

Tab. 4: Comparison of monthly inflow in dry and wet seasons for markets (m^3)

Market	Dry Season (D)	West Season (W)	% Ratio (W/D)
Agbogbloshie	8964	4340	48
Ashaiman	2172	1758	81
Muus Timber	18733	6526	35
Ofankor	8790	2222	25
Total	**38659**	**14846**	**38**

Tab. 5: Market activity calendar

Market	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Agbogbloshie	H	H	H	M	M	L	L	M	H	H	H	H
Ashaiman	H	H	M	M	M	L	L	M	M	M	H	H
Muus Timber	H	H	H	H	M	L	L	M	M	H	H	H
Ofankor	H	H	H	M	L	L	L	M	M	H	H	H
Generic	***H***	***H***	***H***	***M***	***M***	***L***	***L***	***M***	***M***	***H***	***H***	***H***

**H: High inflow; L: Low inflow; M: Medium (intermediate)*

Discussion

Reliability and accuracy of applied approach

The methodology deals with some of the problems that are linked to typical interview-based market surveys in which respondents are unwilling to cooperate especially in the case of domestic lumber markets in Ghana where most of their products are supplied illegally. One drawback of this method is that it does not differentiate composition of species. Accuracy of the results obtained was heavily dependent on the field researchers. For this reason constant data checks and supervision was needed throughout the exercise. Accuracy of the load from different vehicles was paramount for the estimation process. Information was sought from market operators in the typical load of various types of vehicles. Even though the loads may always not be completely full, it is believed that most of them were full. According to Obiri and Damnyag (2011), it is costly to transport illegal lumber to markets when not fully loaded. This is due to the fact that there is a chain of suspected bribery and corruption before the lumber gets to the market. This method is a reliable, fast and efficient approach for domestic market assessment and could be further integrated with conventional interview based questionnaires tailored to specific objectives (see fig. 2).

Significance of results

The study confirms a significantly larger domestic markets as in previous studies (Hansen et al. 2012; Marfo & Mckeown, 2013; Oduro et al. 2014). A direct extrapolation of whole national estimate is practically impossible. The results obtained from the four main lumber markets are approximately consistent with (Hansen et al. 2012) who used a similar approach in 19 lumber sites across the country. Estimating based on results obtained in one region and comparing with

results obtained by Hansen et al. (2012), average lumber estimates would be in the order of about 1 million m^3 with a low and high estimate of about 0.7 million m^3 and 1.3 million m^3 respectively. This estimates exceeds the annual allowable cut (AAC) limit of 1.2 million m^3 (FAO, 2001). Forest Law Enforcement, Governance and Trade (FLEGT) in Ghana is elusive in terms of implementation plan. Lacking the clearly defined measures in strategies in place for regulation and implementation of informal domestic market.

Conclusion

The study confirms no significant changes in the supply of lumber to domestic markets over the last five years. With supply estimated at around 1 million m^3 annually where chainsaw alone constitutes about 80% of supply volume. With the results obtained from the field research coupled with other similar researches, there is the need to strengthen the current FLEGT implementation. According to FAO (2001), local consumption of wood products portray a rising pattern. It is estimated that by 2020 the total domestic demand of lumber in Ghana would be about 1.5 million m^3 round wood, which is equivalent to over 2 million m^3. Totalling the export and domestic demands, the total future requirement for round wood is equivalent to 3.35 million m^3. These results clearly depict the dangers on the environment, ecosystem and recreation in the country if the activities of the domestic lumber markets are not regulated and properly managed nationwide. Still a vital contributor to the economy, the forest sector is the third foreign exchange earner and contributes about 30% of total export earnings. Capacity building, regulation and enforcing FLEGT principles is a sure way to sustain the environment and the economy in the long term.

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Souhrn
Nezákonná těžba je globálním problémem už kvůli negativnímu dopadu na životní prostředí a dané typy ekosystémů. Například Ghana, jakož i další oblasti jsou postiženy nelegálními aktivitami v oblasti těžby dřeva. Často je obtížné měřit rozsah nebo velikost těchto trhů v důsledku nedostatečných údajů a logistiky. Přímé pozorování vozidel zásobujících trh řezivem je spolehlivým a efektivním hodnocením takového obchodování. Bylo zjištěno, že největší zásoba dřeva byla transportována během období sucha. Na základě odhadů a na základě přímého pozorování bylo zjištěno větší množství řeziva na trhu než je povoleno ročními limity. Nelegální odlesňování má také vážné dopady na služby související s lesními ekosystémy jako je rekreace a též dochází k ohrožování biologické rozmanitosti. Aby došlo ke zlepšení, je nutné dodržovat zákon, neustále sledovat trh a provádět kontroly.

Contact:
Ing. Kofi Ampadu Boateng
E-mail: kofikab@gmail.com

DROUGHT ON THE MOHELNO SERPENTINE STEPPE, PRESENT AND PROSPECT UNTIL THE YEAR 2100

Adéla Svejkovská[1], Hana Středová[2], Petra Procházková[3]
[1,2]Department of Applied and Landscape Ecology, Faculty of AgriSciences, Mendel University in Brno, Zemědělská 1, 613 00, Brno, Czech Republic
[3]Department of Crop Science, Breeding and Plant Medicine, Faculty of AgriSciences, Mendel University in Brno, Zemědělská 1, 613 00, Brno, Czech Republic

Abstract
The article deals with the issue of drought in the National Nature Reserve Mohelno serpentine steppe. Drought was solved in terms of potential evapotranspiration in growing season (from March to September). This quantity represents the total amount of water in mm which can evaporate from substrate (grass cover) with optimal saturation of soil profile under specific climatic conditions. This problematics was evaluated for two periods - present and forecast till 2100. It was found that by 2100 can be expected increase in potential evapotranspiration by nearly 50 mm. The present value of potential evapotranspiration, which amounts to 635 mm, should increase to 683 mm and the largest growth of potential evapotranspiration (than is currently) can be expected in August. This value should increase by 20 mm. During vegetation period will not occur only to increase values of these quantity. On the contrary, for example in May can expect decrease of potential evaporation by 9 mm. In general it can be stated that the climate change will result in a change in precipitation patterns over time in the Czech Republic which will become evident in increase of potential evapotranspiration and will lead to a higher incidence of drought. Subsequently, local ecosystems will be affected.

Key words: drought, Mohelno Serpentinne Steppe, potential evapotranspiration, evaporate

Introduction

Mohelno serpentine steppe is located in Vysocina region (Třebíč), approximately 150 m south of Mohelno municipality. The area of the reserve is 50.34 hectares, it was declared in 1933 and is one of the most valuable and most remarkable reserves in our country. The serpentine steppe is situated on a rocky amphitheater on the left bank of Jihlava valley and surrounding platforms. The subject of protection in this area is an extensive set of xerothermic communities of serpentine rocky steppes, thermophilous grasslands and serpentinite pinewoods. Despite the inhospitable conditions in this area, there are over 620 kinds of plants to be found there which is about 1/5 of the entire flora of our country. The biodiversity at this location is determined by a number of factors (Šumpich et al. 2002), one of them being climatic conditions. According Quitt (1971), Mohelno serpentine steppe is located in a slightly warm climate MT11 which is characterized by warm, dry and long summer; short, mild and dry winters and moderately warm spring and autumn. The vegetation period sees precipitation between 350 and 400 mm. The average annual temperature is up to 10 °C higher in the steppe compared to Mohelno municipality. Its specific microclimate also produces subsoil that consists mainly of serpentine. Serpentine soils are stressful for plants for multiple reasons. They are low in nutrients and toxicity as well as drought which is a consequence of overheating of

the dark serpentine rocks (in summer their surface might reach up to 50 °C) and leakage of water through the skeleton substrate. Another cause of the specific microclimate is the geographic orientation of the steppe. Slopes that face southeast and southwest are strongly exposed to sun and sun rays fall on these almost vertically in every season and time of day. In combination with the dark color of the serpentine, the soil in these areas is about 18-24 °C warmer than the air (Fornůsková and Polákova 2014).
It is clear that in case of Mohelno serpentine steppe, drought and high temperature are the conditions of occurence of rare species of plants and animals. Plants respond to these conditions by their short stature, more developed root systems and their "drought-resistant" growth of leaves (leaves are smaller, stiffer and more hairy). Dwarf plants are a special feature of this location, these are referred to as dwarfism. These plants reach just one fifteenth the size of their parent plants. In terms of fauna, the habitat is unique by the occurrence of invertebrates. There are rare species of thermophilic spiders and very rich butterfly and ant fauna. (Šumpich et al., 2002).
Historical context also implies that the change of the described microclimate towards higher humidities and low temperatures lead to the prevalence of unwanted species which resulted in decline of the rare species.

Materials and methods
Humidity conditions at this location are evaluated based on potential evapotranspiration of grass which presents the total evaporation from a certain area. Potential evapotranspiration is quantity which express amount of water which can be evaporate at the optimal water saturation of the soil profile. This magnitude increases as a result of high temperatures which may ultimately lead to the occurrence of dryness.
Potential evapotranspiration is evaluated for two time periods and in both cases the required data was supplied by the Czech Hydrometeorological Institute. The present situation was assessed on the basis of input data from years 1961–2010 and the forecast till 2100 was modelled on input data from period of 2071–2100. The input values for calculation of potential evapotranspiration for both periods were based on the so-called technical data series (TDS) which is a database of daily values of climatic elements taken from 1961 on 787 grid points in the Czech Republic in a grid network of 10 km. It was used the data of the grid point at this locality. TDS were based on a network of stations of the Czech Hydrometeorological Institute and calculated in grid points of outputs of climate model ALADIN - Climate / CZ with 10 km resolution. Before the calculation of the technical data series, the input data was subjected to data quality control using software ProClimDB (Štěpánek, 2012). Specific values of potential evapotranspiration were calculated using agrometeorological model AVISO (meteorological computer and information system) which works on the basis of a modified Penman-Monteith algorithm and allows the calculation of evaporation from various surfaces. The model was modified and adapted to the conditions of the Czech Republic. It is currently operated at the Czech Hydrometeorological Institute and is continuously updated, refined and optimized (Kohut, 2007).
Outlook to 2100 was modelled based on the A1B emission scenario (SRES emission scenarios of possible developments until the end of the 21st century) using regional climate model ALADIN - Climate / CZ which was controlled by global climate model ARPÉGE. The model incorporates physical, chemical and biological properties of the earth's climate system using numeric and mathematical

procedures. The establishment of the aforementioned series of climatic data (technical data series TDS) established by the Czech Hydrometeorological Institute significantly helped the modelling of these characteristics for the present and the outlook in the Czech Republic (Štěpánek, 2012).
Daily values of potential evapotranspiration in the growing season were established for both time periods, wherein the growing season was determined to March to September (total of 214 days). Mean values for each ordinal day of a particular month were calculated for both periods. Subsequently, graphs were created indicating the progress of evapotranspiration and also enabling to compare the two periods.

Results

The curves of the graph in Fig. 1 show the progress (and currently also the outlook) to potential evapotranspiration in Mohelno serpentine steppe in the growing period (March to September). Tab. 1 shows the amount of water that could evaporate in the individual months by optimal saturation of the soil profile. Based on these values, it can be stated that higher values of potential evapotranspiration are expected in the outlook for the growing period of year 2100. Currently, at optimum saturation of the soil profile, up to 635 mm of water can evaporate from this location. According to the outlook for 2100, an increase of less than 50 mm is expected which would make the total of 683 mm. Comparison of the individual months expects the biggest change (increase in value) of potential evapotranspiration in the month of August which could potentially see evaporation of up to 20 mm higher than in the present time. Similar increase in the value of potential evapotranspiration is expected in September when these values are expected to increase by up to 18 mm under given conditions. Increase of potential evaporation is prospectively expected also in July by 13 mm and in March by 11 mm. Conversely, by 2100, potential evaporation in this area should decrease in the months of April and June by 2 mm. Significant decrease in the values of potential evapotranspiration is expected only in the month of May by 8.7 mm.
Generally, it can be stated that an increase in potential evapotranspiration is expected in the locality of Mohelno serpentine steppe by 2100. Course of the changes of this magnitude is shown in the graph in Fig. 2. It is a graph of cumulative values of potential evapotranspiration showing the progress of the overall increase in evapotranspiration during the growing period, i.e. from March to September. The graph shows the above mentioned development which expects that the beginning of the growing season by 2100 will see a slight increase in potential evaporation while from mid-May these values will decline and stagnate in June, when the values of potential evapotranspiration will be roughly the same for both of these periods. The values of potential evapotranspiration are expected to increase again from mid-July and this trend will follow until the end of the growing season.

Discussion

On territory of the Czech republic drough is expected manifestation of climate change. The results of Středová et al. (2016) suggest gradual increase in values of annual air temperature and the air temperature in the growing season. This change is visible when comparing two last fifty years (1901–1950 and 1961–2010), in particular it is extension of areas falling into interval of average annual temperatures 8 to 10 °C, respectively temperature in the growing season 14 to 16 °C (temperatures in the growing season in the southernmost part of South Moravian in the period 1961–2010 reached 16 to 18 °C).

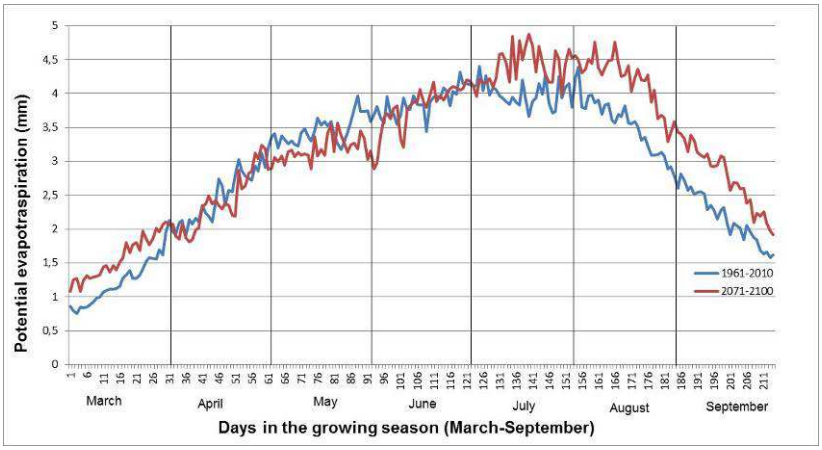

Fig. 1: The course of potential evapotranspiration during the growing season (March-September)

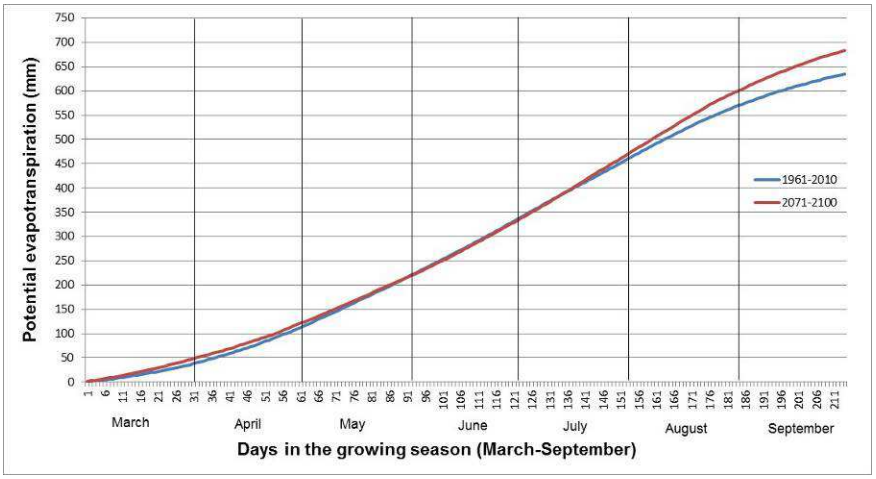

Fig. 2: Cumulative values of potential evapotranspiration

Tab. 1: The amount of water in mm which can evaporate in each months

Month	1961-2010	2071-2100	Increase/decrease by 2100
March	38,3	49	10,7
April	74,6	72,4	-2,2
May	107,2	98,5	-8,7
June	116,1	114,1	-2
July	123,9	136,4	12,5
August	109,8	130,1	20,3
September	65	82,8	17,8
Total	634,9	683,3	48,4
Difference	48,4		

Středová et al. (2016) also state that comparing the second half of the 20th century with the period from 1901 to 1950 shows a slight reduction in total annual precipitation (especially in southern Moravia). According to the predictions in the period 2021–2050 this decreasing trend will offset, however in the last thirty years of the 21st century is again followed decrease of precipitation which will be more pronounced than the differences observed in the 20th century. The change of precipation during the growing season corresponds with annual values but the differences are not as pronounced.
Besides decrease precipitation are also expected changes in their temporal distribution when are expected more intense rainfall and longer periods without precipitation. Combination of periods without precipitation with increased evaporation definitely leads to drought. In terms of soil saturation by water are not intense precipitation optimal. This type of precipitation very rapidly leads to exceeded infiltration capacity of soil and subsequently water flows over soil surface. Soil at a shallow depth under the surface remains relatively dry and combination with higher evaporation leads to drought again.

Conclusion

It was found that by 2100 at this locality will increase values of potential evaporation by 50 mm. It can be expected values till 683 mm. The biggest change (increase in value) of potential evapotranspiration is expected in August. In this month it could evaporate up to 20 mm more than the present. Values of potential evapotranspiration will also increase in March, July and September. By contrast, in April, May and June is expected decrease of these values. Overall, however, will increase values of this quantity and can be expected a higher incidence of drought. Given that the rather dry conditions in this area are desirable for the occurrence of protected species, these changes do not have to necessarily impersonate a problem this particular area. The decisive factor is then the so called ecological valence of specific species that defines the tolerance range of individual species to endure a specific factor.

