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Contents

A NEW POSSIBILITY HOW TO EVALUATE THE LEVEL OF DROUGHT STRESS IN PLANTS FOR THE ASSURANCE OF LANDSCAPE PLANTINGS PROSPERITY

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Abstract
More and more frequent drought spells increase plant mortality, complicate the growth of landscape plantings and impair their aesthetic impression in recreation areas. Improper handling and desiccation of plants before their planting out usually worsen the situation. The aim of this study was to determine the plant survival rate and the growth of plants stressed by desiccation, and to test a possible new method for the evaluation of water losses in plants. Bare-rooted plants of European beech were analysed in 2015, 2016 and 2017. The plants were exposed to desiccation for 0-6 hours and the loss of fine roots weight induced by intentional heat attack was measured before their planting out. Results showed that plants unstressed by desiccation reached the lowest mortality after the first growing season, especially in cases when a drought spell followed their planting out. Poor growth was observed only in surviving plants stressed by desiccation longer than ca 4.5 hours. The shorter was the period of plant desiccation, the faster was the decrease of the weight of fine roots due to the constant heat attack. Limit values are specific for individual species and are influenced by weather after planting out and during the growing season.

Key words: planting, European beech, plant desiccation, mortality, morphological characteristics

Introduction

The change of climatic conditions we have been witnessing in last years is accompanied by increasing air temperatures (Hlavinka et al. 2018). According to the authors, the long-term precipitation amount remains more or less constant; however, the precipitation is not evenly distributed throughout the years and months. There are periods of sudden and torrent rains interlaced with low precipitation periods of varied length and more frequently occurring dry periods. Plant communities respond to the change very sensitively, which causes considerable problems in forestry, agriculture and generally in the landscape. Problematic is not only the growth and survival of woody vegetation (Šimerda, 2018), but also its establishment (Mauer et al. 2018). Particularly the planting out of young trees in the spring appears risky recently because it is often followed by drought spell, which causes inadequate loss of young plants. The impact of failed planting out is not only ecological and economic but also social and cultural namely in areas of emphasized recreational function where the landscape aesthetic function plays an essential role. Thus, planting in recreational areas should be made with using technical and silvicultural measures that would be able to eliminate possible weather fluctuations (Salaš et al. 2018).

To ensure planting success, greater attention should be given to the quality of transplants – not only to their morphological features but also to their physiological condition (Leugner et al. 2018). The authors maintain that one of the most important indicators of the physiological quality of plants is water regime condition at the time

of planting. The lifting of planting stock in nurseries and its handling before planting induce and worsen water stress, which is often a limiting factor during dry periods especially in open plantations in the landscape. According to ČSN 48 2115 (2012), water content in the planting stock can be assessed by using the following methods: (1) measuring of electric resistance or conductivity of young stems; (2) gravimetric measurement, (3) pressure vessel, resp. measuring of water potential/stress; (4) visual assessment of desiccation cellulae in Norway spruce and Silver fir. However, these are either laboratory methods intensive in terms of instrumentation or subjective methods not accurate enough for inexperienced assessors. This is why exact methods applicable in practice are currently sought by means of which we could assess inadequate water loss in plants before their planting out.
In our research, we designed and tested a new method based on the hypothesis that (fresh) plants stressed and unstressed by desiccation lose water from their fine roots at different rates. Compared with the above-ground part of the plant, roots respond to water stress more sensitively (Palátová 2004) because they have no defence mechanisms against it (Landis et al. 2010). The aim of our work was therefore to verify a possible use of method for water content assessment in the planting stock by measuring weight loss in the samples of fine roots during the constant thermal stress.

Materials and methods

In 2015, 2016 and 2017, experimental plantations of European beech (1-1) were established in the late spring (from the end of April to May) in order to simulate unfavourable weather conditions (higher temperatures, low air humidity) at planting. Experimental plot A is situated on the edge of a forest stand near the city of Brno (altitude 250 m above sea level, group of forest types (GFT) Fresh, nutrient-medium Beech - Oak, Warm climatic zone according to Quitt (1971), 49°15‘N, 16°35’E). Experimental plot B is situated in a wooded stony valley 4 km NE of Brno (altitude 300 m above sea level, GFT Fresh, nutrient-medium Beech – Oak, Warm climatic zone, 49°16´, 16°41´). Experimental plot C is situated in a forest complex 40 km north of Brno (altitude 480 a.s.l., GFT Fresh, nutrient-medium Beech, Mildly warm climatic zone according to Quitt (1971), 49°35‘N, 16°45’E).
Prior to planting, the plants were exposed to desiccation for 0.0 – 4.6 hours at a shaded place near the planting site. After the desiccation, closely before planting, a sample of fine roots (ca 5 g) was taken from 3 plants to determine the content of water. The samples were weighed with accuracy to 0.1 g and exposed to hot air flow (electric hair drier with energy input of 1600 W) for 1 min and 2 min. From 2016 onwards, the exposure was 5 min, the reason being increasingly distinct differences among the respective variants. After drying with the hair drier, the samples of fine roots were repeatedly weighed. Weight values of all three repetitions (samples from three plants) served to calculate the arithmetic mean as well as the weight proportion of dried samples as compared with the 100% weight of fresh (not dried) samples. Subsequently, 20 plants were planted out in each variant of drying.
At the end of the growing season (in 2015 also ca 5 weeks after planting), we ascertained mortality of the plants and their basic morphological characteristics (height, diameter ca 1 cm above the root collar and increment length). The morphological characteristics were mutually compared by one-factor ANOVA, resp. by Fisher’s post hoc test. In the case of the non-fulfilment of basic data assumptions, we used the non-parametric Kruskal-Wallis test.

Results and discussion

Tables 1-3 indicate that the longer was the exposure of young beech plants to desiccation, the less weight (water) the samples of fine roots were losing at being dried with the hair drier. Drying out, fine roots apparently lose water lightly bonded in superficial layers first while water firmly bonded inside roots is then evaporated/lost more slowly when treated with the hair drier. If the samples of fine roots exhibited more than 90% of their fresh weight after 1 minute of treatment with the hair drier and over 82% after 5 minutes, the concerned plants were those, which had experienced inadequate length of desiccation prior to planting, whose roots lost excessive amount of water already before they were planted out. These plants exhibited intolerable after-planting losses (pursuant to Decree no. 139/2004 Sb., losses tolerable on regenerated forestland are 10%). Nevertheless, the increment of plants exposed to desiccation was affected only when the samples of fine roots had more than 95% and over ca. 90% of their initial weight after 1 min and 5 min of treatment with the hair drier, respectively. The statistically significant effect of desiccation on the height and diameter of the plants was not demonstrated at all times.

As a rule, the best growing (lowest mortality, greatest increment) beech plants were those that were not exposed to desiccation at all and were not heeled-in prior to planting out (Tabs. 1-3). The samples of fine roots of such plants exhibited less than 80% and less than 70% of their initial weight after 1 minute and 5 minutes of treatment with the hair drier, resp. Since they had not been exposed to desiccation so far, they were losing weight (water) rapidly during the treatment with the hair drier and according to Landis et al. (2010), have no effective defence mechanisms against drying out.

Results of testing in 2015 (Tab. 1) are affected by drought during the growing season (Daňhelka et al. 2015). Although the plants rooted and put forth buds even after a relatively long period of desiccation (up to 4 hours, Experimental plot A), they exhibited inadequate losses at the end of the growing season even after the shortest exposure of 1.25 hour. In the other years, conditions for the growth of plants were favourable; therefore, the plants did not show minimal losses sometimes even after a shorter exposure and grew well. In spite of the fact, not even 0.5 hour desiccation can be admitted before planting not only with respect to uncertain course of weather after planting, but also with respect to uncertain success of planting in the period with favourable temperatures and precipitation (Tabs. 2, 3, Experimental plot A). It should be reminded that the tested plants were exposed to desiccation at the shaded place near the planting site and should they have been exposed to direct solar radiation, the inadequate damage to them would have occurred much earlier. At that, the heaviest water loss in plants apparently occurs at planting itself when the plants on clear-cut areas are exposed to desiccation closely before their fixing in the soil (Leugner et al. 2018).

Planting success is affected not only by desiccation and weather but also by soil conditions and planting stock maturity. The latter two factors (stony soil and lower root collar diameter according to ČSN 48 2115) apparently contributed together with drought to high after-planting losses in 2015 on Experimental plot B also in the variant without the targeted drying out (Tab. 1).

Susceptibility of heeled-in plants to drying out was not demonstrated; fresh plants and plants heeled-in for 1-2 weeks responded to drying in a similar way (Tabs. 2, 3). Nevertheless, losses observed in plants heeled-in after desiccation were greater than in plants exposed to desiccation closely before planting (Tab. 3).

The results of testing are species specific; results of other tree species are not included for the limited size of the publication. Although the trends are similar, limit values of weight loss in the samples of fine roots during the treatment with the hair drier are different.