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Souhrn
Článek se zabývá tématem sucha v národní přírodní rezervaci Mohelenská hadcová step. V rámci tématu bylo sucho řešeno z pohledu potenciální evapotranspirace ve vegetačním období (březen až září), která představuje celkové množství vody v mm, které se může vypařit z podloží (z půdy s travním porostem) při současném optimálním nasycení půdního profilu půdní vodou při konkrétních klimatických podmínkách. Hodnocena byla dvě časová období – současnost a výhled do roku 2100. Bylo zjištěno, že do roku 2100 lze očekávat nárůst potenciální evapotranspirace oproti současnosti až o téměř 50 mm. Současná hodnota potenciálního výparu, která činí 635 mm, by měla za daných podmínek stoupnout na 683 mm, přičemž největší nárůst potenciální evapotranspirace oproti současnosti, se do roku 2100 očekává v srpnu, kdy by měla tato hodnota stoupnout o 20 mm. V rámci jednotlivých měsíců ve vegetačním období však nebude oproti současnosti docházet pouze k navyšování hodnot této veličiny. Naopak například v květnu se očekává, že potenciální výpar klesne oproti současnosti až o 9 mm.
Obecně lze konstatovat, že klimatická změna bude mít na území České republiky za následek změnu v rozložení srážek v čase, což při současném zvýšení potenciálního výparu povede k většímu výskytu sucha. Následně pak budou ovlivňovány tamější ekosystémy. Vzhledem k tomu, že stepní, tzn. sušší podmínky, jsou na řešené lokalitě pro výskyt chráněných druhů žádoucí, nemusí tyto změny znamenat na tomto konkrétním místě problém. Rozhodující je pak tzv. ekologická valence konkrétních druhů, která definuje rozpětí tolerance určitého druhu ke snášení libovolného faktoru.

Contact:
Ing. Adéla Svejkovská
E-mail: xsvejkov@node.mendelu.cz

DYNAMICS OF WINTER SEVERITY AND ITS EFFECT ON RECREATION

Pavel Zahradníček[1,2], Jaroslav Rožnovský[1,3], Jáchym Brzezina[1], Petr Štěpánek[1,2], Aleš Farda[2], Filip Chuchma[1,3]

[1] Czech Hydrometeorological Institute, Brno branch office, Kroftova 43, Brno 616 00, Czech Republic

[2] Czech Globe – Global Change Research Institute of the Czech Academy of Sciences, Bělidla 4a, Brno 603 00, Czech Republic

[3] Mendel University Brno, Zemědělská 1, 613 00 Brno, Czech Republic

Abstract

Air temperature in winter months and colder half-year is an important factor for wide range of human activities, including recreation. As a result of current climate change, average air temperatures increase in winter as well. This, however, does not mean that there are no frosts. Each winter season can be assessed using several parameters. In this paper we used the sum of effective air temperatures below 0°C and -5°C. Absolute minimum air temperature was used as an indicator of the extremity of a particular period. Space-time analysis has been performed for both parameters. Air temperatures in winter months are to a large extent influenced by the continentality of the climate. In general, the temperatures in Bohemia rise faster compared to Moravia and the absolute lowest minimum air temperatures are observed in the Western parts of the country. Based on a multiparametric analysis of climate characteristics, the coldest winter and colder half-year was in 1963, in contrast, the mildest winter was in 2007.

Key words: winter severity, EURO-CORDEX, absolute minimum, effective temperature, recreation

Introduction

Temperature characteristics in the colder half-year (October-March) or just winter (December-February), have a large effect on the extent of recreation and determine its nature. There is currently a very fast development in winter recreation and the conditions for recreation and tourism are also studied from the climatological perspective (Lamb, 2002). Winter recreation includes making use of snow cover and ice, especially in natural environments. The current trends of winter air temperatures in the Czech Republic cause shortening of the period with snow on ground (Zahradníček et al., 2016). Winters with prevailing low air temperatures have positive effect on winter tourism because snowing is more likely and it is also more likely that the snow will not melt quickly. If, however, the absolute minimum air temperature drops below -10°C, it becomes rather uncomfortable to stay outside and this is even more profound if the low temperature is accompanied by higher wind speed. Occurrence of days with air temperatures below freezing point already in fall, at the beginning of winter, or at the beginning of spring, has a major effect on the duration of skiing season and affects the profitability of associated businesses.

Data and Methods

Two characteristics were used to assess the severity of the individual periods and to analyze its temporal variability. First one is the effective air temperature below 0°C and -5°C, i.e. the negative sum of air temperatures below the corresponding threshold. Higher negative sum, especially in case of the effective temperature

below -5°C, means that particular season was characterized by significant occurrence of very cold episodes. Second characteristic is the absolute minimum air temperature. This does not give information about the overall conditions of that winter, but provides information about the extent of temperature extremity in that season (it could be just a very short and cold period).
These temperature characteristics were subjected to space-time analysis using 268 technical stations of the Czech Hydrometeorological Institute, which have data available for the 1961-2015 period (Štěpánek et al. 2011a, b, 2013). So-called average series were created for the purpose of this paper using data from technical stations. First, the number of days with a particular characteristic was determined for each station. The stations were then divided into categories based on their elevation (below 300, 301 to 600, 601 to 900 and above 900 m above sea level) and average series calculated. Next, average series for the Czech R. as a whole was derived using data from all the 268 stations. The changes were analyzed by comparing 30-year periods (1961-1990, 1971-2000, 1981-2010) and also the last 15 years (2001-2015). The significance of linear trends was determined. For the absolute minimum, the return period was found using GEV (Generalized Extreme Value) distribution (Alexanderson,1986). This statistical method is commonly used to determine extremity of a particular parameter, especially temperatures.
Discussion also includes an analysis of possible future development of climate in terms of air temperatures. For this analysis, the outputs of the most recent RCM models from the EURO-CORDEX group, as well as selected GCM models. Two emission scenarios were used – the RCP 4.5 (stabilization of greenhouse gas emissions) and the RCP 8.5 (constant economic growth with no greenhouse gas reduction). These predictions were modelled until the year 2100.

Results

An important temperature indicator is the effective air temperature, which gives the sum of average air temperatures below a certain threshold, in this case 0°C and -5°C was chosen. Higher negative sum of effective air temperatures is observed when the threshold is 0°C, because there are more such days. There is no significant difference between winter season and the cold half-year since 35 to 40% of the overall sum from the half-year is observed in January. In December and February, the sum of effective air temperatures is similar, about one third lower than in January.
From the perspective of effective air temperatures, the coldest period was the normal period 1961-1990, followed by 1981-2010. There are no major differences between periods 1971-2000 and 2001-2015. At lower elevations, the lowest negative sum of effective air temperatures was observed in the last 15 years, however at higher elevations it was between 1971 and 2000. The average increase in effective air temperature sum in 2001-2015 compared to the normal 1961-1990 is approximately 20%.
Statistically significant trend is more common in case of effective air temperature below 0°C. At all elevations there is a significantly lower negative sum of effective air temperatures in the cold half-year and all yearly sums. In winter, the trend is statistically significant at elevations 300-900 m a.s.l. and higher (Tab. 1). On average, the negative sum for the area of the Czech R. gets lower by about 8.5% per decade. Looking at the individual months, the trend is statistically significant for the Czech R. as a whole in December.
In case of the effective air temperature below -5°C there is no significant trend for the lowest elevations. Other areas have significant trends for the cold half-year and

yearly sum (Tab. 2). On average, the effective temperature sum below -5°C gets higher by 10% per decade.

Tab. 1: Linear trend of sum of effective air temperatures below 0°C (°C/year) in the period 1961-2015 (statistically significant values in bold).

	X	XI	XII	I	II	III	IV	XII-II	X-III	I-XII
Czech R.	-0.011	0.138	**0.740**	0.938	0.170	0.334	-0.002	**1.900**	**2.406**	**2.309**
<300m	-0.004	0.086	0.563	0.889	0.158	0.237	-0.005	1.660	**2.006**	**1.925**
301-600m	-0.07	0.123	0.768	0.958	0.155	0.321	-0.014	**1.936**	**2.415**	**2.304**
601-900m	-0.027	0.213	**0.910**	0.993	0.229	0.464	0.000	**2.190**	**2.916**	**2.785**
>900m	-0.065	0.418	**0.958**	0.808	0.236	0.680	0.176	2.019	**3.174**	**3.261**

Tab. 2: Linear trend of sum of effective air temperatures below -5°C (°C/year) in the period 1961-2015 (statistically significant values in bold).

	X	XI	XII	I	II	III	IV	XII-II	X-III	I-XII
Czech R.	-0.002	0.078	0.589	0.880	0.100	0.200	-0.003	1.623	**1.927**	**1.843**
<300m	0.000	0.031	0.435	0.882	0.034	0.112	0.000	1.391	1.545	1.494
301-600m	0.000	0.074	0.609	0.906	0.095	0.167	0.000	1.666	**1.928**	**1.851**
601-900m	-0.004	0.141	0.719	0.833	0.212	0.372	-0.015	1.838	**2.401**	**2.259**
>900m	-0.029	0.225	**0.899**	0.684	0.218	0.614	-0.017	1.871	**2.795**	2.600

Extreme temperature conditions are best expressed using the absolute minimum air temperatures. Their occurrence is influenced more by the current weather conditions than long-term changes in the climate. Very cold days can be considered as extreme weather conditions and can significantly affect the nature, as well as human activities. The average absolute minimum for the colder half-year in the Czech R. is -18°C. A lower value of -18.6°C was observed in the period 1961-1990, while in the last 15 years it was only -17°C. The difference between the lowest elevations and mountain areas is only 1.5°C.

Despite the fact that the absolute minimums over the last 15 years were not as low as in the past, this trend is statistically significant only in case of the elevation range 301 to 600 m a.s.l, where the change is +0.6°C/10 years. Rather than looking at the trend it is important to look at the return period – in other words how much time is expected to pass for a particular extreme minimum temperature to occur again. Absolute minimums which statistically occur every other year are very close to the long-term averages and also similar in their elevation distribution. A value below -20°C is reached when looking at a return period of 5 years. On average, once every 20 years the absolute minimum air temperature in the Czech R. drops below -23°C. When looking at even longer periods the absolute minimum does not get much lower. In case of 100-year return period, the temperature is only 0.6°C lower compared to the 50-year return period. Surprisingly there is also not much difference between different elevation ranges and the absolute minimum is in fact even lower at lower elevations. Lowest absolute minimums with a return period of 50 years were

observed in the eastern and northeastern part of the country. In contrast, the western part of the country, in particular the Ore Mountains (Krušné hory), have slightly milder climate. The difference is even more than 4°C and is due to differences in continentality. Extreme winter climate is also observed in southern Bohemia, where there are many very cold basins. Another interesting observation is that based on absolute minimum air temperature, relatively mild climate is also found in the two largest cities of the Czech R. – Prague and Brno – which could be due to the urban heat island effect (Rožnovský et al., 2016).
We can also evaluate the opposite – relatively high absolute minimum air temperature. The coldest year was 1985 (absolute minimum return period of over 100 years). The average absolute minimum for the Czech R. that year was -25.8°C. Temperatures in 1985 dropped very low in both January (125-year return period) and February (66-year return period). Also two years later, in 1987, the absolute minimum temperatures were very low, with an average for the Czech R. as a whole of -25.2°C (corresponds to a return period of over 100 years). The extremely low temperatures in 1987 were measured mostly in January, but surprisingly also March, when the average absolute minimum was -18°C. The third coldest year in the analyzed period based on average absolute minimum was 1996, with December average absolute minimum for the Czech R. of -23.6°C (return period >100 years for December, but for the year as a whole the return period was only 29 years).
In contrast, a winter with average highest absolute minimum was 1974, when the average absolute minimum air temperature for the Czech R. was -8°C. Such high absolute minimum air temperature is on average only observed once in >100 years. Other very warm years were 2015 (with an average absolute minimum of -10.6°C and return period of 60 years), 2007 and 2008.

Discussion
Year 1963 was characterized by record high negative sum of effective temperatures below -5°C. The absolute minimum that year was not the absolute lowest, but the average temperature for the Czech R. dropped below -23°C. Another extremely cold winter and half-year was in 1985 and third coldest winter season was observed in 1964, however the absolute minimum that year was only approximately -19°C. Very cold half-year was also in 1996, characterized by significantly high effective temperature sum below 0°C. Absolute minimum that year was on average -18.5°C.
In contrast, an extremely warm year was 2007. Effective temperature below 0°C, as well as -5°C were very high, which means that the air temperature only very rarely fell below freezing point or -5°C in winter. Average absolute minimum for the Czech R. that year was -12°C. Other warm winters form a cluster of 11 years with average temperature above freezing point. Very warm winters were also observed in 2014 and 1975 and very warm half-year was relatively recently in 2014 and 2015.
The observed rising air temperature trend corresponds to the predictions of the climate models. For the area of the Czech R., the most recent EURO-CORDEX models estimate an increase in air temperature by 2°C (RCP 4.5) or up to 4.1°C (RCP 8.5) by the end of the century. Until 2050, the temperatures will be rising equally, regardless of the greenhouse gas concentrations, after 2050 the predictions differ based on the emission scenario used. The most recent climatological models predict most profound increase in air temperature in winter period (Tab. 3). Based on the emission scenario 4.5, there will be an average warming of 2.4°C, when using the RCP 8.5 model, the increase is 4.9°C (Štěpánek et al., 2016).

Tab. 3: Deviations of air temperature (°C) calculated using 11 EURO-CORDEX experiments from the 1981-2010 long-term average (Štěpánek et al. 2016).

Scenario	Period	Year	Winter	Spring	Summer	Fall
RCP 4.5	**2021-2040**	0.9	1.1	0.8	0.7	0.8
RCP 4.5	**2041-2060**	1.3	1.4	1.3	1.3	1.1
RCP 4.5	**2061-2080**	1.8	2.2	1.8	1.7	1.5
RCP 4.5	**2081-2100**	2.0	2.4	1.9	1.7	1.7
RCP 8.5	**2021-2040**	1.0	1.1	1.1	0.9	0.9
RCP 8.5	**2041-2060**	1.8	2.1	1.8	1.6	1.8
RCP 8.5	**2061-2080**	2.8	3.3	2.8	2.6	2.6
RCP 8.5	**2081-2100**	4.1	4.9	3.8	3.8	3.9

Conclusion

The aim of this paper was to analyze climatological characteristics, which can determine severity of winters and also to see if there are any significant long-term changes. The sum of effective air temperatures below 0°C and -5°C was calculated and to assess the extremity of a particular period, the absolute minimum air temperature was used. These characteristics were also studied together using multiparametric analysis.

Average air temperature in winter and colder half-year increases at the same rate as in other seasons, with the exception of fall, when the trend is lower and not yet statistically significant. On average, the air temperature in winter increases by 0.36°C per decade, for the colder half-year it is slightly less, 0.30°C per decade. This trend is more profound at lower elevations, rather than in the mountains. In terms of the individual months, the highest increase is in December and January. The warming is more significant in the region of Bohemia than in Moravia.

Statistically significant trend is more commonly observed in case of the effective air temperature below 0°C. In winter, the trend is statistically significant at elevations from 301 to 900 m above sea level. The negative sum of effective air temperature for the Czech R. as a whole gets lower on average by 8.5% per decade.

Average absolute minimum for the Czech R. is -18.0°C. A lower value was observed between 1961-1990 (-18.6°C). In contrast, in the last 15 years it was only -17°C. The difference between lowest and highest elevations is just 1.5°C. The coldest year in terms of the absolute minimum air temperature was 1985, when the average absolute minimum for the Czech R. was -25.8°C (return period of >100 years).

The winter and colder half-year of 1963 was the coldest of all the analyzed years. The negative sum of effective air temperatures below -5°C was record high. The opposite extreme was in 2007, when the winter average was 4.5°C and colder half-year 3.5°C above long-term average. The sums of effective temperatures below -5°C and 0°C were low, which means that the air temperature only rarely dropped below 0°C or -5°C. Average absolute minimum for the Czech R. that year was -12.0°C.

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Souhrn
Důležitým faktorem pro lidské činnosti, včetně rekreace je teplota vzduchu, což platí i pro zimní měsíce a chladný půlrok. K hodnocení teplotních poměrů jsme použili sumu efektivních teplot vzduchu pod 0°C a -5°C. Ukazatelem extremity daného roku je absolutní minimální teplota vzduchu. U obou parametrů byla provedena časoprostorová analýza. Velký vliv na teploty vzduchu v zimních měsících má kontinentalita podnebí, takže v Čechách se v zimě otepluje rychleji než na Moravě a na západním okraji republiky jsou nejnižší absolutní minimální teploty vzduchu. Při víceparametrické analýze klimatických charakteristik vyšla jako nejextrémnější zima a chladný půlrok v roce 1963. Naopak nejméně drsná zima byla v roce 2007.

Contact:
RNDr. Pavel Zahradníček, Ph.D.
E-mail: pavel.zahradnicek@chmi.cz

EVALUATION OF AVAILABILITY OF GREEN AREAS IN URBAN AREAS, TAKING KRAKÓW, POLAND AS AN EXAMPLE

Slávka Gałaś, Michał Gryga
AGH University of Science and Technology, Faculty of Geology, Geophysics and Environmental Protection, Poland

Abstract
Quality and availability of green areas is becoming one of the indicators of quality of life in urban areas. To meet the requirements of the residents fully, existence of various forms of green areas seems to be necessary, including small greeneries located in the neighbourhood, slightly larger lawns with recreation and sport equipment situated in a walking distance from residential areas and considerably large open areas providing space suitable for longer weekend breaks. Analysis of the availability of green infrastructure in Krakow with its division according to the surface area covered by parks: regional, metropolitan, district, local, mini-parks located in the neighbourhood and other areas were made by means of the GIS software and application of network analysis.
Both the size of a given green area and its location in relation to residential areas were taken into consideration as evaluation criteria. In result, maps of service the areas have been obtained which in combination with a map of population density will provide information about the real fulfilment of the needs of residents in terms of availability of the green infrastructure The results of the evaluation have shown that varied green infrastructure is not fully available for Kraków residents and it will help to identify opportunities to improve the current state.