Tab. 1: Weight of fine root samples before planting, mortality and basic morphological characteristics of beech at the end of the growing season after planting in 2015

	Desiccation	Weight of fine root samples before planting (%)			Mortality (%)		Height	Increment of plants	Diameter
		Fresh roots	After 1 min treatment with hair drier	After 2 min treatment with hair drier	After planting	At the end of growing season	(cm)	(cm)	(mm)
Trial plot A	0.00 hr	100	65.5	57.7	0	0	55.8^{a}	11.4^{a}	6.8^{a}
	1.25 hr	100	74.9	70.1	0	15	51.1^{b}	8.7^{b}	6.5^{ab}
	2.50 hrs	100	85.7	82.3	0	30	50.4b	6.7^{bc}	6.2^{abc}
	3.50 hrs	100	89.2	87.1	0	30	45.7^{cd}	4.6^{cd}	5.7^{ac}
	4.17 hrs	100	85.7	82.0	10	10	49.4^{bc}	6.7^{bc}	6.5^{b}
	4.58 hrs	100	92.2	89.9	60	60	43.8^{d}	2.3^{d}	5.9^{bc}
Trial plot B	0.00 hr	100	74.8	67.2	16	80	43.5^{ab}	4.4^{a}	4.8^{a}
	0.58 hr	100	90.0	85.5	15	60	39.2^{a}	5.4^{a}	6.0^{c}
	1.17 hr	100	91.7	88.1	30	90	38.9^{a}	3.1^{ac}	5.5^{bc}
	1.83 hr	100	95.1	92.4	55	90	43.8^{ab}	0.7^{bc}	5.6^{bc}
	2.58 hrs	100	97.0	95.5	80	100	45.1^{b}	0.0^{b}	5.2^{ab}

Tab. 2: Weight of fine root samples before planting, mortality and basic morphological characteristics of beech at the end of the growing season after planting in 2016

	Desiccation	Weight of fine root samples before planting (%)			Mortality (%)		Height	Increment of plants	Diameter
		Fresh roots	After 1 min treatment with hair drier	After 5 min treatment with hair drier	After planting	At the end of growing season	(cm)	(cm)	(mm)
Trial plot A	Fresh plants								
	0 hr	100	80.52	68.60		5	44.1[a]	7.5[a]	6.7[a]
	0.5 hr	100	94.94	87.39		45	43.4[a]	2.0[c]	5.6[b]
	1 hr	100	89.84	81.73		10	49.0[a]	4.8[b]	7.0[a]
	2 hrs	100	96.32	90.00		40	46.1[a]	1.5[c]	6.1[ab]
	3 hrs	100	94.82	89.06		20	44.3[a]	1.9[c]	5.6[b]
	Plants heeled-in for 1 week								
	0 hr	100	69.01	61.04		5	49.0[a]	2.9[a]	6.4[a]
	1 hr	100	93.19	89.31		20	48.3[a]	3.3[a]	6.5[a]
	3 hrs	100	97.35	94.13		50	48.7[a]	1.9[a]	7.2[a]
Trial plot C	Fresh plants								
	0 hr	100	77.48	61.01		0	42.2[b]	5.9[a]	6.4[b]
	0.5 hr	100	81.29	70.32		35	51.3[a]	2.6[bc]	8.4[a]
	1 hr	100	84.99	71.38		0	47.7[ab]	4.3[ab]	7.9[a]
	2 hrs	100	95.43	82.06		70	43.6[ab]	2.2[abc]	7.0[ab]
	3 hrs	100	88.92	80.77		10	43.1[b]	1.8[c]	6.3[b]
	Plants heeled-in for 1 week								
	0 hr	100	83.49	70.68		25	44.1[a]	2.9[a]	7.0[a]
	1 hr	100	87.44	77.42		20	45.9[a]	2.4[a]	6.9[a]
	3 hrs	100	94.05	83.98		25	45.0[a]	2.2[a]	7.0[a]

Tab. 3: Weight of fine root samples before planting, mortality and basic morphological characteristics of beech at the end of the growing season after planting in 2017

* 1hour exposure to desiccation, heeling-in, planting next day

** 1hour exposure to desiccation, heeling-in, next day 1 hour exposure to desiccation and planting

	Desiccation	Weight of fine root samples before planting (%)			Mortality (%)		Height	Increment	Diameter
		Fresh roots	After 1 min treatment with hair drier	After 5 min treatment with hair drier	After planting	At the end of growing season	of plants		
							(cm)	(cm)	(mm)
Trial plot A	Fresh plants								
	0 hr	100	80.9	69.1	-	30	46.3[a]	13.6[a]	6.7[a]
	0.5 hr	100	88.0	82.5	-	15	43.1[a]	10.9[a]	6.2[a]
	1.5 hr	100	96.1	76.1	-	30	42.4[a]	6.5[b]	6.8[a]
	Plants heeled-in for 1 week								
	0.0	100	85.1	72.5	-	0	51.6[a]	5.9[a]	6.6[a]
	0.5	100	90.6	84.2	-	30	49.4[ab]	17.9[b]	6.0[ab]
	1.0	100	97.0	89.4	-	30	44.6[b]	15.2[b]	6.6[a]
	3.0	100	92.9	90.6	-	40	45.1[b]	7.3[a]	4.9[b]
	Plants heeled-in for 2 weeks								
	0.0	100	79.7	62.9	-	5	44.9[a]	7.7[a]	6.2[a]
	1.0	100	93.4	88.2	-	10	50.7[b]	10.2[a]	6.2[a]
	1.0*	100	89.2	81.6	-	25	44.5[a]	9.7[a]	6.7[a]
	1.0x1.0**	100	93.8	87.8	-	25	41.1[a]	2.7[b]	5.9[a]
Trial plot C	Fresh plants								
	0.0	100	78.5	67.8	-	15	52.6[a]	10.1[a]	8.1[a]
	0.5	100	90.3	83.7	-	0	49.3[a]	10.8[a]	5.7[b]
	1.5	100	97.4	88.6	-	5	48.3[a]	6.0[a]	6.0[b]

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Souhrn
Pro zvýšení úspěšnosti výsadeb zejména v rekreačních oblastech se zvýšenou estetickou funkcí krajiny byly zjišťovány limitní délky vysychání rostlin před výsadbou a testována nová metoda hodnocení obsahu vody v rostlinách. K testování byl použit sadební materiál buku lesního, který byl před výsadbou v teplotně a vlhkostně nepříznivých podmínkách pozdní jarní výsadby různě dlouhou dobu vystaven vysychání ve stínu porostu. Před samotnou výsadbou byl měřen hmotnostní úbytek vzorků jemných kořenů rostlin při konstantním tepelném působení proudu horkého vzduchu aplikovaném fénem. Z dosažených výsledků vyplývá, že čím delší je vysychání rostlin před výsadbou, tím k menšímu hmotnostnímu úbytku jemných kořenů při fénování dochází. Nejmenší mortalitu a nejlépe odrůstaly rostliny, které nebyly před výsadbou vůbec vystaveny vysychání. Vzorky jemných kořenů těchto rostliny ztrácely po 1 minutě fénování více než 20 % své hmotnosti, po 5 minutách více než 30 %. Je proto nutná pečlivá ochrana rostlin, zvláště jejich kořenového systému během manipulace od vyzvednutí ve školce až po výsadbu. Nová metoda hodnocení obsahu vody v rostlinách se jeví jako perspektivní, limitní hodnoty jsou však druhově specifické.

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ALPINE TOURISM VERSUS EROSIVE SURFACE DAMAGE: CASE STUDY IN THE LOW TATRAS

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Abstract
Alpine tourism is a very attractive and sought-after form of recreation. The area of the Low Tatras has a high tourist - recreational potential. Recreational activities in such an alpine area have actually negative impact on tourist trails or the country in general. Tourism is known for its significant devastating impact that is caused by over congested and unsuitably tracked network of tourist trails.
The paper deals with the study of reconstruction of a devastated tourist trail Trangoska – Chalet of Gen. M. R. Štefanik in the Low Tatras National Park. Based on terrain reconnaissance the interest area was mapped, quantitative parameters of erosion damage were specified and critical areas identified. These represent the base for the proposed measures to lower the negative impact on the area due to summer tourism caused by a variety of technical and biologic adjustments of the trail itself as well as its surrounding area.

Key words: alpine tourism, tourist trails, erosion, revitalisation

Introduction

Alpine tourism is a very attractive and popular form of recreation. Its most frequent form is hiking the alpine trails. Recreation itself has also a negative impact on tourist trails and nature too. Such form of activity has hand in hand with its beneficial effects upon human beings also broad negative impact. When of a mass character it can exceed the ecologic capacity of the area with negative impact on natural environment. Devastating impact of tourism is evident via overcrowded, in some areas inappropriately trailed or not maintained tourist trail network. Evaluation of such line objects cannot focus only on the trail itself but also on a broader surrounding area. MIDRIAK (1993) lists the following effects of hiking tourism impacts, such as excessive footsteps damaging vegetation and soil, designing new parallel unofficial trails and shortcuts (on the fall line), deterioration of soil characteristics, changes in biomass production of green grass vegetation, intrusion of synantrophic plants and creation of conditions for erosion.
In general, the level of erosion threat in relation to soil increases with the growing altitude of the area as the slope steepness increases, there is higher frequency of rain precipitation, lower vegetation cover density and there is a significant increase of unstable mantle rock layer on slopes as well. Soil transport can be even multi increased in case that surface area is intensely destructed by people, but in such a case we speak about anthropic erosion (MIDRIAK 2006).
The aim of the paper is to propose a case study for the reconstruction of the devastated tourist trail Trangoška – Chalet of Gen. M. R. Štefanik in the Low Tatras National Park.

Materials and methods

The interest area of the researched problematics is the Low Tatras National Park that it is one of nine national parks in the territory of the Slovak Republic and it

covers the largest area. The total area of the national park 72, 842 ha and the protected area covers 110, 162 ha. The national park is 100 km long and 30 km wide. It is divided by mountain saddle Certovica on the west – Dumbierske Tatras and the east part – Kralovohoľské Tatras. The highest peaks are Dumbier (2,043 above sea level) and Chopok (2,024 above sea level) (www.napant.sk).
In the national park and its protective area there are altogether 52 labelled tourist trails with the length of more than 840 km, out of these 167 km are above the upper forest boundary, and 15 educational trails. This area is very attractive for tourists and about 1.7 mil visitors a year (SVETLÍKOVÁ 2010).
The paper focuses on tourist trail Trangoska – Chalet of Gen. M. R. Stefanika, which is part of the tourist labelled trail No. 5426 Brezno – Bystra - Tale (Stupka Hotel) – Trangoska – Chalet of M. R. Stefanika – Krupova hola (grassy upland) – Siroka dolina (lowland) – Demanovska dolina (downland) – Za Vratami with the total length of 37.7 km (www.kst.sk, www.hiking.sk). The trail, of the total length of 3.4 km, elevation 608 m (1130 – 1738 above sea level), ranges through forest and subalpine high vegetation levels, as its trail runs between the down lands of Kozi chrbat from the south and below Dumbier from the north. Topographic locality of the trail has a character of valley line type changing to slope fall line and at its end of slope contoured type.