Key words: green areas, residents, availability, quality of life

Introduction

Quality and availability of green areas have a significant impact on health and quality of life of urban residents. Hence, existence of small green areas located in close proximity to residential areas, slightly larger areas of active recreation with appropriate recreational and tourist infrastructure accessible on foot and large open areas for weekend recreation are especially important. When considering spatial planning policy, it is advisable to include green areas in the effective planning to provide access to various green infrastructures for as many inhabitants as possible. Kraków (Cracow), located on the Vistula River in the southern part of the country, is the second largest city in Poland (GUS 2016, as for 2014) in terms of the number of inhabitants (761,069 people) and its area (326.85 km^2). At present, 62.04% of the area of Kraków is undeveloped, of which the greenery constitutes only 3.61%. The other areas are open ones, and almost half of them are unmanaged lands and wastelands, such as meadows, tree covered areas and riverside scrubs (Studium 2014).

Material and methods

The key attributes of an attractive public place, in particular, publicly accessible green spaces, include (Zachariasz 2006): comfort and image of the place, accessibility and location within the transport infrastructure network, using the space as a public place and social character of the space which enables to develop social relationships in the whole neighbourhood.

The research takes into consideration measurable features such as the size (i.e., area) of a green area, determining its use, and the distance of the area from the place of residence of potential users of the green infrastructure which characterizes its location in the city. The parameters can be evaluated by means of GIS tools: a spatial analysis and a network analysis. The other two attributes of the green spaces belong to strongly subjective features that are described by immeasurable sociological and psychological characteristics so they will not be studied.
On the basis of the literature data, six requirements have been determined which have to be met to consider a particular residential area as the one where availability of green infrastructure areas is fully provided (Stanners & Bourdeau 1995, Czerwieniec & Lewińska 1996, Zachariasz 2006, Barbosa et al. 2007, Ziobrowski 2012, Burlińska 2013). They take into consideration the following structures: a regional park, a metropolitan park, a district park, a local park, a neighbourhood mini-park and any green space at the distance of 900 m from the place of residence (Table 1).
It has been assumed in the paper that a park which is higher in the classification and which is located within a proper distance form the place of residence also meets the requirements of a park lower in the classification as it meets the distance and surface criteria established for the other categories of green spaces. For example: a regional park with an area of over 400 hectares which is not further than 1.2 km from the place of residence, due to its proximity to the recipient of a particular function, also fulfils the functions of a metropolitan and district park.
The entire area that meets one of the six distance requirements mentioned above will be determined as an area of service for a given green site category. The number of requirements out of the six ones mentioned above which are fulfilled gives information on availability of various green infrastructures for residents. A synthetic assessment of availability of the green infrastructure has been carried out and a scale of 0-6 has been adopted, where the grade 6 is the highest possible one and it means that all six requirements have been met and the grade 0 is the lowest possible one, given to areas where none of the requirements have been met.
A spatial data base of location of parks and their area, as well as linear data supplemented with information about point, linear or surface obstacles on the route (e.g. gates, walls and fences, enclosed areas), as well as interactions between sites have been used for spatial and network analyses; the data come from the Department of Environmental Design of the City of Kraków and OpenStreetMap. Due to diversity of the green infrastructure, the first stage of the work has been devoted to determining publicly accessible green areas that will be the subject of the work.

Results

When studying availability of the green infrastructure of the city of Kraków, a total of almost 2,275 ha of urban green areas with public access have been analysed, the vast majority (96.5%) of them are the largest ones: regional, metropolitan, district and local parks (Table 1, Fig. 1).
For each of the requirements, the surface area of a green area in a given category and its share in the total area of the city has been determined. Apart from that, according to the average density of population in urban units, the number of inhabitants for which the specified availability requirement is fulfilled has been estimated (Table 2).
According to the synthetic analysis of availability of various green infrastructures for inhabitants of Kraków, it can be stated that the areas meeting all six requirements

occupy a little over 28 km^2 which is 8.66% of the surface area of Kraków. More than half of the Kraków area is rated 1 or lower, and more than one third has got the rating 0. Availability of urban greenery rated 6 occurs in case of 16% of the Kraków population (almost 120,000 inhabitants). One of five inhabitants of Kraków has access to greenery rated 1 or lower (Fig. 2, Tab. 3). When bringing the results to a single numerical value, the weighted average of rating of the green areas availability in Kraków on a scale of 0-6 and calculated in relation to the surface is equal to 2.01, while for a statistical inhabitant (taking into account an uneven distribution of population) it is equal to 3.28.

Tab. 1: The surface area of green areas per capita and percentage of particular types of green areas in the city of Kraków – cumulative values (Gryga 2016)

Division of green areas according to their surface area			**Cumulated surface area of green spaces per capita [ha]**	**Percentage share of particular types of green areas [%]**
Types of green areas	**Minimum surface area [ha]**	**Maximum distance from the place of residence [km]**		
regional parks	400	8	490.95	21.59
metropolitan parks	60	3.2	1,027.12	45.16
district parks	20	1.2	1,524.48	67.03
local parks	2	0.4	2,195.78	96.54
mini-parks	0,25	0.4	2,269.09	99.76
all green areas			2,274.45	100.00

Tab. 2: Surface area of areas of service for particular types of parks and estimated number of inhabitants having access to them

Division according to the surface area	**Surface area of the area of service**		**Number of inhabitants having access**	
	km^2	**share [%]**	**per capita**	**share [%]**
regional parks	104.02	31.81	270,863	36.36
metropolitan parks	134.20	41.04	475,180	63.79
district parks	88.34	27.02	302,445	40.60
local parks	76.51	23.40	347,803	46.69
mini-parks	89.54	27.39	408,533	54.84
all green areas	168.02	51.39	638,886	85.77

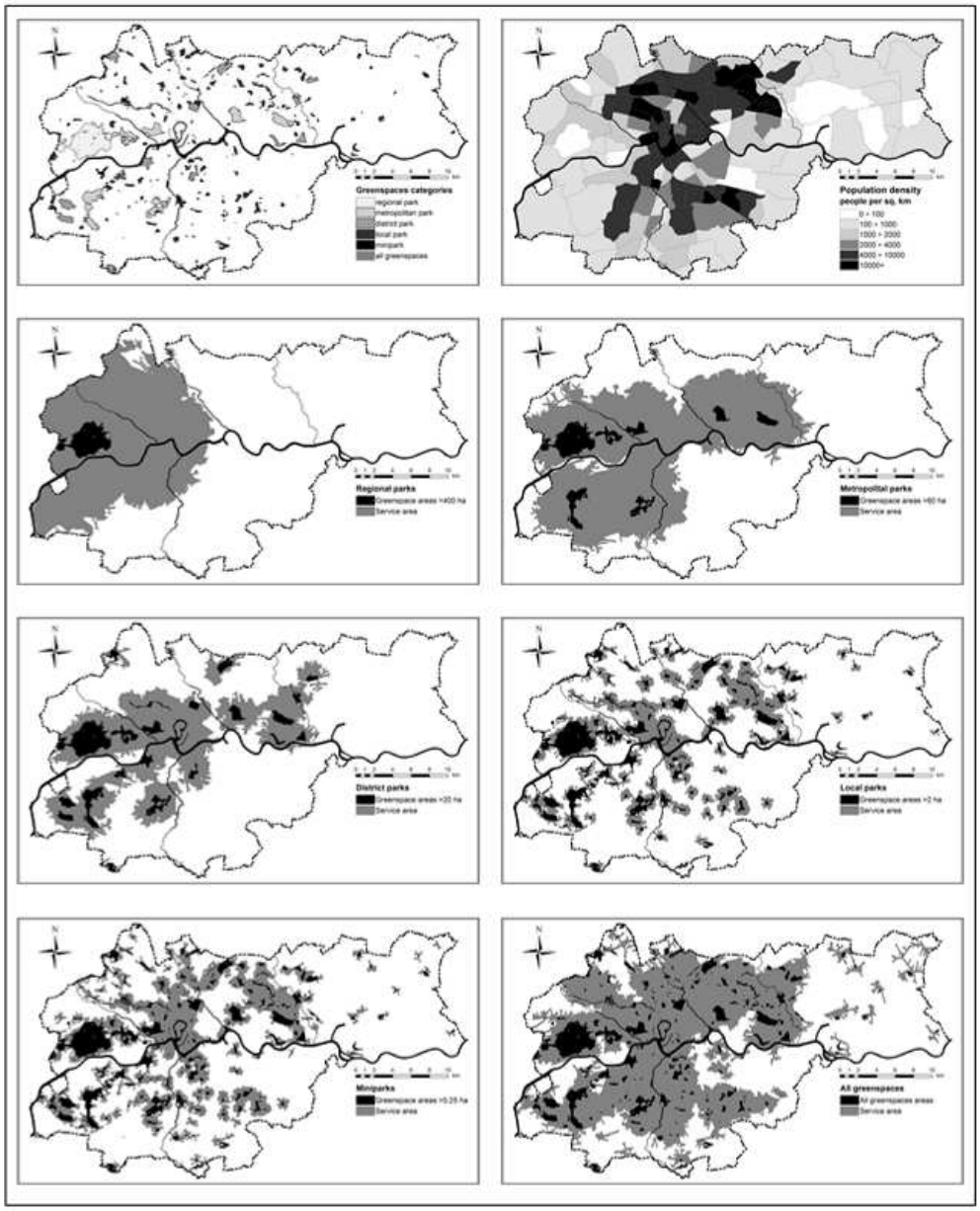

Fig. 1: Availability of urban greenery of the city of Kraków (areas of service) a result of network analysis together with a map showing average population density of urban units and a map of publicly accessible green areas in Kraków, divided according to their surface area

Tab. 3: Synthetic assessment of availability of various green infrastructures (Gryga 2016)

Standard assessment of availability (number of requirements met)	**6**	**5**	**4**	**3**	**2**	**1**	**0**
A share of the total surface area of the town [%]	8.66	6.88	11.22	11.22	11.68	12.98	37.36
A share of the total number of inhabitants [%]	15.79	12.57	20.38	16.86	13.26	11.89	9.21

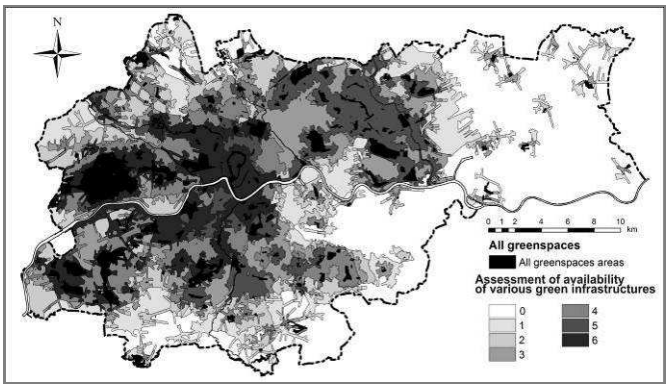

Fig. 2: Synthetic assessment of availability of various green infrastructures including a population density map (Gryga 2016)

Conclusion

The assessment of availability of various green infrastructures for Kraków inhabitants has shown that it is currently not fully provided. The calculated values of the percentage of inhabitants who have access to certain categories of the urban greenery show that the lowest number of people have access to regional parks - mainly because there is only one such park in Kraków and it is located in the western part of the city. The problem cannot be solved by the planned park investments either, as their surface area is much smaller than the assumed minimum for a regional park which is equal to 400 ha. A suggested solution might be creation of a large urban green complex in the eastern part of the city of the surface area of about 600 hectares. A small number of people who have access to local parks (47% of the city inhabitants) is also worth noting. In this case, the planned park investments will not solve the problem either, as they are located mostly on the outskirts of the city, while the problem of poor availability of local parks mainly occurs in the densely populated and built up areas of Śródmieście (City Centre). A proposed solution would be creation of new publicly available parks of the minimum area of 2 ha in undeveloped areas (Gryga 2016). Therefore, it can be concluded that both the results presented graphically on the maps of areas of service and compared with the population density map as well the synthetic numerical value representing the weighted average of the results provide information about the real satisfaction of the needs of Kraków inhabitants with regard to their access to the green infrastructure. The results can be used as a support for preparation of urban

investment plans and as a basis for comparative analysis in time or between other territorial units.

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Souhrn

Z výsledků šetření o posouzení dostupnosti různých zelených ploch v Krakově vyplývá, že v současné době nejsou plně k dispozici. Vypočtené hodnoty procentuálního podílu obyvatel, kteří mají přístup k určitým kategoriím městské zeleně, ukazují, že je velmi nízký počet lidí, kteří mají možnost využít regionální parky a podobná situace nastává v případě okresů a jejich přístupu k místním parkům. Vzhledem k významu dostupnosti zelených ploch v uspokojování potřeb obyvatelstva a jeho vliv na kvalitu jejich života, je třeba přijmout vhodná opatření ke zlepšení situace. Prezentovaný přístup k posouzení dostupnosti a stanovení oblastí pro tvorbu zelených ploch, mohou být základem pro takové akce.

Contact:
Slávka Gałaś
E-mail: sgalas@geol.agh.edu.pl

EVALUATION OF OPINIONS TO THE SELECTED PARAMETERS OF TOURIST TRAILS WITH DISABLED ACCESS FOR WHEELCHAIR USERS IN SLOVAKIA

Mariana Jakubisová
The Borová hora Arboretum, Technical University in Zvolen,
Borovianska cesta 2171/ 66, 960 53 Zvolen, Slovakia

Abstract
This article evaluates the requirements and opinions of disabled people to the issue of accessibility of tourist trails in Slovakia. We analyze the relationships between the preferred length of tourist trails with selected parameters by type of disability and age of respondent based on the questionnaire survey and evaluation of responses. To the interpretation of the results, we used the responses of 57 respondents. Respondents from the Slovakia prefer shorter routes for recreation in forests with averages length of trails 3.2 km (from 2.3 to 4.0 km) what represents half-day activity for wheelchair people. We found that as well as the type disability also age of respondents had not significant influence to individual the selection of trail length. Within the analyzed relationships did not confirmed a direct relationship of selection the length trail to examined parameters. Analysis of tourist trails for wheelchair users is important for estimating of the individual physical fitness and optimum planning of trails difficulty. Results can be used to the optimize of proposals of trails for people with disabilities in a wheelchair.

Key words: hiking trails, wheelchair accessibility, proposal optimalization

Introduction

One way of improving the conditions for disabled people in wheelchair at national and supranational level is their inclusion in to tourism. Building recreational and educational trails without barriers is one of ways discovering of local traditions, history and natural beauty. The usefulness of such activities is essential, because the stay in an natural environment has effects on development of not only physical activities but also the mental health of these people. Slovakia pays more and more attention to the adaptation of tourism infrastructure, recreation and education also for people with disabilities (Jakubis 2015a, 2015b). Currently, persons with disabilities constitute about 10% of the population of the Slovakia (Slovakia Statistical Office 2014). Tourism and recreation in nature play a very important role in the lives of people with disabilities. Tourism for people with disabilities should be treated according to Łobożewicz (2000) not only as entertainment and for relaxation but also as a means of therapy and education for and calming effects on the disability, allowing them to try their hand at different often difficult conditions. According to many experts on the issues of rehabilitation of persons with disabilities (Łobożewicz 2000; Wolski 1979; Weiss 1979) cultivation of tourism can counteract hypokinesis as well as accelerate and support the processes of renewal and regeneration of the body. Tourism also allows people with disabilities to socially integrate and adapt to normal life (Junek and Fialova 2012). The majority of tourist activities undertaken by humans takes place in the natural environment (Navratil et al. 2015). In all activities of tourism, recreation, leisure and education, they may participate as people with disabilities, regardless of the type of disability, age and psycho-motor possibilities. According to Łobożewicz (2000), practice shows that

there is no discipline in tourism that could not be occupying for people with disabilities.

Material and methods

The research presents the results of surveys conducted 2015 on a group of people with disabilities people in wheelchairs in Slovakia. We've analyzed the values of dependent variables (trail length) in dependence on values nominal independent variables (age of respondent, type of disability)for group of 57 respondents. We hypothesized of interactions between stated factors which the were defined according to individual questions taking into account the answer numbers of respondents in each category. For statistical analysis, we used analysis of variance with a significance level of 0.05, and the comparisons were performed using posthoc Duncan test. Statistical analysis was performed to determine of statistically significant differences between the preferences of people with disabilities living in Slovakia. The questions in the survey were designed to determined the preferences of the respondents in terms of selected features of recreational trails, such as the optimal length of the tourist route (Question 1), the age group of the respondents (Question 2) and disability category (Question 3).

Results and discussion

Respondents were asked on the following 3 questions, see Figure 1, 2, 3. The results of research conducted in Slovakia show that according to the survey, the majority (about 40.4%) indicated that the length of trails should not exceed 4 km and should not be less than 2 km. From Figure 1 it is clear that: the most of respondents prefer a route length of 2-4 km (40,4%); 19.3% of respondents indicated that the trail length should be more than 4 km; whilst 17.5% of respondents could not determine the preferred length of the trail; 14.0% of respondent prefer a route length of 1–2 km; only 8.8% of respondents indicated that trail length should not exceed 1 km. Figure 2 show that: 29.8% of surveyed respondents belongs to the age category of 65 years and more; 19.3% belongs to the ages categories of 26-39 and 40-54 too; 17.5% belongs to the age category of 55-64 and 7% to the categories of 18-25 and 17 and less too. From the research (see Figure 3) is clear that in the answers is predominant category (57.9%) of wheelchair users with disabilities in the category "other disability" in compared to the paraplegic (28.1%) and tetraplegic respondents (14%). We found that as well as the type disability also age of respondents has not significant influence to individual the selection of trail length. In Slovakia, appears to be the prefered length of trails 3,18 km (min. 2.3, max. 4.0) for half -day activities according to responses of disabled respondents (see Table 1). Within the analyzed relationships (see Table 1-4, Figure 4-5), we are not confirmed a significant differences between the selection of length trail and category of disability: paraplegic, tetraplegic, other disability. We assume, preferred the choice of trail lenght is directly related mainly to the physical and mental individual potential of disabled respondents, the type of used wheelchair and etc. At in depth analysis using multiple comparison test (Duncan's test) showed that the opinions of Slovak respondents about the optimal length of the route are not significant from each other and no relates significantly to the disability category (see Table 4). Analysis of post hoc Duncan test showed no statistically significant differences between the views of respondents. In the individual categories according to the type of disability (see Table 4), the respondents prefer as the optimum length of the route follows: in K1 = 2.91 km, K2 = 3.14 km, K3 = 2.75 km (see Table 4, Figure 5). So far in the literature in the field of tourism, development and recreation appeared different; the views on

the optimal length of recreational trails are often contradictory. For example, according to Płocka (2002), walking in the woods should span a maximum length of 12 km optimally and be 8 km away. In turn, the optimal length of forest trails should be 1–2 km (Łonkiewicz and Głuch 1991). At the same time, there is a lack of information on the optimal length of routes for people with disabilities in wheelchairs, the needs and expectations of this social group. The study showed that in Polish conditions, as well as in the forests of Slovakia, recreational trail adapted for wheelchairs should not exceed 4 km. According to a research conducted in the Czech Republic, it shows that these routes may be longer (Hrůza, Kotásková 2010).

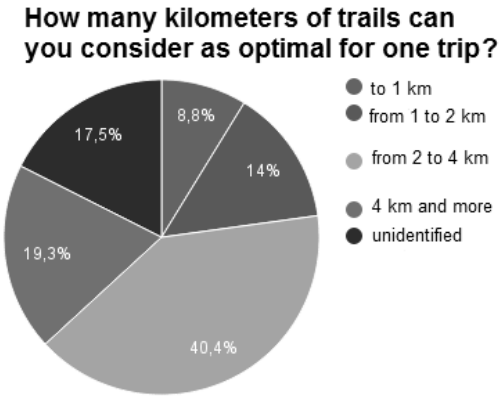

Fig. 1: The answers of respondents to Question 1

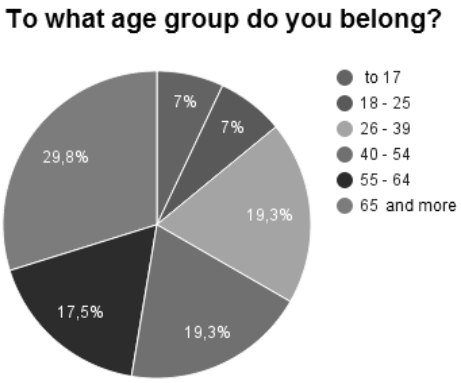

Fig. 2: The answers of respondents to Question 2

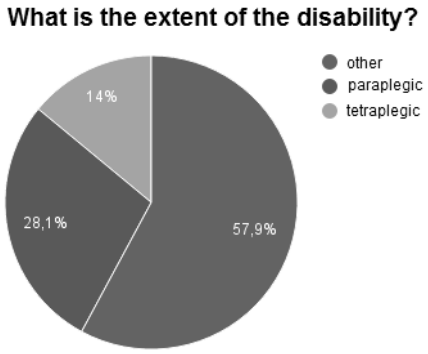

Fig. 3: The answers of respondents to Question 3

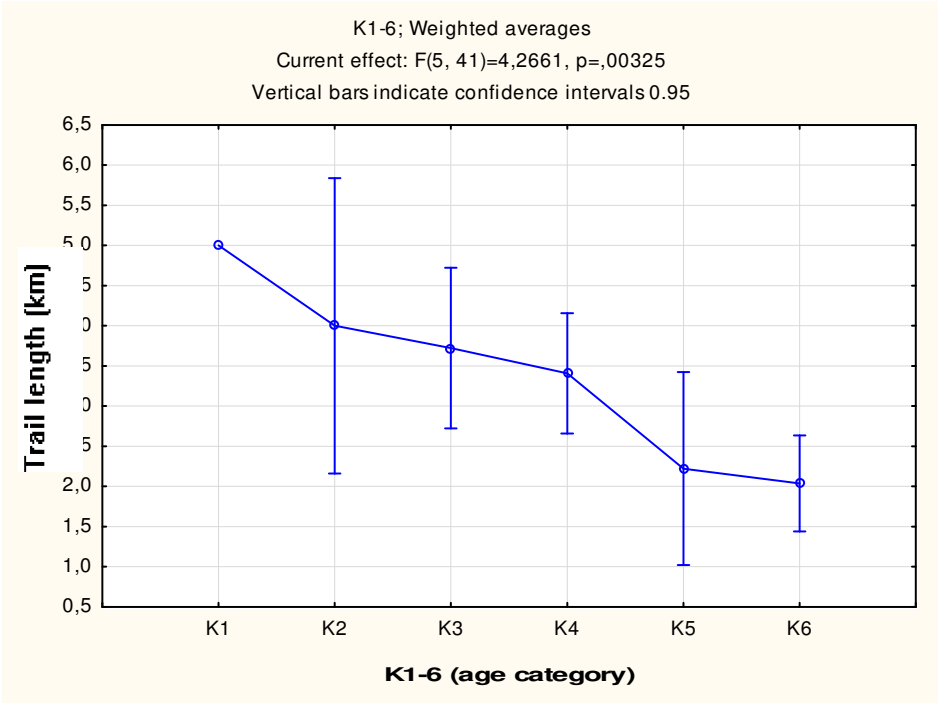

Fig. 4: Answers of respondents on Question 1

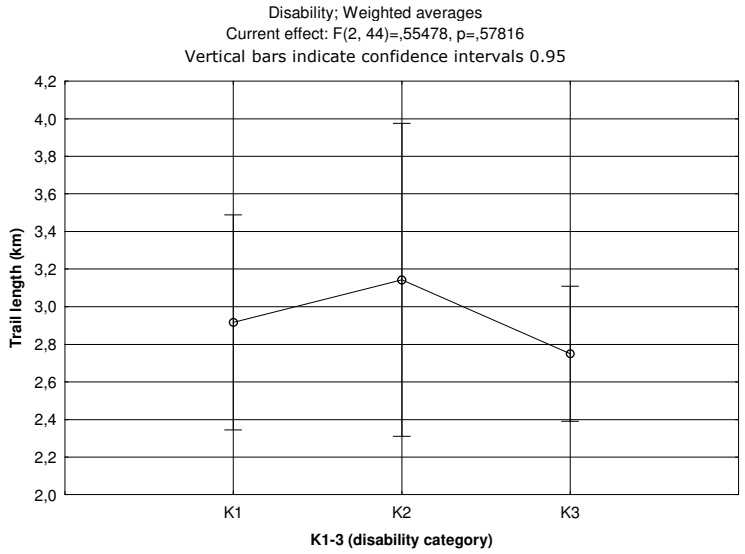

Fig. 5: Answers of respondents on Question 3

Tab. 1: Weighted averages of the length trail according to age categories

	Prom1 K1-6; Vážené průměry (Tabulka12-K1-6.sta) Současný efekt: F(5, 41)=4,0513, p=,00443 Dekompozice efektivní hypotézy				
Č. buňky	Prom1 K1-6	Prom2 DĹCH Průměr	Prom2 DĹCH Sm.Ch.	Prom2 DĹCH -95,00%	Prom2 DĹC +95,00%
1	K1	4,000000			
2	K2	3,500000	0,288675	2,581307	4,4186
3	K3	3,333333	0,235702	2,789803	3,8768
4	K4	3,181818	0,181818	2,776702	3,5869
5	K5	2,333333	0,372678	1,473936	3,1927

Note to Tab. 1: K1-6 - Age of respondents (in years): K1 – to 17, K2 – 18-25, K3 – 26 - 39, K4 – 40 - 54, K5 – 55 - 64, K6 - 65 and more; N – multiplicity

Conclusion

The study not revealed of significant differences in the views of people with disabilities surveyed in Slovakia in researched questions. Respondents from the Slovakia prefer shorter routes for recreation in forests with approximately average length of trails 3.2 km (from 2.3 to 4.0 km) what represents half-day activity for wheelchair people. We found that as well as the type disability also age of respondents has not significant influence to individual the selection of trail length. Furthermore, we found that within the 3 categories of disabilities the respondents chose as the optimal length of route: K1 (paraplegic) = 2.91 km, K2 (tetraplegic) = 3.14 km, K3 (other disability) = 2.75 km, what is not the significantly different from determined value of optimal route. A proper understanding of the differences in the preferences of the respondents require further research to establish the relationship between views on trails for tourism and recreation and their features such as the period of use of wheelchairs, their types (stable, electric initially, the three-wheel,

handcycle and others) etc. Zoning traffic intensity of tourist trails and the creation of modern rules of access to and development of recreational trails must take into account the needs and expectations of disabled users of the area. This issue is still little understood. As a result, the current guidelines for recreational trails in Slovakia hardly contribute to the formation of routes friendly to people with disabilities in wheelchairs.

Tab. 2: Post hoc Duncan test for the length of trails

No.	Duncan test; variable - length of trail (km) The approximate probability for post hoc test Error: ASS = ,61965, DF = 41,000						
	Age K1-6	{1} 4,0000	{2} 3,5000	{3} 3,3333	{4} 3,1818	{5} 2,3333	{6} 2,3077
1	K1		0,395450	0,287428	0,207968	0,012442	0,012443
2	K2	0,395450		0,776174	0,611166	0,072883	0,073140
3	K3	0,287428	0,776174		0,796038	0,111621	0,114633
4	K4	0,207968	0,611166	0,796038		0,152614	0,163753
5	K5	0,012442	0,072883	0,111621	0,152614		0,965182
6	K6	0,012443	0,073140	0,114633	0,163753	0,965182	

Note to Tab. 2:: SS effect - the sum of squares of the dependent variable; DF – the degree of freedom; ASS effect– variance due to the independent variable (X); F – value of the test criteria; p – the minimum level of signifikance

Tab. 3: Weighted averages according to categories of disability

No.	Disability; Weighted averages Current effect: F(2, 44)=,55478, p=,57816					
	K1-3 Dis	Trail length Averages	Stand. deviation Sm.Ch.	-95,00%	+95,00%	N
1	K1	2,916667	0,259905	2,344620	3,488713	12
2	K2	3,142857	0,340068	2,310741	3,974974	7
3	K3	2,750000	0,175368	2,390174	3,109826	28

Note to Tab. 3: Stand. deviation - Standard deviation; K1 – paraplegic, K2 – tetraplegic, K3 – other disability

Tab. 4: Post hoc Duncan test for categories of disability

No.	Duncan test; variable-Trail length Error: ASS = ,84145, DF = 44,000			
	Disabl	{1} 2,9167	{2} 3,1429	{3} 2,7500
1	K1		0,558258	0,665945
2	K2	0,558258		0,340737
3	K3	0,665945	0,340737	

Note to Tab. 4: No. – number; Disabl - disability category; K1 – paraplegic, K2 – tetraplegic, K3 – other disability

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Souhrn

Odborníci na Slovensku věnují stále více pozornosti přizpůsobení infrastruktury cestovního ruchu, turistice a vzdělávání i pro osoby se zdravotním postižením. Studie neodhalily významné rozdíly v názorech lidí se zdravotním postižením v zkoumaných otázkách. Zjistili jsme, že stejně jako typ postižení i věk respondentů nemá významný vliv na individuální výběr délky trasy. Správné pochopení rozdílů v preferencích respondentů vyžaduje další výzkum a ověřování za účelem stanovení nových poznatků prostřednictvím názorů cílové skupiny hendikepovaných lidí na vozíku, například v otázkách užívání různého typu invalidních vozíků (mechanický, elektrický, tříkolka a další) v souvislosti s fyzickým výkonem respondenta, jeho ekonomickými možnostmi atd. Problematika územní dopravní intenzity turistických tras a vytvoření moderních pravidel k navrhování turistických a rekreačních stezek musí brát v úvahu potřeby a očekávání uživatelů se zdravotním postižením v konkrétní oblasti. Tento problém je na Slovensku stále málo pochopen. Výsledkem je, že současné pokyny a normy pro turistické a rekreační stezky na Slovensku jen těžko přispívají k tvorbě tzv. "přátelských" tras pro lidi se zdravotním postižením na invalidním vozíku.

Contact:

Ing. Mariana Jakubisová, PhD.
E-mail: jakubisova@tuzvo.sk

EVALUATION OF THE USE OF LAND RESOURCES IN THE RADOŠINA MUNICIPALITY WITH REGARD TO OPTIMAL LANDSCAPE STRUCTURE AND DEVELOPMENT OF RECREATIONAL ACTIVITIES (AGRITOURISM)

Eva Pekárová, Ľubomír Hanisko
National Agricultural and Food Centre – Soil Science and Conservation Research Institute, Gagarinova 10, 827 13 Bratislava, Slovakia

Abstract
The paper is oriented to evaluation of specific landscape structure within Radošina village with link to optimal structure of farming environment. Relevant landscape properties, especially with regard to the way of agricultural soil use or their spatial variability, represented the base and broader frame for definition of optimal and non-suitable activities for agriculture.
Results of evaluation of individual production units served as base for identification of landscape problems, while landscape regulators and measures for management of investigated area and surrounding environment were specified including agritourism development. Final proposals of optimal structures represent the landscape-ecological potentials and limits for sustainable use of given territory.

Key words: landscape potential, abiotic complex, landscapecological planning

Introduction

In the area of ladscape study as a whole it is increasingly preferred the effective use of agricultural land, taking into account sustainable development and environmental protection.
The carrying capacity or potential of the landscape is the theme of landscape ecology and environmental planning and is very close to the concept of the country burden. In practice, two basic approaches of carrying capacity of the landscape are distinguished. It is the biological approach of which the critical threshold is defined by the amount of population, and the antropocentrical approach from the view of human interests that is the concept of sustainability (Marsh, Gross, 2002).
The carrying capacity of the landscape always refers to a human activity on a certain territory, so it can be understood also as the acceptable amount of changes in the landscape i.e. bearable burden of the certain territory. The carrying capacity of the landscape can be considered as an auxiliary criterion in the environmental planning, whose objectivity is given by the research of a certain territory and legislative standards for environmental components (Act no. 198/2014 Z.z. on nature and landscape protection as amended by later regulations).
The threshold of the carrying capacity of the country is determined according to general limits:
- **Abiotic limits,** derived from the properties of the natural conditions of the territory, i.e. from the geological substrate, relief, surface and ground waters, soils and climatic conditions;
- **Geodynamic limits,** derived from the processes ongoing in the country such as land slide, soil erosion, floods;
- **Ecological limits,** derived from the native significance of components such as the relict soils, peat lands, wetlands;
- **Ekosozological limits,** given by legal protection of nature or nature sites such as protected areas, natural resources or the soil with the highest bonity value;

- **Cultural-historical limits,** given by legal protection of monuments and historic sites;
- **Hygienic limits,** that specify the admissible content of harmful substance in soil, water and in the air;
- **Safety limits,** determining the protection zones of different anthropic objects, e.g. animal farms.

The above limits constitute the basic requirements given to optimal structure and subsequently the quality of the agricultural landscape.

Materials and methods

The paper dealls with the application of a specific assessment of the landscape structure and its optimal linking with production environment as well as the proposals for the optimal management of arable land in relation to the surrounding landscape area.

The methodology of Landscape Planning LANDEP (Landscape ecological Planning), whose fundamental objective is to design an environmentally optimal use of the country i.e. ´where and how to manage´, was used for the evaluation of a selected investigation area within Radošina municipality.

The aim of paper is also to present a concrete proposal for the most appropriate deployment of agricultural activities in the landscape while taking into account the effective land use and protection of the environment. The methodology has a fixed procedure but simultaneously it is also an open system and the particular content depends on the nature of the territory.

In this paper, the basic steps of LANDEP methodology (Hrnčiarová et al., 2006) were carried out in the following sequence:

The first step consisted in the landscape analysis focused on the analysis of abiotic parameters, i.e. slope gradient classes, rock environment, soils and climatic characteristics of the area of interest on the base of BSEU (bonited soil-ecological units) (Džatko et al., 2009) and Soil map of Slovakia 1:400 000 (Hraško et al., 1993).

The second step was the landscape synthesis representing the creation, characterization and classification of spatial elements and creation of homogenous spatial sites which which have approximately the same characteristics, i.e. the same loading of territory by anthropogenic activities as well as the same use. Using geographic information system of NPPC-VÚPOP were spatially defined areas with different abiotic characteristics. Characteristics of given type of territory determine the carrying capacity and therefore the suitability for the use of land resources. In this regard they become a base operational units of decision-making process.