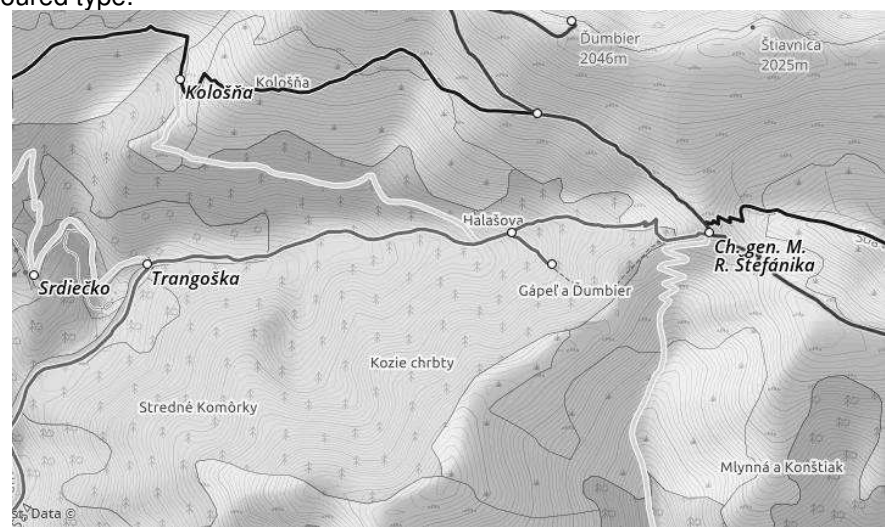

Fig. 1: Map of the Trail (source: https://mapy.hiking.sk

Geological structure of the Dumbier part is of crystalline core. It consists of the most resistant Palaeozoic eruptive and transformed rocks that build mostly sierra and the southern part of the mountain range. In its layers are, in greater amount, present stones of marlaceous nature, mostly of chalk, softer, weathering and erosion lees resilient character. As concerning the climatic conditions, the researched area belongs to cold area, cooler alpine, even cold mountain zone with a years s average temperature of 4 °C, with January average temperature of -7 °C, average precipitation of 1,200 – 1,600 mm and 180 days covered by snow annually (KOLEKTÍV, 2002).
Methodology of the paper focused on terrain reconnaissance with the aim to map technical condition of the trail and to make proposal for proper measurements to be taken to reconstruct the devastated trail. Within the terrain work basic length, width, and gradient characteristics were mapped, as well as the technical parameters of

the trail with focus on specification of the range of erosive damage. At places with the highest degree of erosive damage a surface range of such damage was quantified. Based on the findings and stated characteristics, the trail was divided into 30 areas, for which individual measures were proposed for its renewal and revitalization. The proposed measures were of technical, biological or combined character.

Results and discussion

The tourist trail of special interest has the following route:

- the trail starts at a car park at the IC (Information Centre) Trangoska, has a character of valley, runs along the mountain-stream Bystrianka, of slight gradient (5 – 8 %), with the length of 1 – 2 m, with boulder-like surface, with no sights of erosion,
- from its 0.610 km the trail forks, has a character of slope fall line type, the surface is rocky, with no visible sights of erosion, the damage is evident on vegetation due to walkers as these create their own parallel trails along the official one,
- from its 1.452 km there is also evident a slight erosion, present are not functioning or sludgy stone steps, more parallel trails walked by tourists, the surface is of soil-rocky texture, with slight gradient (up to 8 %), the trail runs along the mountain stream, the surrounding banks are covered by spruce vegetation,
- from its 2.074 km the trail turns from the water stream, runs through spruce vegetation below the locality of Jaskyňa mŕtvych netopierov (cave), the inclination grows rapidly (over 20 %), the surface is mostly rocky with visible signs of water and anthropogenic erosion, creating erosion furrows into the depth of 30 cm, present is a non-functioning or damaged transversal drainage (wooden steps), which tourist avoid which causes damage of the herbal layer and the surrounding area of the trail,
- from its 3.317 km the area runs through the dwarf mountain pine zone and there also begins the most critical part, the trail and its immediate surrounding area are badly devastated, significant erosion is present with visible furrows 30 – 50 cm deep, at places even with deeper terrain depressions (sometimes 180 cm deep), transverse drainage is non-functioning and damaged, surface of the trail is rocky, but continually the rocky material diminishes and from the stationing at 2.716 km it changes into soil surface with no presence of rocks, gradient ratio reaches maximum, up to 28 – 36 %, the trail gradually changes into serpentines, present is also widening of the trail or creation of parallel trails with numerous shortcuts (the length of 1 – 5 m). Critical damage is up to the stationing at 2.929 km. Within the given zone where at cross sectional cuts surface terrain changes caused by erosion were measured, for the total existence of the trail there was the total of - 236.2 m^3 of soil carried away from the land horizon that is 0.39 m^3/m.
- the final part of the trail changes its character into crest type with slighter gradient (7 %), with rocky surface and at the end of the trail with rocky pavement.

When proposing the project or the tourist trail revitalisation the fact that the place of interest is located in the area of the national park with high level of nature protection had to be taken into account as well and therefore all proposals for its revitalisation are dependent on approval of the National Nature Protection Agency. As the trail is located in extreme alpine environment, the accessibility and also the use of mechanism and technically more demanding solutions are not feasible. Also from the financial point of view it is necessary to use the most economical solutions. The challenge was to use the maximum of available sources of material present directly in the locality or in its immediate surroundings.

As already stated, the trail was divided into 30 parts, so when designing the project, each part was approached individually depending on conditions and needs. The following steps and principles were used:

- for critical eroded steep areas, it was necessary to secure safe drainage or slowing down the speed of flow of the surface running water. In lower parts of the trail with the sufficient amount of available material traverse drainage in form of stone steps was proposed. In the upper parts where stone is not present anymore, wooden steps using spruce round billets were designed. This material will have to be carried up to the designated areas, or partially use the existing blow downs and breaks in surrounding growths. If any existing damaged and non-functional steps are present, these have to be removed.
- erosion protect securing of eroded areas or clearage of dual and parallel trails was proposed by using goetextiles (jute net with density 250 g/m^2) in combination with grassed and afforestation techniques.
- vegetation securing of the affected areas is proposed by autochthonic herbaceous vegetation that can be obtained by mowing of the surrounding meadows and by use of slag from dried hay.
- for afforestation stocks of wood species with mature and strong root system were used, even in lower parts of the trail, such as common spruce (*Pices abies*), French cherry (*Sorbus aucuparia*) and at the upper forest boundary dwarf pine (*Pinus mugo*).
- when performing clearage of the dual trails and various man-made shortcuts it is necessary to secure that tourists are not able to move around these sections.
- at areas with much eroded surface tiling using flat stones from the nearby area in dry form was proposed.
- steep eroded areas with soil surface without stones were proposed to be treated by a terrace solution in form of wooden steps made from round billets.
- areas with sliding base of a cutting slope were designed to be treated by wooden terrace walls.

Practical experience from the designated area was taken into consideration when proposing the tourist trail renewal. In the past one of our departments at the Faculty of Forestry at the Technical University in Zvolen participated in the an activity of a successful stabilisation of the south-eastern slope Dumbier to its saddle at the Chalet of M. R. Štefánik, which with its area at that time in the Slovak nature protection was unique and one of its kind.

The slope was due to incorrect route location and shortcuts as well as excess tourist load significantly damaged by erosion. Revitalisation was successfully completed, the slope is stabilised without any signs of erosion, even though the trail is not accessible to tourists even after 25 years (www.cestasnp.sk).

Preventing devastating of nature and country by alpine tourism very often requires also regulation of tourist activity in particular areas. According to MIDRIAK (1993) majority of trails in the Dumbier Tatras (69.5 – 91.7 %) is based on easily eroded soil and belongs among surfaces with low resistance, therefore he proposed to limit intensity of hiking tourism to 53 – 100 persons/km/day in this particular area. Excessive tourist load leads to exceeding limits of nature and country capacity.

Conclusion

The Low Tatras National Park represents a unique area where natural treasure was preserved in its all variety.

Preserving such a protective natural environment and at the same time using the area for recreation must be balanced. To reduce erosive features on tourist trails it

is necessary to keep functional technical condition of anti erosive measures. On the other hand, it is necessary to direct the movement of tourists who often with their chaotic movement, intolerant behaviour towards tourist marks or not accepting the designated tourist tracks cause the unfavourable situation at trails. Nonetheless it is also necessary to influence tourists by safety-educational measures.

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Souhrn

Příspěvek se zabývá rekreací ve vysokohorském prostředí formou pěší turistiky ve vztahu k negativnímu dopadu na turistické stezky a přírodu, který se projevuje přehuštěnou, místy nevhodně trasovanou neboli neudržovanou sítí turistických stezek, což může způsobit překročení ekologické únosnosti území. Cílem práce je případová studie návrhu řešení obnovy zdevastovaného turistického chodníku Trangoška - chata gen. M. R. Štefánika, který má délku 3,4 km, převýšení 608 m a je součástí značené turistické trasy č. 5426. Zájmové území se nachází v národním parku Nízké Tatry, kde se nachází 52 značených turistických tras s výměrou více než 840 km a 15 naučných stezek. V rámci terénních prací byly zmapovány základny morfologické charakteristiky a technický stav chodníku. Na místech s největším erozním poškozením byl kvantifikován plošný rozsah těchto poškození. Celkový odnos půdy z půdního horizontu dosahoval průměrnou hodnotu až 0,39 m^3/bm na nejvíce poškozených úsecích. Na základě zjištěných charakteristik byl chodník rozčleněn na 30 úseků, pro které se pak navrhovaly opatření na obnovu a revitalizaci chodníku. Navrhovaná opatření byly charakteru technického, biologického nebo kombinovaného.
Na omezení erozních jevů na turistických stezkách je třeba udržovat funkční technický stav protierozních opatření, usměrňovat pohyb turistů, či ovlivňovat turisty ochranářsko – výchovnými opatřeními.