The third step consisted in the landscape evaluation (assessment). It plays an important role in the LANDEP methodology because abiotic characteristics were used for determination of landcape use suitability for localization of selected agricultural activities. The result of partial potentials was the final potential for each of the activities in the area of interest, i.e. for arable land, permanent grassland, vineyards, orchards and forests. The requirements of individual activities on landscape-ecological conditions were confronted with the real landscape properties by limits which result from both legal regulations and landscape characteristics.

Fourth the and final step were the proposals of landscape-ecological measures on the basis of abiotic complexes evaluation, the essence of which was the selection of functional and optimal activities, and by use of limits to mitigate the negative impact on the environment.

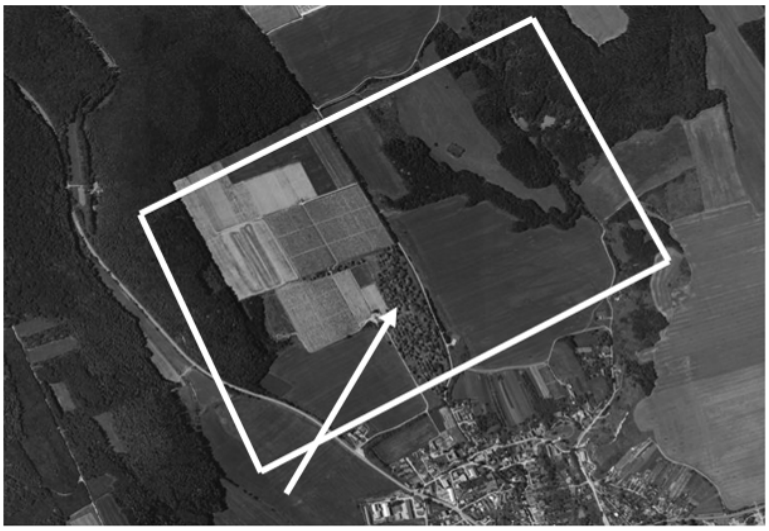


Fig. 1: The delimitation of the investigation area in the part of Radošina municipality
Legend: Soil portal - Soil Science and Conservation Research

Investigated area

The investigated area in the Radošina municipality is located in the productive agricultural area northwest of the Nitra loess hills on the border of Považský Inovec in the side stream valley Radošina. The village is located at a height 282 m above the sea. The coordinates 17°56'17.5'' east longitude and 48°32'44.2'' north latitude length characterize geographic location and its cadastral area covers an area of 3,438 hectares. The slope gradient is a significant differentiation factor of prevailing processes and in the landscape planning represents a fundamental characteristic of the use of land resources. In investigated area the slope gradient ranges from 1° to 8°. By regional geomorphological division this area belongs to the ensemble Považský Inovec and two subassemblies - Krahulčie hills and Inovecké foothills. The southern part consists of upland Tertiary sediments covered by loessial loams and loess. Northern uplands part on the south-eastern slopes of Považský Inovec consists of Mesozoic bedrocks. They are overgrown by oak-hornbeam forests with thermophilic oak stands. There is a mixture of soils represented mainly by Haplic Luvisols, Aplic Luvisols and forest Cambisols. The investigated area belongs to warm and dry climatic area with mild winter. Average annual temperature represents 9°C. In the investigated area dominates arable land with loamy Haplic Luvisols.

Selected spatial data were processed in the framework of the activities of NPPC-VÚPOP. After processing of current spatial land-use the five basic units were created, namely: arable land, permanent grassland, vineyards, orchards and forests, which represent spatial diversification of the different potentials for intensive agricultural and forestry land use. Due to diversity of land use and for the purpose of evaluation, the investigation area was delimited by visible horizons which are partly incorporated into the oak-hornbeam forest.

Results and Discussion

From the view of a functional use of the territory, for the individual activities three levels of potential were defined (see Table 1):

A: high potential (good conditions for development activities),

B: medium-high potential (limited, but nevertheless the matching conditions for the development of the activity),
C: low potential (very low assumptions for the development of the activity).

Fig. 2: Spatial representation of land cover: arable land, permanent grasslands, vineyards, orchards, forests
Legend: OP – arable land; TTP – permanent grasslands; SAD –orchards; VIN – vineyards; X – nonagricultural land

Through the assessment based on the LANDEP methodology were determined potentials of selected production units resulting from their abiotic characteristics that together determine the suitability of land use. For all abiotic complexes of investigation area were on the base of individual components defined partial potentials for each of assumed activities. Final potential for each activity, based on partial potentials, corresponds with different restriction of actual land use. Table 2 indicates the changes in use of the investigation area, which can be defined as changes in land resources, spatial structure, or the subdivision of land within the given territory. In the next step the optimal use was compared with the actual existing use with aim to reach compliance. The suitability of the location of intensive agricultural activity is the result of the evaluation of the restrictions arising from the types of abiotic factors. The method of evaluation consisted in the fact that if in all abiotic parameters were favourable conditions, the restriction was indicated as very low with high potential. On the contrary, if at least one indicator showed the highest degree of restrictions for a given activity, the restriction becomed know as high. In this way, allocated territory gives us a frame idea of possible development of the assessed activities (see Table 2).

Tab. 1: Partial potentials of the individual components of abio-complexes for selected activities of the area

The component of abiotic complex		The partial potentials				
climatic region		**Arable land**	**Permanent grasslands**	**Forests**	**Vineyards**	**Orchards**
code	***category***					
02	warm, dry, upland	B	A	A	A	B
soil subtype		**Arable land**	**Permanent grasslands**	**Forests**	**Vineyards**	**Orchards**
code	***category***					
44	loamy Haplic Luvisols	A	A	B	A	A
45	loamy and sandy-loamy Haplic Luvisols to Albi-Haplic Luvisols	A	A	A	A	A
48	loamy Haplic Luvisols and Albi-Haplic Luvisols with skeleton admixture	B	A	B	A	A
50	loamy eroded Haplic Luvisols and loamy Stagnic Glossisols	C	A	B	B	B
52	loamy Haplic Luvisols and Eutric Regosols	B	A	B	B	B
Slope		**Arable land**	**Permanent grasslands**	**Forests**	**Vineyards**	**Orchards**
code	***category***					
1	1°- 3°	A	B	C	B	A
2	3°- 7°	B	A	B	A	B
3	7°- 12	B	A	A	B	C
Skeleton content		**Arable land**	**Permanent grasslands**	**Forests**	**Vineyards**	**Orchards**
code	***category***					
0	without skeleton	A	A	A	A	A
1	low content of skeleton	B	A	B	B	B
2	medium content of skeleton	C	B	B	B	B

Soil depth		Arable land	Permanent grasslands	Forests	Vineyards	Orchards
code	***category***					
0	0.6 m and more	A	B	A	A	A
1	0.3 – 0.6 m	A	A	B	B	B
2	up to 0.3 m	B	B	C	C	C
Soil texture		**Arable land**	**Permanent grasslands**	**Forests**	**Vineyards**	**Orchards**
code	***category***					
1	loam-sand	B	B	C	B	B
2	loamy	A	A	A	A	A
5	sand-loamy	A	A	B	B	B

Tab. 2: Potential and limits of the use of land resources of investigation area

The actual use of land resources	**The Potencials and limits; land resources use**	**The level of suitability of the use of land resources**	**Proposal**
Arable land 8102/1, 8111/1	High potential Low limit	1st level	To retain an arable land
Arable land 8005/1,7001/1	Medium potential Medium limit	2nd level	Reduce the proportion of arable land, increase the proportion of permanent grassland.
Arable land 9101/1	Low potential High limit	3rd level	Exclude the use as arable land, increase the proportion of permanent grassland and woody vegetation.
Permanent grassland 8003/1, 8004/1	Medium potential Medium limit	2nd level	Maintain the existing use.
Vineyard 9004/1, 8109/1	High potential Low limit	1st level	To maintain vineyard in a system of integrated production.
Fruit orchard 8106/1	Medium potential Medium limit	2nd level	Since the slope is 3° to 7°, a system of ecological cultivation as a valuable landscape element is recommended (prospective site).

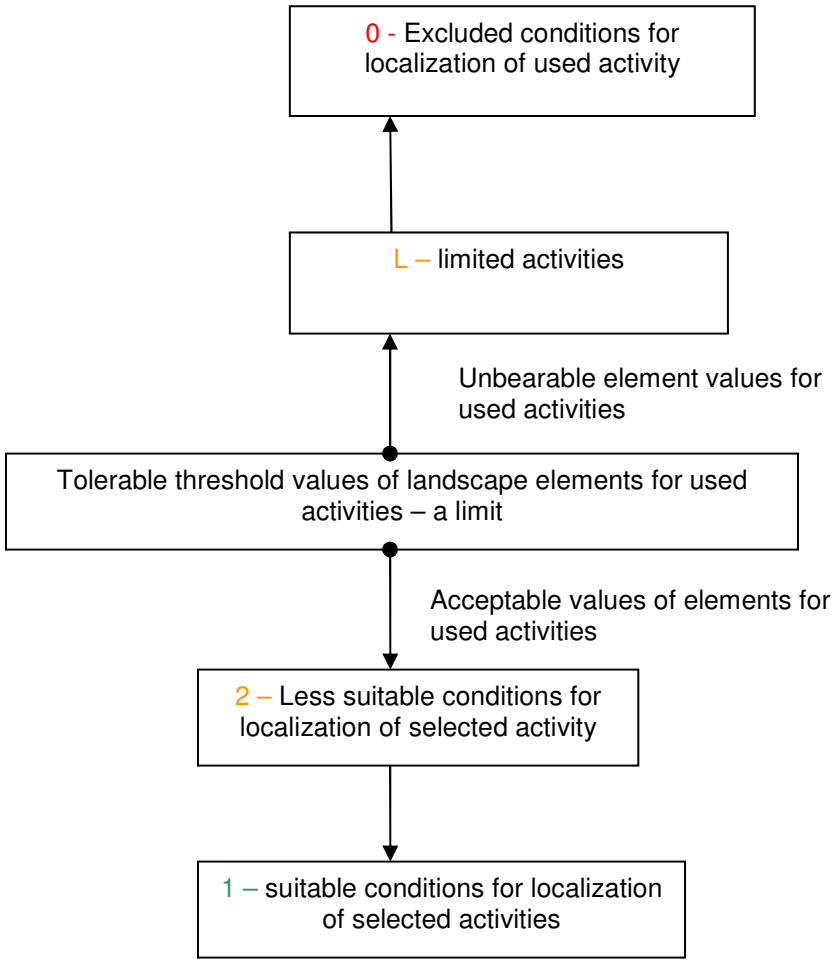
The proposal of landscape-cological measures, as a process of determining of landscape suitability to locate the required activities, consisted in comparison of landscape-ecological conditions for required activities with real landscape properties with help of limits. The final step is the result of a combination of individual potentials determined on the base of abiotic characteristics of ecological importance of territory which represents some limitations of current activities. On the other hand, it allows the development of the new production and complementary activities, icluding

agritourism. The creation of limits to determine the suitability of land use illustrates Scheme 1.

Basic landscape-ecological measures consist in:
- Maintenance of structure and land compactness with the original anthropogenic forms of relief,
- Determination of the dominance of production units with high production potential,
- Limits and constraints in the framework of the enlargement of the municipality area, and,
- at the land use change and the grouping of landscape elements.

To the increase of the stability of agricultural landscapes contributes also proposal of additional measures, which include measures implemented at the highest quality soils endangered soil by erosion processes where is necessary to implement relevant measures. These embrace the use of appropriate antierosion crop rotations with the correct alternation of crops with an emphasis on the cultivation of permanent and temporary grassland and perennial leguminous plants, introduction of contour tillage and exclusion the cultivation of row crops. All agricultural activities within the cadastre of municipality is necessary to implement with respect to protection of nature and natural resources, to what positively contributes the existing system of cultivation of vineyards in integrated production. To improve it, there is suitable to use a greater variety of species composition of grasses in interrow space, and to implement mulching. It is necessary to try to retain the forests, as a significant ecologically stabilizing element of the territory and in parts with an increased risk of landslides soil above 6° there is the need to implement more friendly methods of management with prohibition of large clearings of forest stands, especially. On the blocks with a high limit and a low potential mainly on the higher-lying clusters is suitable to create educational tourist views as a significant landscape aesthetical segments of the territory. A more sensitive way to the location of the significant technical and building objects is related to the above mentioned measures.

In the framework of the biodiversity it is necessary to pay attention to optimization of species composition of forest stands and (re)plant or introduce the original oak and hornbeam wood species, especially on the unused surfaces, which are exposed to erosion. It is necessary to eliminate the occurence of non-native tree species and their spreading to other sites, and to optimize the ecological conditions of the herbaceous layer at the field edges. To preserve the recent biodiversity of the territory it is suitable to choose the crop resistant varieties typical for the given area.
On arable land of investigation area it is necessary to implement a local monitoring focused on the management in the integrated production of vineyards and the preservation of local production potential in the framework of the Rural Development Programme of Slovak Republic for period 2014 - 2020. Equally important is also the maintenance of existing liner stands that perform ecologically stabilization function, and resolve the partial disharmony of blocks (production units) in context with the surrounding structure of the land. It is necessary to strive for the preservation of the protected area planted by chestnut trees (Castanea sativa Mill.) and orchard, as a valuable landscape elements to agritourism. Last but not least, it is necessary to supplement and stabilise the surroundings of the cart-ways and access roads by the planting of belts of fruit trees or herb vegetation. Areas of arable land can be divided into smaller units with the use of hedges and belts of the traditional vegetation of the area. It helps also to prevent the introduction of invasive species that reduce biodiversity of the investigation area.



Scheme 1: Tolerable threshold values of landscape elements for used activities – a limit

In the framework of the protection of the environment and ecological regulation it is appropriate take into account sustainable development by minimising material and energy inputs, with the aim of preserving the historic, cultural and attractive places in Radošina.

Conclusion

Radošina is one of the few sites of Nitra region, where the effort of maintenance of the typical agriculturally used structure and traditional rural landscape with added value of wine region is largerly manifested. At present, only the actual potential of the landscape cannot guarantee the attractiveness of given arera at recreational activities development. Therefore it is necessary to pay particular attention to optimizing the landscape structures.

Obtained results can find application in other processes of landscape-ecological planning and are also the base for optimizing the use of the area of interest for the purpose of agritourism. After realisation of abovementioned proposals the defined model area creates a visually and functionally linked space with the surrounding landscape, which encompasses unique values of cultural as well as the natural landscape.
We believe, that preservation and development of landscape structures with interlinking of ecological approach and intensive cultivation will be sufficiently supported also in the future by tools of Rural Development Programme of The Slovak Republic or respectively within sustainable development, because only the sustainable environment can provide quality services with a unique character.

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Souhrn

V příspěvku se hodnotila konkrétní krajinná struktura části obce Radošina s propojením na optimální strukturu pěstebního prostředí. Relevantní vlastnosti krajiny především ve vztahu ke způsobu využívání půdy, resp. jejich prostorová variabilita představovali základní východisko a širší rámec pro vymezení optimálních a pro zemědělství nevhodných aktivit.
Výsledky hodnocení jednotlivých produkčních bloků byly podkladem pro identifikaci krajinných problémů, přičemž byly specifikovány krajinné regulátory a opatření pro

management zájmového území a okolního prostředí včetně rozvoje agroturistiky. Výsledné návrhy optimálních struktur představují krajinnoekologické potenciály a limity pro udržitelné využívání daného území.

Contact:
Ing. Eva Pekárová
E-mail: e.pekarova@vupop.sk

FLOOD PROTECTION MEASURES IN SLOVAKIA - POLDERS

Vlasta Ondrejka Harbuľáková, Matúš Lechman, Martina Zeleňáková
Technical University of Košice, Faculty of Civil Engineering, Institute of Environmental Engineering, Vysokoškolská 4, 042 00 Košice, Slovakia

Abstract
Extreme rain events have always been a problem and a challenge in the urban society. When they occur in urban areas the consequences can be striking with severe flooding and damage to properties and infrastructure. Svacenický jarok, Beša and Frička polders presents non-structural flood protection build in different rivers in different parts in Slovakia with the same aim – to protect the areas and lives. Its characteristics, operation mode and parameters are presented in this paper.

Key words: dry basin, earth embankments, flood mitigation measures, flow

Introduction

In last decade the climate change has been an increasing issue. Most studies agree on the climate change being a reality, but the opinions about the severity and the prognosis on the future climate differs. Some studies states that extreme events like heavy precipitation will occur more frequently in the future (IPCC 2007, Christensen & Christensen, 2002) whereas other studies states that measured precipitation series does not indicates an increased frequency of heavy rain events. A British study agrees on extreme rain events occurring more frequently, but also makes an important statement that the vulnerability for extreme rain event exists already today (DEFRA 2012).
Since 2000, new factors, such as accelerating climate change and the economic crisis, have come into play. In the coming years, climate change will pose a major challenge for water management across the EU. It is likely to bring:
• Lower rainfall and higher summer temperatures in the south, putting stress on scarce resources. The Commission's 2007 Communication on Addressing the challenge of water scarcity and droughts finds that implementing the WFD will be crucial.
• More rain and a higher flood risk in the north. Floods are already becoming increasingly frequent: since 1990, 259 major river floods have been reported, 165 of them since 2000. The 2007 Floods Directive adopts a new, proactive approach, requiring Member States to prepare preliminary flood risk assessments for all river basin districts by 2011, followed up in 2013 by flood hazard maps. By 2015, Member States should have flood risk management plans, ready to link into the next cycle of river basin management plans (RBMPs) (2016-2021).
In the view of this, public involvement will be crucial to meet the goals of the WFD as well as the Floods Directive. Yet large numbers of Europeans are still unaware of their right to have a say on the future of water. It is important to communicate that every effort makes a difference. Consultations on the next cycle of river basin management plan preparation together with consultations on the preparation of flood risk management plans should start by the end of 2012. (www.ec.europa.eu, 2010).
Flood risk can be much reduced by implementation of measures (Šlezingr, 2016). These can be divided into two main categories: structural and non-structural measures. Structural measures reduce flood risk by constructed objects or modifications that control the surface water flow (Markova et al., 2014; Šlezingr and

Fialova, 2012; Pelikan and Šlezingr, 2015) while non-structural measures reduce flood risk by keeping people safe through better planning and urban development.
Examples on non-structural measures are emergency planning, awareness campaigns, flood warnings systems and land planning while examples on structural measures are embankments, barriers, conveyance of surface water and polders (Jha et al., 2012).