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AN UNCONVENTIONAL PROMOTION OF ROCK OUTCROPS IN ŽĎÁRSKÉ VRCHY PLA USING REMOTE SENSING

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Abstract
This paper presents the approach and results of geoinformatical outcrop analysis in Žďárské vrchy Protected Landscape Area (PLA). This locality is typical with the outcrops on the tops of ridges, which overhang surrounding valleys. Local outcrops have been studied and described very well, also because Žďárské vrchy is one of the most attractive recreational locality in central Czech Republic, which attracts attention of tourists, sportsmen, scientists, especially geologists. In this paper, we would like to continue in geomorphodiversity studies and try to interpret these specific shapes using Remote Sensing data. We used Airborne Laser Scanning (ALS) data and Digital Terrain Model (DTM) to visualize these shapes and create another view on them for wide range of interested people, tourists and visitors. Through models based on laser scanning we can gain better overview of these localities, which are not usually overlookable well because of complicated terrain geomorphology and grown vegetation.

Key words: outcrops, Remote Sensing, Airborne Laser Scanning (ALS), Digital Terrain Model (DTM), PLA Žďárské vrchy

Introduction

PLA Žďárské vrchy is located in the centre of the Czech Republic on the border of Bohemia and Moravia. This PLA was proclaimed in 1970 and spreads on the area more than 70 000 ha. This landscape is typical with its highland character as the average altitude ranges between 490 m and 836 m above sea level. The highest point is Devět skal (rock outcrops with altitude 836 m). Terrain is characteristic by large ridges and deep widespread river valleys and in detail view by cryogenic shapes – torrs, rock outcrops, frost cliffs, usually surrounded by cryoplanation terraces and fallow fields (Bína, Demek, 2012). Geological subsoil is formed by metamorphic crystallinic rocks – gneiss, migmatite, mica schist and phyllite. Local climate is cold, wet and windy with average annual temeperature 6 °C and precipitation 800-1000 mm. The main goal of PLA management is to keep and protect harmoniously balanced cultural landscape and significant natural phenomenos (Čech et al., 2002). One of the conservationists activity is the retrievement of gneiss rock block remote view on the tops. Nowadyas these block are surrounded by grown spruce forests, which visually cover them. These artifical forest stands have been species poor monocultures with low ecological stability. For that reasons, management tends to forest convertion to loose stands with original species rich composition (fir, beech, maple, etc.) and plant and animal communities relianted to them. Concurrently, also the visual landscape aspect will be applied, as the main visual axises of top outcrops should be retrieved (Doubek, 2013, Hlaváč, 2014). In this article, some of the outcrops visualization methods will be presented in order to show, how will these localities look like after stands convertion and loose. In Žďárské vrchy PLA, we can find about 15 main rock groups and many smaller outcrops and adjacent fallow fields. For our analysis, we chose Malínská skála area in Blatiny cadastral area (Fig. 1). Altitude in this locallity ranges between 720 and

811 m. Lot of rock formations can be found there like frost cliffs, torrs, honeycombs, castle koppies, rock basins, chambers etc. This rock formation consists of several partial block groups; for example Zubří skála, Výspa or Amfiteátr are the most significant ones. The shapes are influenced by natural processes like rock collapse, foliation, nivation, frost-shattering, mass movements and cryogenic activity (Bajer et al., 2014).

Fig. 1: Malínská skála surrounded by spruce monoculture stands (author: Mgr. Iveta Ježková)

Materials and methods

For outcrops visualization, the ALS data were used, as DTM of the 5th Generation of the Czech Republic was created (method Natural Neigbour, grid 0.5 m). The first step was the definiton of automatical outcrop identification method. For this analysis Focal Statistics was used, which calculates a statistic of the values for each input cell location within a specified neighborhood around it. DTM was our input layer, neigbourhood was specified as a circle with radius of 3 cells. The statistics type was Range, which calculates difference between largest and lowest value of the cells in the specified neighborhood. Than these differenced values were classified into 4 classes – difference less than 2 m like NoData and groups of values between 2-4 m, 4-6 m and more than 6 m. Using this method all main rock blocks were identified.

Next analysis consisted in visualization of DTM in localities with outcrops. We continued with methodology used for DTM visualization in the area of Babická plošina (Balková, Bajer, 2017). In that procedure means mathematical multiplication of Hillshade (H), Sky View Factor (SVF) and Positive Openness (PO) layers were aplicated. For analysis in Malínská skála locality, another combination was examined. We used Negative Openness (NO) instead Positive and added Topographic Wetness Index (TWI) into calculation. TWI is a combination of slope and water accumulation, it indicates terrain water retention susceptibility and seems to be another possible tool for geomorphology interpretation.

Last step consisted in 3D visualization of resultant raster layer created by previous calculation. The best view on the outcrops was chosen and than compared with rock dislocation scheme mapped for the purpose of climbing (Doležal, Trefulka, 2006).

Results

The first analysis was focused on automatical identification of outcrops using Focal Statistics. Resultant layer is depicetd in Fig. 2. After comparison with scheme for

climbers, mentioned above (represented by red polygons in Fig. 3), we can state that all main rock blocks were reliably determined and concurrently almost no faulty identifications were calculated. In northern part of the locality, the main top outcrop Zubří skála (with height about 20 m) is determined well.
For the purpose of visualization of the outcrops, raster layers combination of Hillshade, TWI, SVF and NO was used. All the rock blocks were correctly interpreted, only southern part of outcrops Výspa and Ďáblova kazatelna are not so distinct, as we presumpted (Fig. 3).
These blocks are more visible after 3D coloured visualization of the locality with 1.5 exaggeration aplicated for better distinction (Fig. 4).

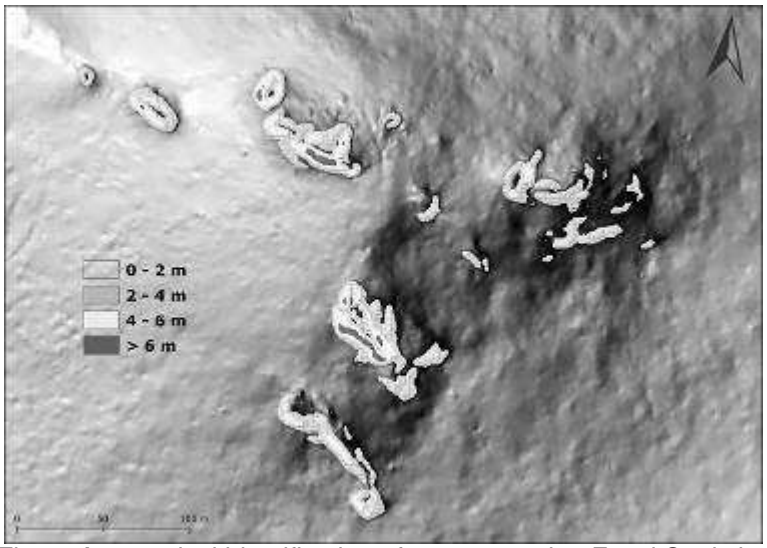

Fig. 2: Automatical identification of outcrops using Focal Statistics

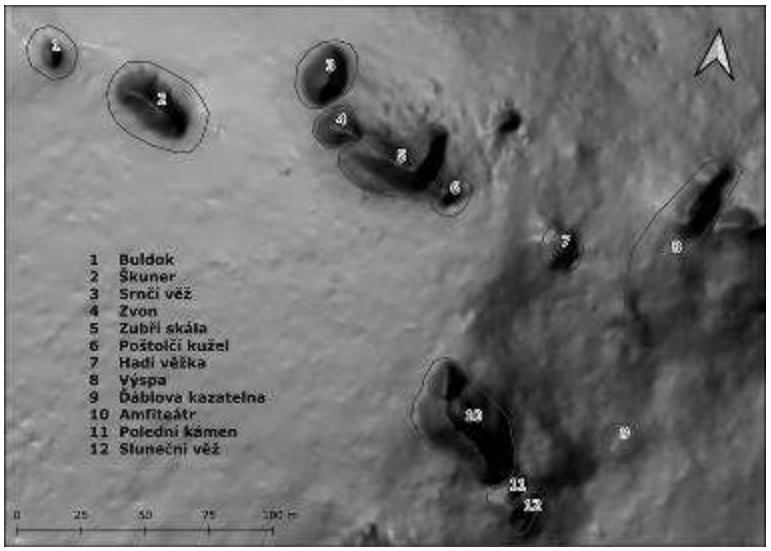

Fig. 3: Main rock outcrops of Malínská skála visualized using Hillshade combined with TWI, SVF and NO compared with real situation

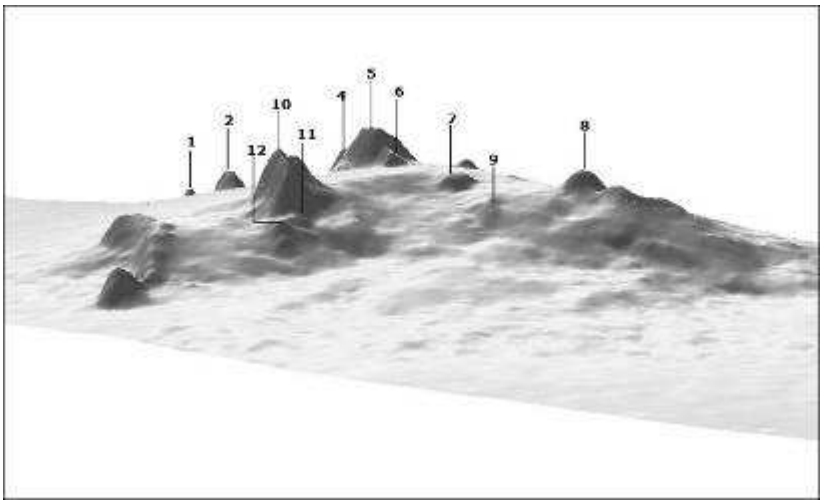

Fig. 4: Rock outcrops of Malínská skála in 3D visualization

Discussion

In this paper we would like to show some possibilities of unconvenial outcrops promotion following effort for restitution of leaning rock outcrops visual and landscaping significance. Undoubtedly, terrain models are the best way, how to depict potential situation after achievement of management intent, consisting in stands loose or partial deforestation. In this study only total deforestation was performed based on DTM data. However it is possible to use also digital surface model with vegetation included. Using this data, we are able to draw up more realistic situations, where some stands or individual trees are preserved, whereas others are stumped and consequently evaluate the visual aspect of certain locality. Terrestrial Laser Scanning offers much more accurate view of outcrops, It is considerably more expensive and is not the objective of this study, but undoubtedly provides better results.

These models represent also an attractive way of presentation of these localities to visitors, tourists, scientists and other interested people. Moreover, landforms like this uncover the features which would normally remain hidden, so they increase the geodiversity of the area. They show the various geological issues or geomorphological processes, that is why they can serve as a terrain handbook for Earth sciences and are able to be used for the geoeducational purposes (Kubalíková et al., 2016). In the area of top outcrops in Ždárské vrchy, the educational boards are usually installed. The information brought through them contains data about endangered animal and botanical species, PLA management and abiotical conditions including geomorphology. We are convinced, that terrain models and 3D visuallizations should be also the important item of these boards, as they are really suitable tool for geomorphology recognition, orientation in the filed and demonstration of the management introduced above. Especially situations in Fig. 3 and Fig. 4 represent appropriate use of particular images for these purposes. Also presentation on Agency for Nature Conservation and Landscape Protection of the Czech Republic website is very benefical for promotion of the management idea and its actual process including this visual demonstration.

Conclusion

This paper summarizes suitable choices of DTM data use for rock outcrop modelling, which are relatively distinctive geomorphological shapes, dominants of surrounding landscape. Area around Malínská skála was chosen as the trial locality, as it is one of the most attractive and significant destination for interested visitors. Though DTMs have become a progressive and developing issue, it has still been a matter rarely used for public education and familiarity. For this reason, several examples of their inclusion are proposed. Also the method for automatical outcrop identification is presented as one of auxilary analysis in landscape and nature conservation management.

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Souhrn

Tento příspěvek shrnuje dostupné možnosti využití dat pro tvorbu digitálních modelů terénu v oblastech skalních výchozů – výrazných geomorfologických prvků a dominant okolní krajiny. Jako zkušební lokalita bylo vybráno území kolem Malínské skály, která je jednou z nejatraktivnějších a nejvýznamnějších turistických destinací. Přestože digitální modely terénu se v poslední době staly progresivní a neustále se vyvíjející záležitostí, stále nejsou dostatečně využívány pro vzdělávání veřejnosti. Z toho důvodu bylo navrženo několik příkladů jejich využití v řešení této problematiky. Článek také stručně prezentuje metodu automatické identifikace skalních výchozů jako jedné z pomocných analýz využitelných v krajinném plánování a ochraně přírody.

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ANALYSIS OF STABLE AREAS IN THE LANDSCAPE (IN TERMS OF LANSCAPE STRUCTURE) – STUDY AREA „BRNĚNSKO“, SOUTH MORAVIA, CZECH REPUBLIC

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Abstract
The paper presents the method and manner for analysing the locations of stable areas (sites without any changes to the manner of land use in the period between the first half of the 19th century until the present) in the model area of „Brněnsko“ - South Moravia. Stable areas give the landscape its typical landscape character. Areas without a change of land use – without qualitative alternation to the type of plot were identified by analysing 6 lines of historical land use development in GIS. Inputs of this analysis are historical maps, historical aerial pictures and current orthophotos.
The analysis suggests some 43 % of the land cover of the Brněnsko model area is without land use changes. The remaining 57 % of land has undergone at least one change in the type of plot over the monitored period. The most represented area without any change in land use are arable land – 39,3 %, followed by forests (1,8 % of land), built-up area (1.9 %). Other land use types (permanent grassland, vineyards and orchards) are represented to a negligible extent.

Key words: stable area, land use, Brněnsko region, historical maps

Introduction

Landscape and its disposition are characterised in their uniqueness based on a remarkable variety of natural and cultural conditions (Kupka 2010). Lokoč and Lokočová (2010) quote that landscape is formed by cultural and natural processes. Anthropogenic processes act very quickly and over a short space of time. Landscape is constantly changing and even the less perceived alterations may be crucial (Lipský, 2000, Boltiziar et al. 2008, Fladmark et al. 1991, Klvač and Bielová 2012). By using the landscape, man alters its disposition which is an issue covered by several authors (Löw, 1995, Lipský and Romport 2007, Bičík 2010), who identify this process as the cultural landscape.
The cultural landscape of the Czech Republic is a very rich and varied one due to the changeable natural conditions of individual landscapes as well as the historical development (Štréblová et al. 2014, Míchal 2001). In the last few centuries the Czech landscape has undergone massive changes in the way the land is used (Stejskalová et al. 2013). In the present time, changes in landscape are among other things currently controlled by landscape planning (Karásek et al. 2014). Havlíček (2013) states changes in land use can be characterised in the form of stable used areas, etc. Land used in a stable manner creates the backbone of the landscape.
The paper presents an analysis of these historical changes in the Brněnsko area. The objective is to localise places in this territory with as few historical changes (or possibly none) as possible. We call these areas for the purposes of this article “stable areas” – from the point of view of landscape structure and landscape character.

Materials and methods

The area of Brněnsko (Fig. 1) is located in the South Moravian region in close proximity to the regional city of Brno. Model area contains a total of 7 cadastral territories. The total area of this area is 45.8 km^2.

Spatial grid data and vector data were used as a basis for research utilising maps (historical maps and current orthophoto maps) provided by the State Administration of Land Surveying and Cadastre and also the Military Geography and Hydrometeorological Office in Dobruška (historical aerial snaps). All data was processed and assessed using ArcGIS software.

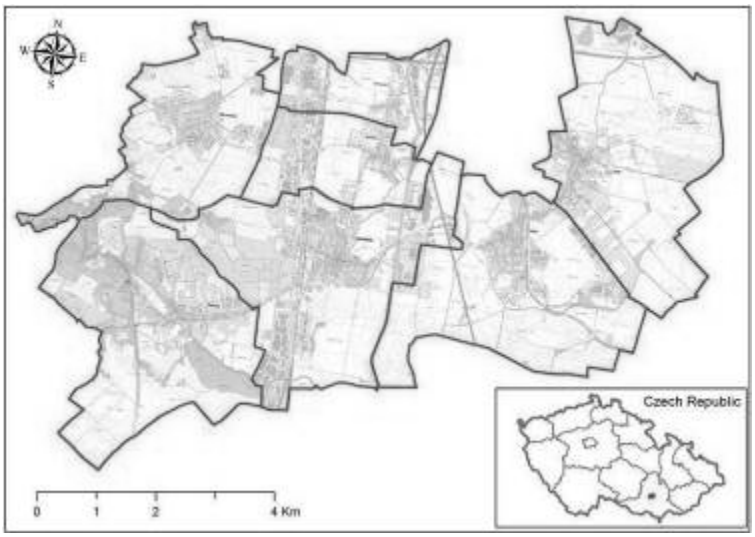

Fig. 1: Model area „Brněnsko“

Land-use change

Comparing the changes in land use, six periods were under scrutiny (1836–1852 (2nd military mapping), 1876–1878 (3nd military mapping), 1950 – historical aerial photo, 1990 – historical aerial photo, 2006 – orthofoto, 2016 – present orthophoto). Land use categories (Tab. 1) in individual time series was assessed (Fig. 2).

Tab. 1: Landscape categories

Code	Culture	Code	Culture
0	Other area	4	Vineyard
1	Arable land	5	Forest
2	Permanent grassland	6	Water area
3	Orchard	7	Built-up area

This layer contains information on land use in the attribute table for individual polygons (locations in the model area) for each time series. This layer is identified by a six-digit code. The six-digit code 111111 for instance shows that at all terms there was arable land in the location. Should there be a change in land use in the course of the 6 series in the given polygon (zone) (for instance 111121 – in 2006 the site was grassed over). These areas will be identified as areas, where there was 1 change in land use.

FID	Shape *	2mm	3mm	1950	1990	2006	2016
0	Polygon	0	1	1	1	1	1
1	Polygon	0	1	1	1	5	1
2	Polygon	0	1	1	5	5	1
3	Polygon	0	1	5	1	1	1
4	Polygon	0	1	5	1	5	1
5	Polygon	0	1	5	5	5	1
8	Polygon	1	1	1	1	1	1
9	Polygon	1	1	1	1	1	2

Fig. 2: Sample of attribute table in ArcGIS of the "Brněnsko_land_use" layer (rows represent individual areas in the landscape – polygons, columns represent time series, numbers identify the culture – type of plot)

Results and Discussion

The Brněnsko area of interest was historically used for farming mostly (arable land). This is particularly due to the terrain morphology - excellent quality soil (chernozem), warm climate, development of villages and towns. Tab. 2 and Fig. 3 clearly show that the most extensive in all categories of land use in terms of acreage in all analysed time series is arable land. Yet the area scope of individual land use categories has changed considerably over time.

Tab. 2: Land Use in the Brněnsko area of interest in time series

Brněnsko area	**2nd mm**	**3th mm**	**1950**	**1990**	**2006**	**2016**
Culture	**ha**	**ha**	**ha**	**ha**	**ha**	**ha**
Forest	562,7	221,0	232,4	303,1	308,1	389,5
Arable land	3746,8	4411,7	4494,9	3483,3	3331,0	2920,1
Orchard	24,3	17,1	161,9	493,7	496,0	327,6
Permanent grass.	707,8	396,1	15,5	29,2	37,3	163,0
Vineyard	116,7	84,7	0,0	17,0	11,9	14,4
Water area	0,0	1,3	0,0	0,0	0,9	22,7
Other area	0,0	3,8	12,0	30,4	77,6	97,4
Built-up area	112,3	135,0	353,9	913,8	1007,8	1335,9
Total	***5270,6***	***5270,6***	***5270,6***	***5270,6***	***5270,6***	***5270,6***

The result of overlay analyses of land use data layers in six time series is a new map Brněnsko_stable_areas. This map locates and quantifies areas in the landscape where over the period under study was no change in land use in the Brněnsko (study area) under scrutiny. This map is classified according to individual land use categories (Fig. 4).