Polders

A polder is a low-lying tract of land enclosed by embankments (barriers) known as dikes that forms an artificial hydrological entity, meaning it has no connection with outside water other than through manually operated devices (Larsson, 2012). The structure of the polder system contains the following elements: outer perimeter dams, to give protection from high levels outside the polder; internal dams; construction for necessary pumping out (pumping stations) or natural water discharge; an adjustment reservoir near the pumping station; main channel external channels and drains for intercepting surface and ground water; drainage channels with the water receiver; road and road construction. Depending on the range of natural conditions, polder system may include all these elements or only parts of them (Rusetski, 2009). There are three main types of polder, with different hydrological regimes; not flooded, flooded and the length of flood adjustment.
Selected polders and their functions and technical parameters are introduced in next parts of the paper. Discussed polders were built in Slovakia and presents part of the flood protection or only one flood protection measures constructed in tormented areas.

Svacenický jarok polder

Svacenický jarok polder at is situated in the western part of Slovakia in the cadastral area of Myjava town, particularly in the part called Turá Lúka (Fig. 1). Myjava town was often affected by heavy floods, which caused considerably material damages and thus significantly limited quality of life of inhabitants. Polder is part of flood protection in the area, which lies in the western part of Slovakia. Construction of polder is used for flood protection of area under the construction and also for the culmination of the flood wave. Polder was design for Q_{100}. (Vodotika.sk, 2017). Svacenický jarok polder was built 0.600 kilometres from the river on the right tributary of the Myjava river, because of the most suitable morphological profile. This tributary called Svacenický jarok flows into Myjava the river 69.0 kilometres from the part of town called Myjava Turá Lúka.
In the basin of the Myjava river the recurrence of the flood situation existed and it caused considerable material damages and the threat of loss of life. Therefore it was approached to comprehensive water management situation assessment, which showed that in except of the adjustment of agricultural, forestry and other anthropogenic activities also the technical measures must be implemented. Detailed analysis of the morphology of the territory showed that the most important element of flood will be polders located at various critical tributaries of the main Myjava river. Construction was planned in two chronological orders. In the first order the construction of six polders were chosen. Polder at Svacenicky brook has the greatest efficiency and thus affects the polder flood situation in watershed stream Svacenický Jarok. Polder Svacenický Jarok is able to transfer the entire amount of design flood Q_{100} (enviroportal.sk, 2008).

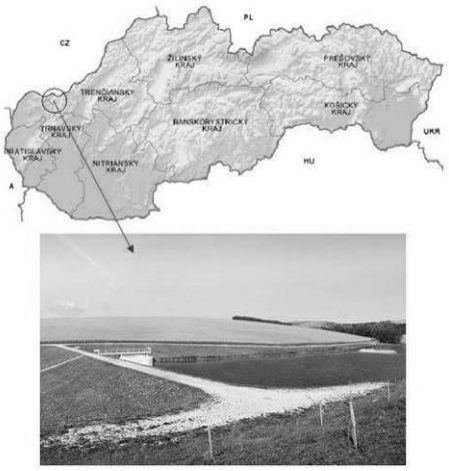

Fig. 1: Svacenický Jarok polder and its location in the map

Frička polder

The purpose of the construction of the polder is to provide flood protection to Frička village and its surroundings before torrential waters, which appears with increasing frequency in recent years (Fig. 2).

The maximum flow rate that can convert existing natural flow of river bed without consequences is Q=8.0 m^3/s. Outlet of the polder was designed for this flow (8 m^3/s) and overflow was designed for Q_{100} = 30 m^3/s. Polder was put into operation in 2006. Polder is designed so that the handling of water takes place without human intervention. At higher flow rates, the polder self-fills and realizes the transformation that depends on the shape and volume of the flood wave. In the event when the flood wave with a flow rate and volume cause filling the entire volume of the polder when the function of the bottom outlet will not be enough to transform the flood wave, water level in polder will rise continuously. In such circumstances transformation will be underway over safety spillway (Kolesárová, 2012).

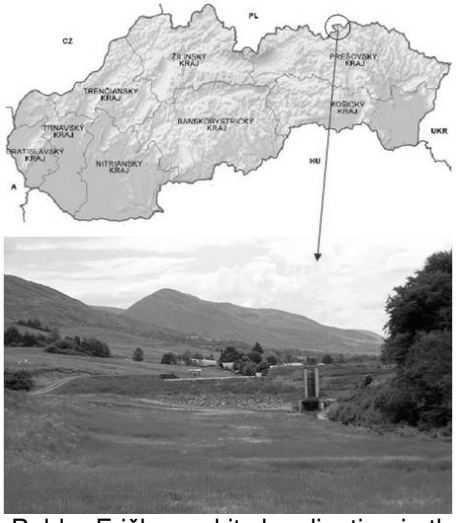

Fig. 2: Polder Frička and its localization in the map

Polder Beša

Polder Beša is built in the Košice region, in Trebišov district near the Beša village. Polder was built at the turn of the 50s and 60s in the framework of comprehensive water regulation of Eastern lowlands. Polder Beša is the largest dry polder throughout Central Europe, in which the inflow and outflow of the water can be manipulated and controlled (Fig. 3).

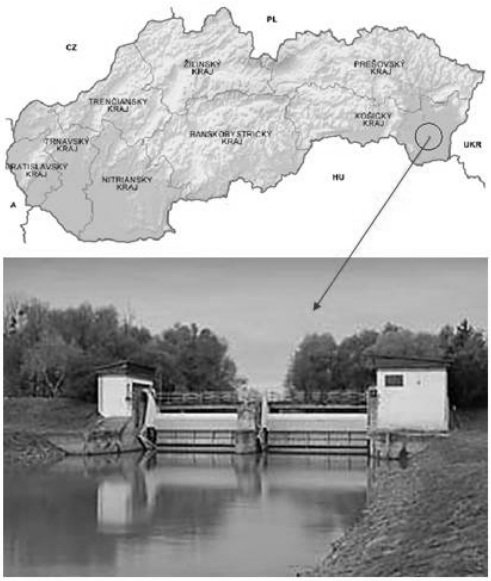

Fig. 3: Polder Beša and its localization in the map

The catchment area of Bodrog river is a complex system consisting of four main rivers (Latorica, Laborec, Uh, Ondava) of intersecting each other in a small space. In fact, together with insufficient longitudinal inclination was the cause of frequent flooding. Every year it was flooded nearly 45 thousand hectares of the lands. The most aggressive was Latorica river. Some municipalities were completely flooded in 1924. Latorica river area belongs to the protected areas (sopsr.sk, 2010). The dry basin is able to capture up to 53 million cubic meters of water on the area of almost 1,568 hectares. Beša polder is filled up with Laborec river thus relieving Latorica river during the flood flow. This river flows from Ukraine to the territory of the Slovak Republic. Polder Besa contains of the two segments which are 12 meters wide.

Conclusion

Polders have to be designed properly because it affects the flow of the river and the ecosystem. As a flood protection measures combination of polder and dikes are often used. The dikes around it need constant maintenance and repair. If the dikes are breached the floods could be devastating. In Slovakia many polders have been constructed because many areas are suffered from flood. Also combination with can be found in many catchment in Slovakia. This combination seems to be a good flood mitigation measurement. Except these structural measures presented in the paper, also consideration of non-structural measures cannot be ignored in the field of flood protection.

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Souhrn
Polder je ochranný protipovodňový objekt, jehož poloha a objem jsou často omezeny morfologickými jednotvárnostmi údolí, výskytem sídel a objektů, které svým budováním a provozováním nesmí ohrozit. Není prakticky všude možně vytvořit polder s objemem, který by při povodních mohutných rozměrů pouštěl do toku pouze malé neškodné průtoky. Pro zajištění nejvyššího účinku poldrů se musí zajistit, aby se prostor určený k ochraně naplňoval ve fázi shromažďování povodňové vlny. Pokud se naplní dříve a to v době nástupu povodně, tak se retenční účinek pod nádrží na průtoku může omezit a to výrazně. Aby se zajistila správná funkce a nejefektivnější účinek, je důležité dimenzovat vhodný poměr kapacity výpustných objektů ve spodní části při průtočné nádrži vzhledem k předpokládanému průtoku v čase povodně, nebo zajistit řízením napouštění a vypouštění suchého poldru. Příspěvek prezentuje přehled vybraných technických opatření vybudovaných na Slovensku se zohledněním všech požadavků na správnou funkci poldru a na zajištění dostatečného stupně protipovodňové ochrany.

Contact:
Ing. Vlasta Ondrejka Harbuľáková, PhD.
E-mail: vlasta.harbulakova@tuke.sk

FLOWERING EPIPHYTES IN SECONDARY MANGROVE FOREST AS A POTENTIAL TARGET FOR INCREASING THE RECREATIONAL ATTRACTIVENESS IN GREEN REZERVA IN NICARAGUA

Anna Kupec[1], Petr Maděra[1], Petr Kupec[2]

[1] Department of Forest Botany, Dendrology and Geobiocenology, Faculty of Forestry and Wood Technology, Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic

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

Abstract

In epiphyte populations, there are many of attractive species, genera even all families. Orchidaceae and Bromeliaceae family can be considered as one of the most attractive plant families, especially in bloom period. Recreational utilization of the mangrove forest is comparatively low, limited to specialists or eco-friendly holiday-makers. It is obvious that the occurrence of attractive epiphytic species such as flowering orchids can increase the recreational potential of mangrove forests. This article presents the results of research focused on the habitat structure of epiphyte communities in mangrove ecosystems in Green Reserva - private reservation in Nicaragua. The aim of the study is to answer the question if occurred epiphyte populations can positively influence the recreational potential in Green Rezerva.

Key words: mangrove, structure of epiphytes, recreational attractiveness, Green Rezerva, Nicaragua

Introduction

This article presents the utility options of flowering epiphytes occurrence, mostly orchids and bromeliads, for increasing of recreational potential in the mangrove forests in humid tropic climate on the example of Green Rezerva in Nicaragua. Popularity of ecotourism and bioprospecting is rising nowadays, both are going hand in hand. One of important kinds of bioprospecting is bioprospecting focused on observation of indigenous plants or endemic species. As Benzing (1990) mentioned, it is evident the localities with those epiphytic plants occurrence can be recreationally attractive, even these are mostly inaccessible or relatively unknown.

Nicaraguan Green Rezerva has humid tropic climate. Original communities were tropical rainforests and mangrove forests with rich in biodiversity. However, the locality is quite out-lying, this is one of the most important reasons why the reservation is not recreationally used so far, the owner of Green Rezerva is interested in it's above all public ecotourist utilization. It is obvious the proper recreational management and marketing of natural resources could lead to the increasing of recreational potential and practical effect of the locality.

Materials and methods

Locality

Green Rezerva is private reservation belonging for more than thirty years to Pfranger's family. The reservation was established by Räto Pfranger and nowadays is managed by his son Gaudenz Pfranger. One of the most significant moments was

devastating strike of hurricane Joan- Miriam in 1988. Afterwards the owner of reservation started with conservation of nature, forest inventory and botany management. The forest was let to natural regeneration without any human influence.
Green Rezerva occupies more than 250 ha of Caribbean coast, northern from the Bluefields. Reservation consists of 245 ha of secondary forest and residual 5 ha is designated for accommodation. There are 145 ha of wetlands, mangroves and land dominantly influenced by water.
As for mangroves, there is Kukra river flowing into reservation which provides together with Caribbean Sea the necessary brackish water to them. The system of water channels located along to the edge parts of reservation provides important water source for mangroves too and there is a possibility to float through the channels by canoes. There are also two small lakes in the channels, all the channels and lakes ale completely bordered by canopy mangrove forest. Mangrove forests are mainly composed of *Rhizophora mangle L.*
This area is full of indigenous animal species such as jaguar, tapir, spider monkeys etc. During quiet floating through the channels can be observed butterflies, birds, crabs, frogs, turtles and even alligators.
All the system of channels throughout the boundary parts of reservation are dominantly affected by tides. Some channels even are not accessible during the low-tide period due to lack of water.

Fig. 1: *Encyclia alata (Bateman) Schltr*. Founded in mangrove forest

Methods
The species composition was surveyed in June 2015 during tropical rain forest research focused on inventory of trees and plants as well as on the structure of epiphyte nearly 30 years after the disturbation process caused by hurricane Joan-Miriam. Mangrove channel was surveyed and there was done botanical inventory of vascular epiphytes. Two kilometers long mangrove channel was divided into sections after 100m. After every 100m segment was made stop for choosing one tree on both sides of the channel for vascular epiphyte inventory. All vascular

epiphytes on chosen trees were recorded with their number and determinate. This design was chosen due to enormous number of epiphytes individuals.

Results

During this survey was found out following results. Tab.1 presents the results obtained during the experimental field work. The total number of 13 vascular epiphytes species were determined living on observed trees. The most abundant specie is *Tillandsia bulbosa Hook. (*see Tab.1). Particular species were sorted into each botanic Families. As presents tab.1 the most presented Family is *Bromeliaceae*. The most attractive characteristic as for the bioprospecting or recreational utilisation generally is ability to attractive blooming (visibility, colour, size of bloom…) That is why the particular species were sorted according to their ability to bloom. (see Tab.1)

In Fig.2 circle chart presents the proportion between potentially blooming vascular epiphytes species and epiphytes without ability of attractive blooming. It is obvious more than 95% of presented species can bloom with very high attractivity.

Tab.1: Results of vascular epiphyte representation in mangrove forest, Green Rezerva Nicaragua

No.	Species	Family	No. of individuals	%	Attractive bloom
1	*Tillandsia bulbosa Hook.*	*Bromeliaceae*	141	51,65	✓
2	*Tillandsia caput- medusacae E. Morren*	*Bromeliaceae*	28	10,26	✓
3	*Catopsis berteroniana (Schult. & Schult. f.) Mez*	*Bromeliaceae*	26	9,52	✓
4	*Oncidium sp.*	*Orchidaceae*	19	6,96	✓
5	*Vriesea sp.*	*Bromeliaceae*	16	5,86	✓
6	*Tillandsia utriculata L.*	*Bromeliaceae*	11	4,03	✓
7	*Peperomia sp.*	*Piperaceae*	8	2,93	-
8	*Tillandsia anceps G. Lodd.*	*Bromeliaceae*	8	2,93	✓
9	*Aechmea bracteata (Sw.) Griseb.*	*Bromeliaceae*	7	2,56	✓
10	*Anthurium trinerve Miq.*	*Araceae*	4	1,47	-
11	*Encyclia alata (Bateman) Schltr.*	*Orchidaceae*	3	1,10	✓
12	*Brassavola sp.*	*Orchidaceae*	1	0,37	✓
13	*Polypodium fraxinifolium Jacq.*	*Polypodiaceae*	1	0,37	-

Discussion

Green Rezerva is entirely convenient for such a type of sustainable tourism. There are not only remarkable places in mangrove forests, but also magnificent tropical rain forest with thousands of plant and animal species. This forest is in places hardly accessible, but with local guide is possible to pass through.

Number of flowering species evidently increases the recreational potential of the area. Benzing and Seemann (1978) considered interactions between epiphytes and their supporting and dependent fauna to be significant. Research methods used in the article correspond with standard research methods of epiphyte biodiversity.

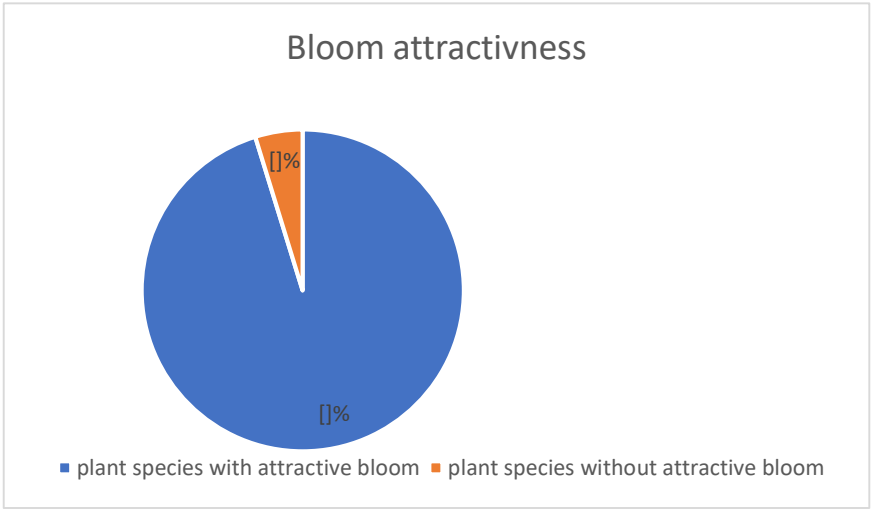

Fig. 2: Circle chart showing the bloom attractiveness in percentage

Conclusion

The Green Rezerva above all following also the ecotourism (eco-management) rules. The reservation uses sea water desalination system, solar collector system for heating the water, prohibits using of detergents and artificial chemical products etc. Accommodation is made mainly of local materials (hardwood, bamboo, grasses etc.). For local transport nearby the reservation are used only canoes because of the risk of water contamination for both the water organisms and mangroves.