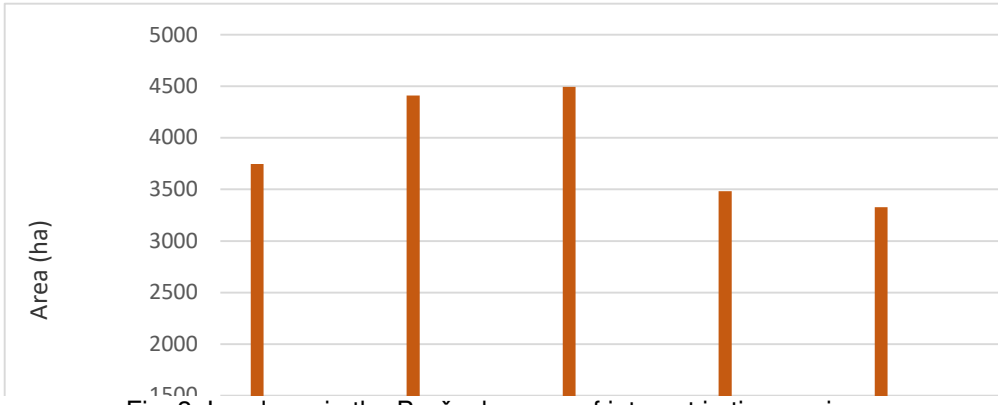

Fig. 3: Land use in the Brněnsko area of interest in time series

Tab. 3: Areas without change in land use during the first half of the 19th century to the present (2016)

Areas without any change in landuse in all time periods	ha	%
Arable land	2070,29	39,280
Permanent grass.	0,49	0,009
Orchard	0,013	0,000
Forest	92,92	1,760
Built-up area	97,65	1,850
total	2261,4	42,9

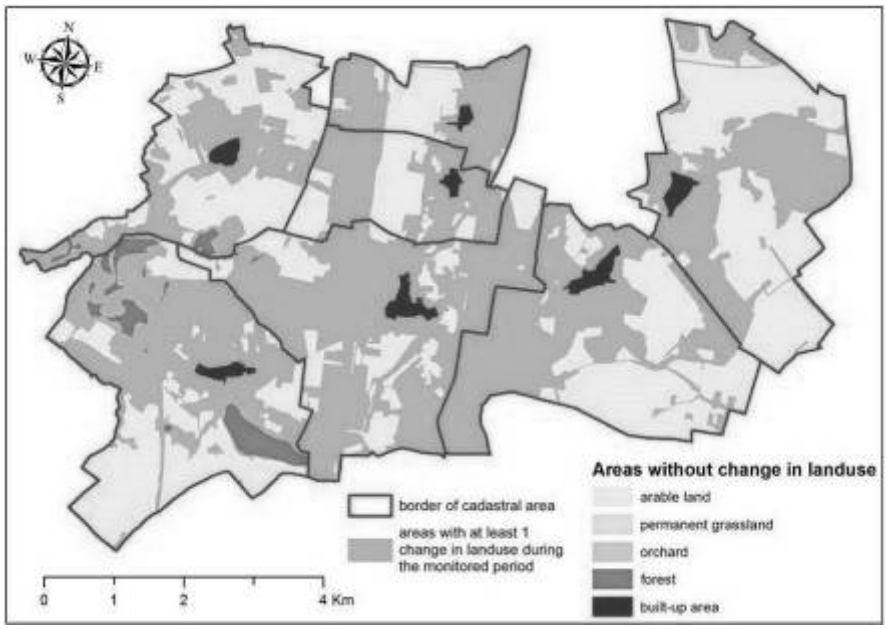

Fig. 4: Areas without any change in landuse (in all time periods) – Brněnsko area

The analysis implies that some 43 % of the Brněnsko model area has been used without change of land use (from 2nd military mapping to 2016). The most represented area without any change in land use are arable land – 39 % (historically 3747 ha, in present 2920 ha, area without chance in land use – 2070 ha). This area is used long-term (historically) mostly for farming. Forests and meadow cultures have already surrendered land to production interests in the past – mostly arable land. Historically, the forests were on an area of 563 hectares. At present, their area is only 390 ha. There are only 93 hectares (1,8 % of the Brněnsko area) of forest with no change in land is use (for the period from the first half of the 19th century to the present). A similar situation is with permanent grassland. Their area was historically 708 ha. At present only 163 ha. The location of permanent grassland without land use change is only 0,5 ha (0.009 % of Brněnsko area). The landscape character of the settlement is represented by smaller villages. Built-up areas (without change in land use) are located 1.8 % of Brněnsko area. These are particularly the original cores of towns and villages that constitute the base of their built-up areas to date.

Conclusion

Analysis of landscape structure brings precious information on the development of land and the current needs of society. The social pressure on the landscape has been accelerating in recent centuries. We can perceive a notable change in the landscape structure in Czech conditions particularly as of the 2nd half of the 20th century. This is when large-scale agricultural expanses came into existence due to the collectivisation of agriculture – by ploughing over small landscape elements and thus creating vast arable soil fields. Information on the historical development of the Brněnsko area under scrutiny (South Moravian region) were obtained from historical maps whose quality and valuable information are fundamental for such analyses. The results of the study clearly show there have been many changes to land use in the last few decades. Locations without such changes to landscape structure, occur only rarely. Finding that there was at least one change in about 60% of the area cover under scrutiny points to the fact that changes in landscape happen very often and on a large scale. From the first period of the 19th century to the present day, the area of arable land was the most preserved without changes in the use of the territory. In some 39 % of the model area, the culture of arable land has not changed over the time series at all. On the other hand, this arable land is currently concentrated into large blocks of several dozen or even hundreds of hectares. This arable land used to be formed into small fields of much smaller size in the past. Arable land is the most extensive category in all-time series. The area of permanent grassland and forest has been significantly reduced.

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Souhrn
Příspěvek prezentuje metodiku a způsob vyhodnocení lokalizace stabilních ploch (lokalit bez změny ve způsobu využívání území za období 1. poloviny 19. století do současnosti) v modelovém území Brněnsko. Podkladovými materiály k hodnocení krajinného pokryvu (land use) byly historické mapy, historické letecké snímky, ortofotomapy. V rámci analýzy byly identifikovány plochy, které za zvolené časové období zůstaly beze změny landuse – nedošlo ke kvalitativní změně druhu pozemku. V modelovém území Brněnsko je dle provedených analýz historického vývoje cca 43 % výměry území stabilní – nedošlo ke změnám landuse. Na zbývajících 57 % území došlo minimálně 1x za sledované období ke změně druhu pozemku. Nejstabilnějšími plochami je v průběhu času orná půda (cca 39.3 % území), následuje intravilán (1.9 %) a lesní porosty (1.8 % území). Ostatní kategorie landuse (TTP, sady) jsou mezi stabilními plochami zastoupeny v minimální míře.

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ANALYSIS OF THE IMPACT OF SETTLEMENT PATTERNS ON LANDSCAPE PROTECTION IN TWO DIFFERENT EUROPEAN RURAL AREAS

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Abstract
The colonization occurred at large scale during the past centuries has contributed to shape the image currently perceived from a landscape. The settlement dynamics are especially interesting, having played an important role. Several traces of extinct settlements and their access routes are usually still visible in many today's European landscapes. Aim of this study is to evaluate the impact on rural landscape of different settlement patterns and relevant accessibility routes. Two different European rural areas, located in the Czech Republic (Silesia region, "Frýdek-Místek" area) and in Italy (Basilicata region, "Vulture" National Park) were analysed and compared. GIS-supported statistics were used to investigate the main landscape components, focusing on the reasons at the basis of their formation and successive decline due to war, epidemic or economic reasons. Main results obtained have shown that these important historical legacies are increasingly disappearing in both the study areas. While the increase of modern farming activities and general oblivion in public awareness is the main reason in the Czech villages, the settlements in Basilicata region are currently endangered by environmental risks. In both cases there is a serious loss of the cultural heritage of the rural landscape, with consequent reduction of its public recreation opportunities.

Key words: extinct settlements, rural landscape, village accessibility

Introduction

The memory of a landscape is endless, and although nature itself helps with self-regulating abilities, the steps of our ancestors who have worked can be found there, witnessed by the transformation of the landscape, as we know it nowadays. The analysis of rural land modifications, as well as the wider environment and landscape context in which they take place, is important in order to understand the profound transformations connected with human intervention and natural events (Statuto et al., 2017; Picuno et al., 2017).

Changes in land use and management have indeed led to the degradation of several cultural landscapes in some European rural areas, with relevant consequences for local populations, landscape functionality and the maintenance of ecosystem services (Statuto et al., 2016). In the Czech Republic, the originally forested area was disturbed by the arrival of the first Slavic settlers dealing with agriculture. They first settled along large rivers and streams, and later moved to less suitable locations (Pokladník & Roudný, 1994). In Italy, on the other hand, natural areas have decreased during the first half of the 20th century, giving more space to the agricultural land, due to some agricultural reforms and relevant socio-economic changes, which have also led to change the agricultural activities. In this way, in some internal areas of Southern Italy, the cereal crops often replaced the pastures, with consequent modification of the landscape structure over the time. However, in

the recent years, a common opposite phenomenon widespread in the same areas occurred, mostly evident in some Italian southern regions, as the Basilicata region (Statuto & Picuno, 2017). Here, many agricultural areas were abandoned due to socio-economic and demographic reasons, with their consequent re-naturalization and susceptibility to natural hazards. This phenomenon is currently more frequent, due to the loss of the "*control action*" played by the presence of humans who, living in constant contact with the agricultural production, developed a synergetic function of close proximity to the extra-urban land. Rural buildings - spread all over rural areas for farming, storage and processing of agricultural products, and constituting, at the same time, housing for the farmer and his family - have been, and still represent, a unique way by which humans have populated, in harmony with the natural elements, the agricultural land. Joining the primary production needed for human nutrition with the control and care of rural land, has strongly influenced the agricultural environment and the visual perception of its landscape (Picuno, 2016).
Aim of the present study is the evaluation of the impact on a rural landscape of different settlement patterns and relevant accessibility routes in two different European rural areas, located in the Czech Republic and in Italy.
These two study areas have been selected to show differences, as well as similarities between the different ways chosen by our ancestors to settle the territory.

Material and methods

The study area that was analysed in the Czech Republic is the "Frýdek-Místek" area in the Silesia and Moravia regions (209 km^2). The foothills of the Beskydy Mountains, where the city of Frýdek-Místek is located, in the medieval village with less intensity, were formed. Apparently the rivers Ostravice and Olše represented a border area separating two major settlement centres, namely the Moravian valleys inclining to the Danube and the Silesian-Malopolsk region (Adamec, 2014).
The italian study area is the "Vulture Regional Park", located in Basilicata Region (195 km^2). Here, the situation appears quite different. In the area close to the city of "Rionero in Vulture", the original settlement is spread over two hills around 656 meters above sea level, and the territory characteristics are the direct consequence of the past volcanic activity of Mt. Vulture (Principe & Giannandrea, 2006). Its landscape was positively influenced by the activity of the extinct volcano, both from an agricultural and environmental point of view. Indeed the fertile soils deriving from the volcanic activity and land morphology allowed the development of a rich variety of valuable crops (in particular olive groves and vineyards) and several types of natural areas which have been protected by the European Commission. This area is also conditioned by the massive and constant management of the territory as, for example, with the chestnut cultivation. In this case, the control of the land by man is almost total, while it is possible to admire a nearly total naturalness on the summit area, dominated by forests of Turkey oak and beech woods, having a strong tourist appeal. During the last seven centuries, the *Rionero in Vulture* rural landscape has been modified by at least seven earthquakes (Gizzi & Masini, 2006).
The comparative analysis has been performed by implementing some GIS-supported programs (*i.e.*: ArcMAP; QGIS), while the "STATISTICA-12" software was used for a *Principal Component Analysis* (PCA). The slope analysis and the reclassification into 4 categories: 0°-20°, 20°-40°, 40°-60°, 60°-81(201)° was used within a GIS to explain the typical distribution of the road network in both regions. On the other hand, the implementation of the PCA method (Daffertshofer et al., 2004) was performed, considering the following parameters: area, altitude, population, density and origin. As a case, all cities were used both on the Italian territory (self-

reliant PCA for the municipalities of: Rapolla, Barile, Rionero in Vulture and Atella) and Czech (self-reliant PCA, in which the municipalities of: Frýdek - Místek, Baška, Pržno, Metylovice, Frýdlant nad Ostravicí, Pstruží, Čeladná, Kunčice nad Ondřejníkem, Frenštát pod Radhoštěm and Trojanovice were considered).

Results

The route nets which were present in the 19th century are still evident in both areas. The first result coming from this comparative analysis is that, from a long-term point of view, the road net system in both cases has not disappeared, acting on the contrary as a base on which the road net system has increased according to the development (Fig. 1).

Moreover, the classification of the study areas into four parts according to the slope (Fig.2) enabled the evaluation on how accessing the landscape goes hand in hand with the altitude and natural conditions, the highest parts of mountains being forested.

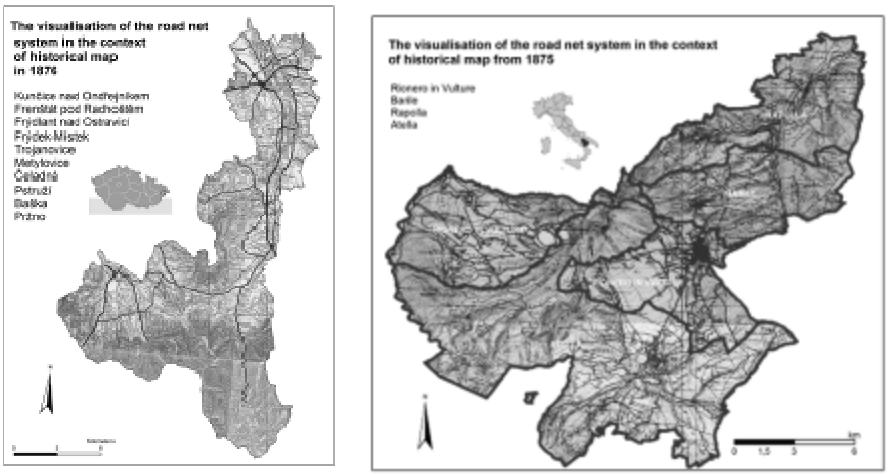

Fig. 1: road net system in 1876 in the Frýdek-Místek area (left) and in 1875 in the Vulture area (right)

During the processing of the PCA method, according to the analysis of the correlation matrix of own numbers and scree plot, the results showed that the first and second major components explain a total of 87.6% (I.: 54.22% and II.:33.38%) of the original scattering of the variables from the survey in the Czech Republic and 76.3% (I.:41.29% and II.:35.04%) of the original variance of the survey variables in Italy. In both countries there is a correlation with origin, the cities in Italy being connected with their year of foundation. The trend is that the larger villages are those who have developed more recently. On the other hand, in the Czech Republic, the origin has no effect on size, but the older villages are, the lower they are distributed (Daffertshofer et al., 2004). Italian cities that were founded later are now larger in size, whereas in the Czech Republic there is no correlation with the current population in 2017 (Fig. 3).

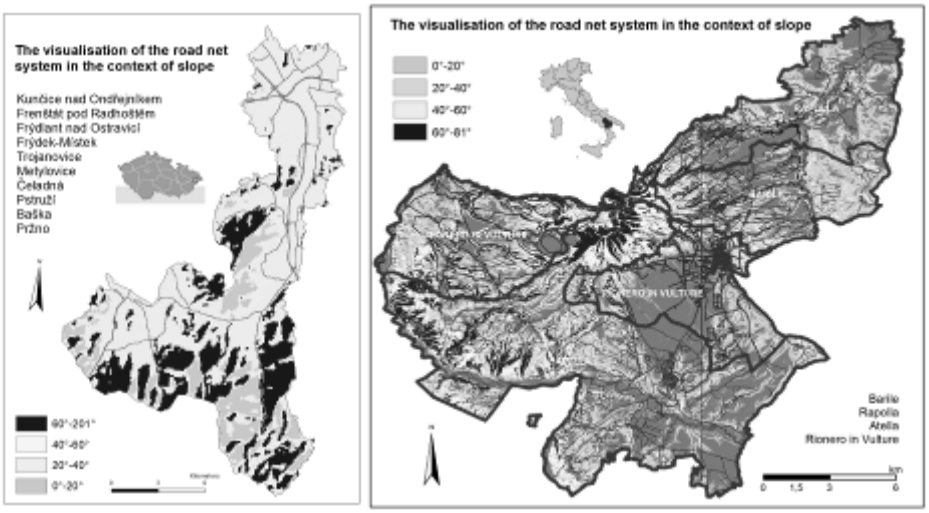

Fig. 2: Current road net system correlated to slope in the Frýdek-Místek area (left) and in the Vulture area (right)

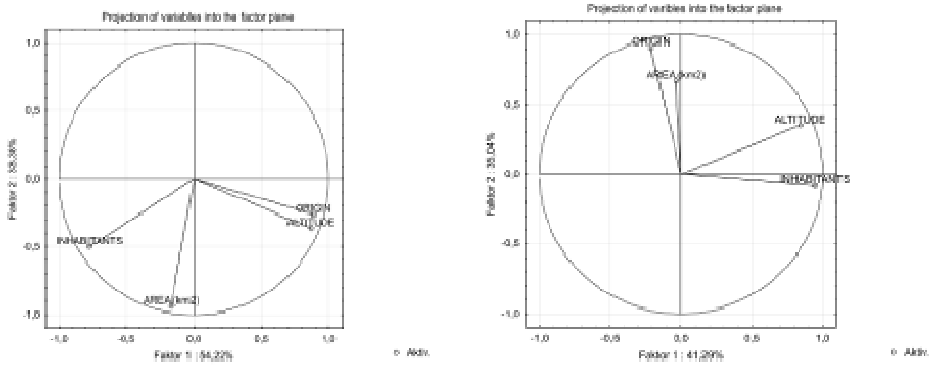

Fig. 3: Analysis for the Frýdek-Místek (left) and for the Vulture area (right)

Discussion

There are some connections between the two analyzed areas, such as the origin of the cities, which were mostly built during the colonization in the 11th until the 18th century. Similarities may be also found in connection to war conflicts which were destroying the natural assets. Concerning environmental risks, in Basilicata the most serious problems are earthquakes, which can be destructive for huge areas. The Czech area is stricken mainly by floods, fire and dry, which may be a serious problem in the future. The distribution of road network for many centuries did not change significantly. This happened – other than economic reasons - since the first layout of land was based on cultural identity heritage, the owners having not allowed to change the traditional arrangement of their forefathers land. Historical development by accessing the landscape was dealt with by Hrůza (2013), who also applied historical practices to the current conditions. According to his research, the road once built seems to be a permanent construction in the landscape and the forest ecosystem (Hrůza, 2014).

Conclusions

In spite of a different geographical position of the two considered countries, the process of colonization was similar. In the past, the soil with the settlement close to the Vulture volcano provided also high yields of wine and olives. The tendency in the Czech Republic was to seek out the most fertile areas with a great production of crops and pasture, according to the region of Beskydy. The role of the economy and long-term disposition was remarkable, so the distribution of road nets did not change for centuries in both countries. Some differences in creation settlements pattern were anyway shown by the PCA analysis that was performed. The connection between distribution of older Czech villages and their placements was found out, while younger Italian villages showed a tendency to have bigger areas of settlement.