Reservation is quite suitable for recreation especially due to pleasant humid tropic climate and convenient site at Caribbean seaside.

Except the research of systematics according to mentioned methodology there were also recorded another plant species suitable for bioprospecting. Tropical forest canopies support a high diversity of plants and animals. (Ellwood, Foster 2004, Kelly et al. 2004). In Green Rezerva mangrove forests can be found in several life forms. The most usual form is obviously phanerophyte, represented by mentioned secondary mangrove forest composed mainly from *Rhizophora mangle L.*, marginally supplied by *Pachira aquatica Aubl.*. These species are locally recruited by cryptophytes (*Acrostichum sp.*), cryptophytes- geophytes (*Hymenocallis litoralis (Jacq.) Salisb.*). The most visible and attractive are undoubtedly epiphytes which are interesting not only for remarkable flowers, but even for the their structures.

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Souhrn
Tento článek se zabývá vyhodnocením rekreační atraktivity sekundárních mangrovových porostů v rezervaci Green Rezerva v Nikaragui. Práce se zabývá vlivem intenzivního výskytu cévnatých epifytů v mangrovových porostech na atraktivitu lokality pro ekoturistiku a bioprospekting. Na základě posouzení atraktivity cévnatých epifytů prostřednictví estetické kvality jejich kvetení bylo prokázáno, že lokalita může být díky intenzivnímu výskytu atraktivních kvetoucích epifytů považována za rekreačně potenciální, ačkoli je poměrně špatně dostupná. Při vhodném rekreačním managementu a především marketingu existuje, dle názoru autorů, reálný předpoklad naplnění rekreačního potenciálu lokality.

Contact:
Bc. Anna Kupec
E-mail: xjashari@node.mendelu.cz

GEOCACHING AND INGRESS AS A NEW TREND IN RECREATIONAL USE OF THE LANDSCAPE

Helena Lorencová, Ivana Lampartová, Aneta Lančaričová
Department of Environmentalistics and Natural Resources, Faculty of Regional Development and International Studies, Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic

Abstract
This article introduces game Geocaching and an alternative game Ingress. Geocaching is currently very popular activity for tourists which is causing growth of environmental hazard due to increasing number of players around the world. The article presents also an alternative game Ingress, which is environmnetal friendly thanks to its virtual character. A questionaire survey which is evaluated was designed to determine the awareness of Geocaching and Ingress and their impact on the environment.

Key words: tourism, environmental impact, cache, nature protection

Introduction

Geocaching only emerged in the year 2000. The activity was conceived shortly after the removal of Selective Availability (i.e.,the intentional degradation of GPS signals), which had been in place to restrict theaccurate use of GPS to the US military (Taylor et al., 2010). Due to this improved accuracy of the system (the error of more than100 m was reduced to 10–15 m) and its opening to the general pub-lic, small containers could be specifically placed and located in thelandscape. In particular, relatively cheap GPS receivers, including smartphones, and widespread access to the internet have helped geocaching flourish throughout the world (McNamara, 2004; Cord, et al., 2015). Geocaching is outdoor game. Main goal is to find treasures. This game is on the boundary between sports and tourism. By GPS system or other navigation techniques we can hide or seek box – geocache, cache. Cache is usually hidden in some signification location, cultural, historical or natural monument near its location, thus players (cachers) learn new things and explore new places. Geocaching is not only about finding the „treasures“, but especially about exploring new places, where the caches are hidden (Lorencová et al., 2014). Today the geocaching phenomenon involves more than six million geocachers playing with more than two million geocaches hidden all over the planet. The biggest geocaching community is organised within the Geocaching.com website (see web panel), but there are international and national alternatives (Donadelli, 2014; Telaar et al., 2014). Nowadays are around the world on various web portals registered millions of caches. Caches are located on seven continents including Antarctica and in more than 100 countries around the world (Lorencová et al., 2014).
Geocaches vary in size and difficulty and are typicallyhidden in any type of place that the owner (the person who has hidden the cache) finds particularly interesting and that she/he wants someone else to experience (Gram-Hansen, 2009; Cord et al., 2015). There are several textbooks and guide articles providing an introduction to and overview of the activity (McNamara, 2004; Taylor et al., 2010). Other writings focus on understanding geocaching practices and motivations (O'Hara, 2008) as well as the success ofgeocaching as a location-based game (Neustaedter, et al., 2011; Cord, et al., 2015).

Ingress is a smartphone game using "augmented reality" principles. Niantic Labs has developed an augmented virtual reality mobile app game called Ingress in which agents must seek out and control locations for their designated factions. The app uses the Google Maps interface along with GPS to enhance a geocaching-like experience with elements of other classical games such as capture-the-flag. Thanks to your smartphone using Android or iOS operating system and the Ingress application you will get to know your sorroundings in a completely new way: historical landmarks, works of arts, even seemingly trivial places you pass everyday will play their role in a battle for the future of the humanity. By the autumn of 2013, Ingress was made available to the general public and an iOS version was made available in 2014.

Materials and methods

This article presents results of quantitative survey based on short anonymous online questionnaires conducted in 2015 (sample size n = 100). We distributed the link to the questionnaire through various mailing-lists. The questionnaire consisted of 13 questions with a mix of closed and half-open questions. The questionnaire could be completed easily in 5 to 10 minutes. The first part of the questionnaire was focused on Geocaching and the importance of nature and landscape conservation and the other part was focused on Ingress. The last part of the questionnaire was designed to assess the structure of respondents, mainly demographic data such as sex, age and education. The goal was also to determine whether respondents are aware of alternative game called Ingress, and whether they would appreciate the creation of educational trails for Geocaching or Ingress. The main research questions of quantitative survey:

1. Do you know the game Geocaching?
2. How long have you been playing the Geocaching?
3. What does primarily motivate you to play this game?
4. Do you visit also some interesting places around the Cache?
5. Do you choose your holiday in consideration of Geocaching?

Results

Geocaching appears to be mostly a male activity, because 57 questionnaires have been filled out by males and 43 by woman. The most of the respondents were from ages 15-30 (63%). Another 32% of the respondents fell into the age group 30-50 years and the rest 5% to the category of 50-70 years. Other age groups were not represented. Other questions related to characteristics of the respondents were devoted to educational attainment. The largest share (54,1%) of all respondents indicate a higher education. Full secondary education was represented by 32,7%, 8,2 % without graduation exam, and 5,1% with basic education. The total of 35 respondents came from Brno and surroundings, 10 Prague and the other respondents from different parts of Czech Republic (Plzen, Ostrava, Olomouc, Most, Teplice, Rakovník, Pardubice, Košice).

The question which focused on knowledge of the game Geocaching and length of gameplay had three response options. 73% of the respondents replied that they know the name and are active players. 24% know the game, bud are not the players. And the last 3% of the respondents don´t know this game. The survey was thus mostly answered by people who play the game in their free time. The second question (“How long have you been playing the Geocaching?”) was answered as follows: 35% of respondents play this game 1-5 years and 31% more than 5 years, and 7% less than a year. 22% of respondents do not play the game at all. In the

category of the "other" answered some respondents that they are going to start play Geocaching. 3 people responded that they are playing the game for approximately 7 years and more, but only occasionally. Interesting answers were given in the question number 3, which asked what primarily motivates respondents to playing this game. The greatest motivation for players is getting to know some interesting places (78%). 58% of the respondents play Geocaching as some variegation during the visit of interesting places. Almost 34% and 35% received answers "Time spent with friends" and "I do not think out trips –somebody else did it for me." 30% of respondents are motivated by a desire to solve complex tasks while spending time in nature. Only 21% of all respondents play the game for getting points. There was also given a possibility to verbally fill an own answer. One respondent replied that at the beginning of the game was for him the motivation a new technology. Someone is motivated by a traveling or physical activity. From the responses it is clear that the vast majority of respondents like to explore interesting places through this game. This result confirmed the assumption. Furthermore 76% of the respondents answered that they visit interesting places around the cache. The respondent was asked whether the choice of his/her holiday is affected by the presence of caches in the area. The vast majority answered that not. For 17% of the respondents, is the presence of caches in the area, where they will spend the holidays, an important factor. We can therefore say that geocaching is for the most people a complementary activity that can liven up their free days in nature, but does not affect the choice of holiday destinations. The second part of questionnaire was pointed into nature impacts. We evaluated, if is for respondents, important or not to protect nature and the countryside. We evaluated it on a point scale of one to five (1 = not important, answer 5 = extremely important). More than a half of the respondents rated this question with 5 points - nature and landscape protection is very important to them. 29% responded with four points. For 15%, is the protection of nature and landscape important only partially, for the remaining 5% is the protection of nature and landscape not interested at all. To complement this question, we investigated if the respondents "realize the potential negative impacts on the landscape while playing Geocaching? Approximately half of the players are aware of the risks and try to behave considerately. Only 2% of the players do not play the game due to this reason.

I consider alarming that 39% of respondents assume that these risks are negligible and do not take them into account. Another part of questionnaire was focused on Ingress. The question was: "Did Have you heard about the alternative Ingress, which is more environment friendly?" Followed by a brief introduction of the game:¨"Ingress is an online game for your mobile phone which allows you to play the game in reality, completed applications of virtual reality – you do not walk or climb anywhere, , but play only virtually. However you have to physically visit the place. The application allows to map the real world to the current actual position of the user detected from GPS to "see" the so-called virtual portals, which are located in interesting or important places around the world". A quarter of respondents said that they know the game, but are not an active players. 3% play the game and are aware of its positive compared with game Geocaching. 4% also play the game, but the positives do not realize. In a variant of the "other answer" the most respondents expressed that they are not aware of the positives of Ingress compared with the game Geocaching. The remaining 62% of respondents do not know the game. Following question was: "Did you get knowledge about the Ingress through this questionnaire and do you like it?" - 37% of the respondents do not like the game at all, but 26% do. The rest of respondents already knew the game. The last was the

question about the game on the educational trails. Respondents were asked whether they would appreciate if the two aforementioned games, in the case of certain routes, followed the trails. The largest number of respondents answered YES, but it is not essential to them. 20% would greatly appreciate this opportunity and less than a quarter answered that they do not matter. 12% of respondents would not appreciate this option and 3% of respondents who selected "other", replied for example, that the main advantage Geocaching is for them to just explore distant places off the main tourist routes. There is noticeable that some of the players Geocaching appreciate to search boxes in remote areas where is surrounding landscape affected the most. As satisfactory I consider that more than 60% of respondents would appreciate if they could during playing on the trails follow up and gain new knowledge about the area where they are.

Discussion

The results show that not all players Geocaching, (although the vast majority do), prefer considerate search boxes and prefer rather more remote locations outside of marked trails. Even this relatively small percentage of players might have as a result a large influence on the transformation of the original character of the landscape in which mailboxes are looking for. The results of the survey confirmed the assumption about Geocaching knowledge and so far little awareness of Ingress. A positive finding is that the majority of respondents has a positive attitude towards nature and landscape protection and appreciate the continuity of games on the trails.

Conclusion

If you would like the results simply generalize, we can say that the sample of respondents corresponds to middle-aged men, higher education with a focus on conservation and nature and landscape that the game pays approximately 1-5 years and his motivation is mainly to meet new places and variegation trip. While playing Geocaching is trying to be considerate. Ingress he does not know and would appreciate if the both games were bound to nature trails.

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Souhrn
Tento článek představuje hru Geocaching a alternativní hru Ingress. Geocaching je v současné době velmi oblíbenou aktivitou turistů a se vzrůstajícím počtem hráčů po celém světě roste riziko ohrožení životního prostředí. Článek přináší také alternativní hru Ingress, která je díky svému virtuálnímu charakteru zcela šetrná ke svému okolí. Bylo vyhodnoceno dotazníkové šetření, jehož předmětem bylo zjistit povědomí o hře Geocaching a Ingress a jejich vlivu na životní prostředí. Pokud bychom jeho výsledky jednoduše generalizovali, dá se říci, že vzorek respondentů odpovídá muži ve středním věku, vysokoškolského vzdělání se zájmem o ochranu a přírody a krajiny, který se hře věnuje přibližně 1 - 5 let a jeho motivací je zejména poznání nových zajímavých míst a zpestření výletu. Při hraní Geocachingu se snaží chovat ohleduplně. Hru Ingress nezná a ocenil by, kdyby obě hry byly navázány na naučné stezky. výsledků je patrné, že ne všichni hráči Geocachingu, ač převážná většina ano, upřednostňují ohleduplné hledání schránek a preferují spíše odlehlejší místa mimo značené trasy. I toto poměrně malé procento hráčů, může mít ve výsledku velký vliv na přeměnu původního rázu krajiny, ve které schránky hledají. Výsledky dotazníkového šetření potvrdily můj předpoklad o znalosti hry Geocaching a prozatím malém povědomí o hře Ingress. Pozitivním výsledkem bylo zjištění, že převážná část respondentů má kladný vztah k ochraně přírody a krajiny a ocenila by návaznost her na naučné stezky.

Contact:
Ing. Helena Lorencová, Ph.D.
E-mail: helena.lorencova @mendelu.cz

GRASSLANDS AS PART OF THE STABILIZATION OF THE BANKS

Miloslav Šlezingr[1], Kateřina Ošlejšková[2], Jan Kozák[3]
[1,2]Department of Landscape Management, Faculty of Frestry and Wood Technology, Mendel University in Brno, Zemědělská 3, 613 00 Brno, Czech Republic
[1,3] University of Technology, Faculty of Civil Engineering, Žižkova 17. 60200 Brno, Czech Republic

Abstract
The grassland of a stream bank slope reinforces soil surface and, to a great extent, prevents the occurrence and development of erosion. When proposing suitable grass mixtures, we work on recommendations - Marhoun 1981, Šlezingr, Úradníček 2005, etc.. The question how the establishment of grassland will deal with this contribution.

Key words: reservoir, wasser, bank, grass

Introduction

It is necessary to realise that grassland composition, its endurance, overall involvement and consequential viability depends on the number of created and sufficiently developed individuals in the first two to three months after seeding. (Pelikán, 2015, Synková, 2009).Although seeding is the most common method of establishing grassland, it is not the only one.

Materials and methods

1. Establishment of Grassland by Seeding

Prior to seeding, the laying of a humus layer on disturbed planed stream bank slope is expected. The follow-up seeding is manual, or mechanisms may be used, from early April to late August. Seeds need to be fertilised in the soil by rolling. If possible, watering in the first month and top dressing are important. To prevent the undesirable development of weed, one or two weeding treatments are necessary after approx. 8 to 12 weeks of seeding. The protective function of stands starts to work within only 2 to 3 months of seeding (Junáková, 2013, Šlezingr, 2010).

2. Establishment of Grassland by Sodding

For fast and almost immediate effective grassing of banks, so-called sodding may be used. Sods can best be obtained from an adjacent site (meadow, pasture) that has approximately the same site conditions as the locality being reinforced. Sods shall be taken by means of special knives, cutting strips approx. 40 – 50 cm wide. Separate the strips from subsoil using a shovel to achieve optimal sod thickness. [1,4].Thus removed grass strips shall be divided into squares with sides of 40 – 50 cm. The produced sod should immediately be placed on the site being reinforced.

3. Establishment of Grassland by Hydro-seeding

This is a hydraulic method of seeding when a mixture of seeds, water, fertiliser, organic substance and anti-erosive additives are sprayed under pressure. In this way, inaccessible slopes and other places can be re-vegetated. Within seeds, the prescribed grass mixture or seeds of tree species can be used (Šlezingr, 2010, Zeleňáková, 2016, Pelikán, 2015).

4. Other technologies

In addition, pre-planted grass carpets, especially wherever an immediate aesthetic and stabilisation effect is requested, divided stabilisation strips, slope stabilisation by

means of coconut or jute nets placed on the seeded area (prevents erosion) etc. can be used.

Conclusion

Of course, grass mixtures may be modified according to particular conditions, or specific requirements and purpose of grassing. Details can be found, for instance, in the publication Vegetace v úpravách vodních toků a nádrží, L. Novák a kol.

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Souhrn

Součástí stabilizace břehů je také travní koberec pokrývající svah, tvořený vhodnou travní směsí. Travní porosty na březích je možné zakládat několika způsoby. Základím způsobem je výsev. Další z možností je založení travního porostu drnováním. V tomto případě je nutno mít v blízkosti vhodnou travní plochu pro odběr drnů. Zvláštní případ je využití hydroosevu. Tento způsob je možno využít v případě ozelenění nepřístupných lokalit, skalních výchozů, původních nefunkčních částí opevnění, apod.

Mezi ostatní technologie můžeme zařadit využití předpěstovaných travních koberců, předpěstovaných travních koberců s vnitřní výztuží (zapracovaná geosíť), možné je i využití vegetačních tvárnic – nikoli betonových, ale plastových výlisků ve formě pláství – komůrkových stabilizačních pásů, aj.

Nutno zdůraznit, že travní koberec je základem protierozní ochrany svahu, tvořícím břeh.

Contact:

Miloslav Šlezingr, prof. Dr. Ing.
E-mail: slezingr@node.mendelu.cz

IMPACT OF ARTIFICIAL SNOW ON SKI SLOPE VEGETATION AT KOŠÚTKA SKI RESORT - VEPORSKÉ VRCHY MTS.

Michal Mikloš[1], Martin Jančo[1,2], Ilja Vyskot[3], Katarína Korísteková[1,4]

[1] Department of Natural Environment, Faculty of Forestry, Technical University in Zvolen, T. G. Masaryk street 24, 960 53 Zvolen, Slovakia

[2] Department of Biology and General Ecology, Faculty of Ecology and Environmental Sciences, Technical University in Zvolen, T. G. Masaryk street 24, 960 53 Zvolen, Slovakia

[3] Department of Environmentalistics and Natural Resources (FRDIS), Faculty of Regional Development and International Studies, Mendel University in Brno, Tř. Generála Píky 2005/7, 613 00 Brno, Czech Republic

[4] Department of Fire Protection, Faculty of Wood Sciences and Technology, Technical University in Zvolen, T. G. Masaryk street 24, 960 53 Zvolen, Slovakia

Abstract

Although most of the ski resorts in Slovakia are dependent on the snowmaking, there are just few studies on the relationship between artificial snow and vegetation. To assess the effect of artificial snow and related management activities on the ski slope vegetation, we measured snowpack properties and compared the changes in species richness, diversity, evenness, species pool and herb-layer coverage of plant communities under artificial and natural snow. After natural snow had melted away in the surrounding landscape of the ski slope, the depth and the density of the artificial snowpack was still very high. The depth of artificial snow was dependent on the position towards the snow lances. The statistical analyses confirmed significant differences in the characteristics of plant communities under natural and artificial snow. Significantly lower average species richness and herb-layer coverage but higher species evenness and percentage of bare soil was found under artificial snow. The differences in the species pool and diversity were not significant. Snowmaking in a low elevation ski resort of Košútka guarantees the operation of the ski slope during winter seasons. High production of artificial snow affects ski slope vegetation both directly (changed snowpack properties) as well as indirectly (management activities as ski slope grooming, grading, mowing etc.) .

Key words: ski area, ski piste, technical snow, plant communities, snowpack properties

Introduction

Snow and snow cover is very important in the temperate and mountainous parts of Slovakia for e.g. water management (Bartík et al., 2014 and 2016; Holko et al., 2009; Hríbik et al., 2009), changes in seasonality of floods (Jeneiová et al., 2016), flood peaks and flood volumes (Szolgay et al., 2016), seasonality micro- and mesoclimate, transport of nutrients and pollutants (Minďáš et Škvarenina 1995; Mezei et al., 2014; Střelcová et al., 2006; Vido et al., 2016), protection of soil and plant vegetation during dormancy, preventing spring water losses etc. (Hrvoľ et al., 2009; Středová et Středa, 2015; Střelcová et al., 2009). Occurrence of snow cover is also connected with winter tourism, that represents an important economic sector in the mountainous regions of Europe (Damm et al., 2014). However, winter tourism depends on good snow conditions and hence, it is very sensitive to the lack of snow (Elsasser et Bürki, 2002). Studies dealing with climate trends indicate that the

number of winters with insufficient snow conditions will increase (Elsasser et Bürki, 2002). Decreasing duration of snow cover and solid precipitation occurrence at lower elevations has been detected as a general trend in Slovakia (Central Europe) (Hlavčová et al., 2015 and 2016). Unfortunately, many Slovak ski resorts are located at low elevations. Hence, ski tourism was declared as the most vulnerable industry to climate change (Scott et al., 2006). A system of technical snowmaking, which was first used by Austrians in the Alps at the beginning of 70s became a main strategy how to reduce the dependence on natural snow. Artificial snowpack (result of technical snowing) has different physical (depth, density etc.) and chemical properties (Melanie et al., 2014). In low elevation ski resorts, skiing is possible mostly because of artificial snow production. Artificial snow on these ski slopes is therefore directly connected with management activities of ski slopes such as grooming, grading, mowing etc., which significantly affect ski slope vegetation (Kammer, 2002). The majority of ski resorts in Slovakia are located at low elevations and in nature reserves. Thus, it is currently highly desirable to deal with the impact of artificial snow on the environment in Slovakia.
The presented work examined the low elevation ski resort of Košútka with the aim:
- to determine the depth and the density of the remaining artificial snow and its spatial distribution on the ski slope
- to analyse the differences in the characteristics of ski slope vegetation under natural and artificial snow.

Materials and methods
The research was performed in Košútka resort (Fig. 1; 500–720 m a.s.l.; 48.559 N, 19.535 E) located in the Inner Western Carpathians (Slovenské Rudohorie Mts. – Veporic Unit, Slovakia). Since its establishment in 2007, the ski resort has used a system of technical snowing. The ski slope is 950 m long with a slope from 7° to more than 25° and northerly and westerly aspects. The area is formed by biotite tonalites, intrusive magmatic rocks and granodiorites, on which Cambisols on the crystalline rocks occur (Gömöryová et al., 2013; Vilček et Bujnovský, 2014). The area belongs to the slightly warm climatic region with a mean annual precipitation total of 800–900 mm and a mean annual temperature of 4–7°C (Škvarenina et al., 2009a, 2009b; Vilček et al., 2016; Vido et al., 2015). The potential natural vegetation would consist mainly of beech and fir-beech forests, or submontane beech forests (Škvarenina et al., 2004). The current vegetation is mainly composed of species representing the *Violion caninae* alliance, but also of ruderal, pioneer or other species (tab. 2). Meadow communities under natural and artificial snow are managed by the same management.
After the natural snow had melted away in the surrounding landscape of the snowed ski slope (Fig. 1), the depth and the density of the artificial snow was measured at the end of the winter season of 2011/12 (13.3.12). Due to the high density of the artificial snow, snow pits had to be dug to measure the snow depth and density (Fig. 2). Snow density was determined with the mass method using a tube model of VS-43. The measurements network consisting of 96 points covered the whole ski slope (Fig. 2). From the measurements performed in this network we derived the model of the artificial snow distribution on the ski slope by spline interpolation technique (Fig. 2) using the ArcGIS 9.3 software. To evaluate the relationship between the snow depth and the distance towards the snow lances we used the snow depth values from the model of snow distribution at five different distances from each snow lance, namely at 5, 10, 15, 20, 25 and 30 metres from each snow lance (perpendicular distance to the border of snow distribution model). The relationship was examined

using the linear regression and average snow depths. The snow lances used in the ski resort had fixed positions and their range was 30 metres. By combining the created model with the terrain GPS mapping performed during the winter season we distinguished three zones with: i.) artificial, ii.) mixed and iii.) natural snow (Fig. 1).
Plant community relevés were performed at 48 plots of 1x1m from 6 to 10 August 2012 (Fig. 2). The positions of the relevé plots were selected following the stratified random sampling, while the number of plots under natural and artificial snow was kept equal and the site conditions (aspect, slope, soil characteristics) of all plots had to be comparable. We recorded the information about the vegetation structure, species composition and the percentage of the plot with bare soil. The coverage and the frequency of vascular plants was estimated using the 11-point Zlatník scale of abundance and dominance (adjusted Braun-Blanquet scale). Creation of a synoptic table was performed in the Juice program. We used Juice to calculate the following vegetation characteristics: i) cover percentage in the relevés; ii.) Shannon-Wiener index of species diversity and Pielou's evenness index (1975) $J = H´/ \ln S$; ii) number of species of *Violion caninae* alliance; iii.) number of diagnostic species of *Violion caninae* alliance.
The groups of relevés under natural and artificial snow were compared with Mann-Whitney W-test in STATGRAPHICS Centurion XVI at 5 % significance level. Every average value is presented with its standard deviation (mean ± SD).

Results and discussion
After natural snow had melted away in the surrounding landscape of the snowed ski slope, there was still a large amount of irregularly distributed artificial snow on the slope (Fig. 2). This state was determined at the end of every monitored winter season in Košútka ski resort (Hríbik et al., 2014). The variability of the modelled snow depth was extremely high, the snow depth fluctuated from 0 cm to more than 150 cm. The maximum measured snow depth of 198 cm was situated close to the snow lance and minimum equal to 0 cm was observed on the other side of the ski slope. The modelled values of snow depth showed a strong linear relationship to the distance from the snow lances (Fig. 3 left; $r^2 = 0{,}961$). The snow depth decreased with the increasing distance from the snow lances by 2,59 cm per 1 m on average (measured in the direction of snow production). Several studies conducted at higher elevations of the European Alps similarly demonstrated that the snow depth on the ski slopes was greater than the depth of natural snow in the surroundings because of technical snowing (Stöeckli et Rixen, 2000; Rixen et al., 2004). Snowpack on snowed ski slopes lasts up to 4 weeks longer than in the surrounding landscape due to its increased snow depth (Melanie et al., 2014). The work of Hríbik et al. (2014) revealed that in Košútka ski resort snowmelt is by three to four weeks delayed (winter seasons 2010/11 až 2012/13).
The average density of artificial snow was 0,618 ± 0,1 g/cm^3. Its density varied from 0,457 g/cm^3 to 0,850 g/cm^3 (Fig. 3). The average density of natural snow in March varied from 0,244 g/cm^3 to 0,432 g/cm^3 (Hríbik et al., 2012; period 2004-2006 at 600 m a.s.l. site close to Košútka ski resort). Rixen et al. (2004) , and Stöeckli et Rixen (2000) determined an average density of artificial snow during winter season equal to 0,523 g/cm^3 and 0,525 g/cm^3. These studies also revealed that not only snow depth but also snow density are significantly higher on the artificially snowed ski slopes when compared to natural snow pack. We revealed higher density of artificial snow than in the studies from the Alps most probably because snowpack at low elevations contains more ice during snow production (Rixen et al., 2004) and also because our measurements were performed at the end of the winter season.

On the base of the species composition of the plant communities on the ski slope we classified them into *Nardetea strictae* class Goday et Carbonell 1961, *Violion caninae* alliance (oligotrophic mesophillic stands) Schwickerath 1944 a *Campanulo rotundifoliae-Dianthetum deltoidis* association Balátová-Tuláčková 1980. On the research plots under the artificial snow we revealed the reduction of the number of species, the retreat of differential species of Violion caninae alliance and the decrease of average coverage of the herb layer as well as of the species of *Violion caninae* alliance (Fig. 4). In addition, the percentage of bare soil under artificial snow increased ($29,0 \pm 12,9 > 0,7 \pm 0,9$; $p < 0,5$), as well as the frequency of species indicating dry soils: *Calamagrostis epigejos*, *Gnaphaliu sylvaticum*, *Veronica officinalis*, and at the same time the average coverage and frequency of moss species and seedlings of pioneer species also increased *Betula pendula*, *Populus tremula*, *Salix* sp. On the artificially snowed part of the ski slope we also observed the reduction of the total and the average number of species, but the index of species diversity increased only insignificantly because of higher evenness (Fig. 5). The increase of evenness can be explained by substantial decrease in the coverage of the dominant species *Agrostis capillaris* on the artificially snowed plots.

The reduction of the number and coverage of species on the plots with artificial snow was also recorded by Kammer (2002) a Pohl et al. (2012). Kammer (2002) detected a significant decrease in the number and coverage of species, which were classified under natural snow. A great number of literature showing the impact of artificial snow and management activities on ski slope vegetation is available, in particular, on the decline in plant species diversity and changes in species composition of plant communities (Stöeckli et Rixen, 2000). These studies were conducted higher at elevations exceeding 1000 m a.s.l. In our low elevation ski resort we revealed a similar trend, although we could not prove the reduction of diversity due to the increase of evenness and the spread of new species.

In alpine habitats, snowpack properties seem to be an important determinant affecting ski slope vegetation (Stöeckli et Rixen, 2000). In the low elevation resort of Košútka management activities seem to be most important variables connected with artificial snowpack, although they did not directly change snowpack properties.

Fig. 1: Low elevation ski resort Košútka (Central Europe, Slovakia). Delayed snowmelt on ski slope where artificial snow is applied.

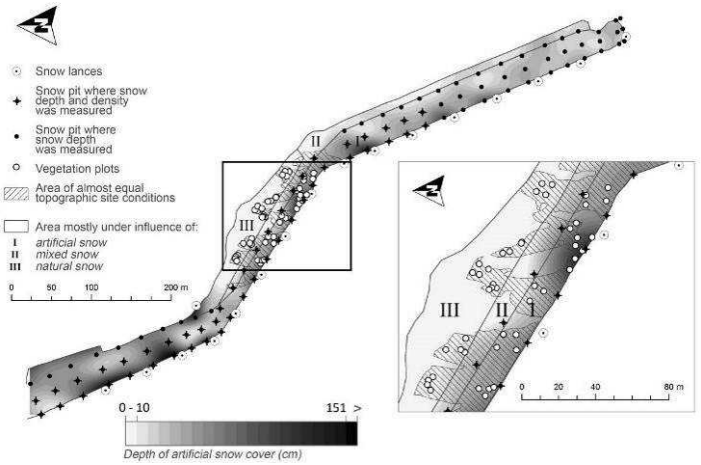

Fig. 2: Snow and vegetation survey design and model of the artificial snow distribution on the ski slope, after a natural snow disappeared in the area

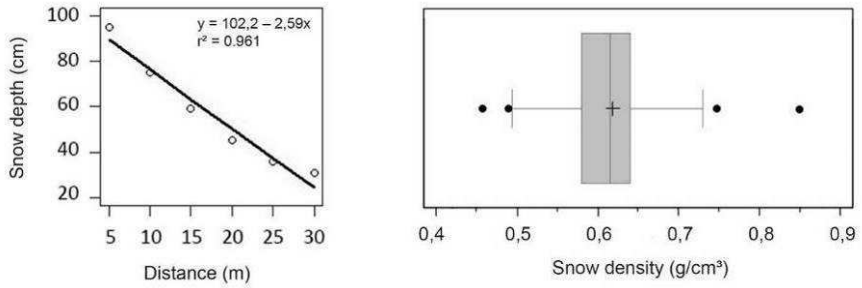

Fig. 3: Strong linear relation between average artificial snow depth (modeled values) and distance towards snow lances (left) and Box and Whisker plot of measured artificial snow density values (right)

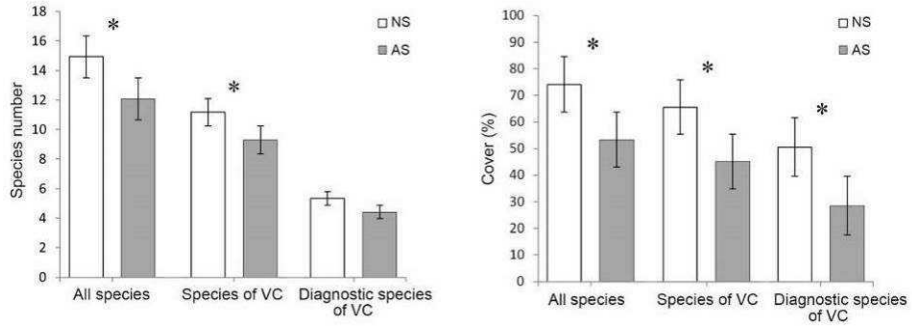

Fig. 4: The average number (a.) and average cover (b.) of: i.) all species of vegetation records, ii.) species of Violion caninae alliance („VC“) and iii.) diagnostic species of Violion caninae in the relevés under the artificial (AS) and natural (NS) snow cover. Asterisk indicates significant differences ($p \leq 0,05$), mean values ± 1 standard deviation (Mann-Whitney test)

	Species pool	Species richness	Evenness (Pielou 1975)	Shannon-Wienerov index
AS	34	12.08 +/- 2,75	0,82 +/- 0,086	2,17 +/- 0,179
vs.	<	< *	> *	>
NS	39	14.92 +/- 2,43	0,73 +/- 0,074	2,02 +/- 0,275

Fig. 5: Comparison of vegetation characteristics under the artificial (AS) and natural (NS) snow cover. Asterisk indicates statistically significant differences ($p \leq 0.05$), n = 24 (Mann-Whitney test)

Conclusion

The aim of the work was to analyse the properties of artificial snow cover and its impact on ski slope vegetation on the example of Košútka ski resort. We found high depth and high density of the artificial snow, which was unevenly distributed on the snowed part of the ski slope. The characteristics of the plant communities under the artificial snow differed from those under the natural snow. Under the artificial snow we revealed e.g. lower average number of species, lower coverage of a herb layer, and lower average species richness.

In the low elevation ski resort of Košútka we observed changes in the characteristics of plant communities, but these changes are most probably not caused by the changes in snow cover properties, but result from the activities connected to management of the artificially snowed part of the slope (e.g. snow grooming, skiing, ski slope grading, drainage). Artificial snow cover is directly connected to these activities because skiing is performed on the artificial snow. The conclusions refer to the locality, at which the pilot project was performed. We assume that similar processes occur also in other ski resorts with similar natural conditions where skiing is mainly performed on artificial snow. To generalise the observed knowledge about the impact of artificial snow on vegetation it is necessary to apply a similar research design to several ski resorts which would represent a broader geographical area.

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Souhrn
Sněhová pokrývka, která zůstává na lyžařském svahu střediska Košútka, je zjevně umělá, protože má extrémně vysokou hustotu a výšku. Je tvořená především umělým sněhem, protože její výška závisí na vzdálenosti od zasněžovacích tyčí. Na lyžařském svahu pod umělým i přírodním sněhem se v obou případech vyskytují oligotrofní mezofilní porosty druhu Violion Caninae, avšak s významnými odchylkami. Produkce umělého sněhu zaručuje provozuschopnost nízko položeného střediska, v kterém se lyžuje hlavně na umělém sněhu. Umělý sníh má přímý (změna vlastností sněhové pokrývky) i nepřímý (management svahu) vliv na vegetaci lyžařského svahu. Klíčovým faktorem, který způsobuje změny v rostlinných společenstvech, jsou pravděpodobně aktivity související s managementem svahu (sněhové pokrývky) a ne specifické vlastnosti umělé sněhové pokrývky.

Contact:
Ing. Michal Mikloš
E-mail: miklosmiso@gmail.com