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Shrnutí

Šetřené lokality měly, i přes velmi odlišnou geografickou lokalizaci, obdobný proces kolonizace. V dohledatelné historii bylo osídlení v blízkosti sopky Vulture motivováno především možností dosažení velkých výnosů pěstovaných oliv a vinné révy. Ve sledovaných lokalitách České republiky byla přítomnost optimálních podmínek pro pastvu hlavním parametrem výběru oblasti pro osídlení. Ekonomické hledisko a dlouhodobá dispozice krajiny nepředstavovaly zásadní důvod pro změnu rozložení sítě cest, a to ani ve sledovaném měřítku staletí. Byly však stanoveny také odlišnosti v charakteru osídlení. Např. metodou PCA byl zjištěn vztah mezi rozšířením dříve založených českých vesnic a jejich umístěním z hlediska nadmořské výšky. Naproti tomu, pokud tyto vesnice vznikaly v pozdějších dobách, tato metoda poukázala na tendenci zakládat italské vesnice o větší rozloze.

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ANALYSIS OF THE RECREATIONAL USE OF LAND IN THE SELECTED LOCALITY OF TRAINING FOREST ENTERPRISE MASARYK FOREST IN KŘTINY

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Abstract
Monitoring of visitor arrivals is one of the tools which help to ensure quality and suitable management of the respective area. The article aims to analyse the number of visitors arriving at the selected area of the Training Forest Enterprise Masaryk Forest in Křtiny. The research project involved monitoring of visitor arrivals at Ressl forest road in the stretch between Kopaniny and Josef Ressl Gamekeeper's Lodge. The monitoring was carried out by a specialized company, which placed a pyroelectric sensor (automatic counter) to the selected locality. The automatic counter was located on a forest road leading from the Kopaniny crossroads past Josef Ressl Gamekeeper's Lodge to Bílovice nad Svitavou. The respective device counts all the road users (pedestrians, cyclists, in-line skaters, etc.) regardless of their type. Counting is done on the principle of detecting the differences between human body temperature and ambient temperature. Two directions of the visitor flow were recorded–IN and OUT. During the entire period of monitoring, 68,410 passages were detected in both the IN and OUT directions in the locality of Ressl forest road. The results of this research project will be used by the Training Forest Enterprise Masaryk Forest in Křtiny to monitor the recreational potential of the individual forest districts, including the influence of the City of Brno on recreation in the interest area.

Key words: automatic counter, forest roads, forest enterprise, management, recreational function.

Introduction

In the long-term view, supporting recreational activities plays a significant role in the policy of regional development which is based on a contemporary developmental theories and tourism theories in the years after the World War II. (Telfer 2002).
The recreational use of the territory is very often bound to the term of tourism.
Tourism, as well as any other human activity, affects both community and locality where it is actively performed. Although the term impact is often negatively perceived, it is not always detrimental. In fact, tourism can have positive impacts on the respective locality and, in some cases, even a positive effect on the natural environment. (Lück, 2008)
Despite the fact that opinions on impacts of tourism are still rather controversial, it is clear that tourism is the main economic force in the world (Weaver, 2001).
A complex monitoring of tourism generally aims to provide basic information about the number of visitors and about the time variability of their visits (within a day, a week, a month of year, and a season) and the spatial distribution of the visitors within the target area (Zahradník et al. 2012). Data about the structure of visitor opinions are also the standard part of the output. Recently, visitor monitoring has

been one of the main activities related to tourism conducted by administrations of large protected areas (Bláha 2010; Kala, Salov 2010; Kos 2010).
With the present-day growing standard of technologies, it is possible to use devices specialized in counting various target objects. As a result, almost anything moving can be monitored in field: pedestrians, cyclists, cross-country skiers, motorists, paddlers, etc. Providing the devices are combined suitably, it is possible to distinguish individual types of tourists to the locality reliably and to determine their ratio. A complex visitor monitoring combines uninterrupted counting of visitors by automated field devices (various types according to the requirements on the subjects to be counted) with a regular physical survey and a questionnaire survey (see e.g. Fialová et al. 2014).
Automated field counting using counting devices allows for gaining basic information about the number of tourists. A more advanced (and more expensive) configuration also provides information about types of counted subjects (e.g. distinguishing pedestrians from cyclists) and about the direction of their movement. Nowadays, several basic technologies are used for this purpose. (Zahradník et al. 2012)
The article aims to analyse the number of visitors arriving at the selected locality of the Training Forest Enterprise Masaryk Forest in Křtiny. The project task was to monitor visitor arrivals at Ressl Forest Road between Kopaniny and Ressl Gamekeeper's Lodge.

Material and methods

The Training Forest Enterprise Masaryk Forest in Křtiny (hereinafter referred to as the "TFE MF Křtiny") is an organizational part of Mendel University in Brno and a purpose-made facility of the Faculty of Forestry and Wood Technology. The enterprise was founded in 1923. Its total acreage accounts for 10,495 ha (the acreage of the forest land is 10,265 ha). The enterprise is divided into three forest stands: Vranov nad Dyjí (3,345 ha of forest), Habrůvka (4,006 ha of forest), and Bílovice nad Svitavou (2,920 ha of forest). (TFE 2018)
All aspects considered, the locality on Ressl Forest Road (forest stand of Bílovice nad Svitavou) was selected for the monitoring. The selection of the specific place was based on the characteristics of the used technology and the rules for the measured data relevance. First of all, the places with multiple passages by the same persons were excluded. Periods and characteristics of the visitor arrival monitoring are shown in Tables 1, 2.

Tab. 1: Period of the monitoring on the selected forest roads in the TFE MF Křtiny in 2017

Monitoring characteristics	Period of monitoring	Assessed period	Number of whole days	Number of working days	Number of non-working days
Ressl Forest Road	6 July 2017 – 28 December 2017	1 January – 26 June 2017	330	227	103

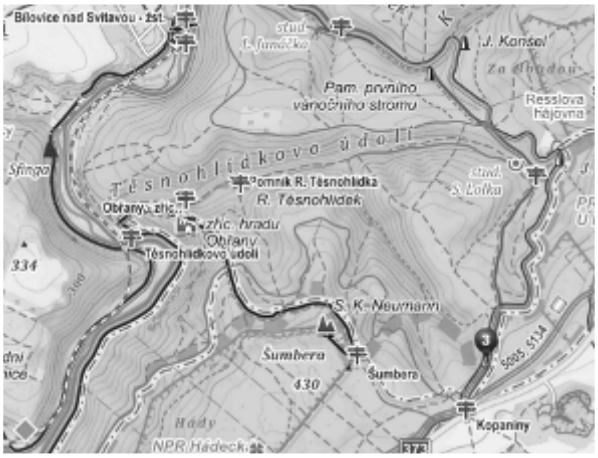

Fig. 1: The locality of Ressl Forest Road

Tab. 2: Characteristics of the visitor arrivals monitoring in the locality of Ressl Forest Road in 2017

Monitoring characteristics	Marking	Surface	Width	Direction distinguishing
Ressl Forest Road (between Kopaniny and Ressl Gamekeeper's Lodge)	Ressl Forest Road	Bitumen	4 m	Yes

The automated counters Pyro Box Compact by Eco-counter and Trail Counter by TRAFx were used to monitor the forest road users. These devices are intended for counting all path users (pedestrians, bikers, in-line skaters, etc.) without distinguishing the type of user. The counting works on the principle of measuring differences in temperature of a human body and the ambient temperature. With double-sensor counters, it is possible to determine the direction of movement. Being equipped with batteries, the counters are not dependent on external power supplies. Data are saved in a memory in hour-long intervals. Thanks to a flexible mounting system, the counters can be installed on any column or tree trunk.
A Microsoft Office programme was used to evaluate the results.

Results

This section presents the results of the monitoring of the visitor arrivals at the locality of Ressl Forest Road. The overall results are provided in Tab. 3, selected indicators are in Tab. 4.

Tab. 3: Overall results of the visitor arrivals at the locality of Ressl Forest Road in 2017

Locality	Assessed period	Overall visitor arrivals - uncalibrated	Calibration coefficient	Overall visitor arrivals - calibrated
Ressl Forest Road	1 January – 26 June 2017	68,410	1.20	80,639

During the assessed period, 68,410 passages were recorded in total in the locality of Ressl Forest Road. The hourly data were adjusted using the calibration coefficient of 1.20, which resulted in obtaining the estimated number of visitor arrivals of 80,639.

Tab. 4: Selected indicators of the monitoring of the visitor arrivals at the locality of Ressl Forest Road in the period between 1 January and 26 June 2017 (both calibrated and uncalibrated data)

Selected indicators	Ressl Forest Road	Ressl Forest Road IN (direction to Bílovice)	Ressl Forest Road OUT (direction to Brno)
Uncalibrated data			
Records in total	68,410	39,023	29,387
Records – working days	35,853	21,494	14,359
Records – non-working days	32,557	17,529	15,028
Daily maximum	Sat 29 Apr 2017 (1,088)	Sat 29 Apr 2017 (482)	Sat 29 Apr 2017 (606)
The most frequent day	Sunday	Sunday	Saturday
Hourly average	9	5	4
Daily average	207	118	89
Daily average – working days	158	95	63
Daily average – non-working days	316	177	146
Monthly average	6,310	3,599	2,711
Calibrated data			
Records in total	80,639	44,650	35,989
Records – working days	41,960	24,528	17,432
Records – non-working days	38,679	20,122	18,557
Daily maximum	Sat 29 Apr 2017 (1,305)	Sat 29 Apr 2017 (554)	Sat 29 Apr 2017 (751)
The most frequent day	Sunday	Sunday	Saturday
Hourly average	10	6	5
Daily average	244	135	109
Daily average – working days	185	108	77
Daily average – non-working days	376	195	180
Monthly average	7,438	4,118	3,319

Overall, 68,410 passages in both the directions IN and OUT were recorded during the whole period of monitoring in the Ressl Forest Road locality. The monthly average of records was 6,310, the daily average 207 (all days counted in), and the hourly average number of records was 9. The daily maximum of 1,088 passages of Saturday 29 April is linked to the weekend prolonged by the 1 May bank holiday. The day of the week with the most frequent passages was Sunday. The daily average of passages on non-working days accounts for 1.5 multiple of all days' average and for twice the average of working days. Compared with the direction to Brno, the number of path users moving in the direction to Bílovice is higher by more than 25%.

Recalculating the data with the calibration coefficients (IN=1.15; OUT=1.24), the overall estimated visitor arrivals exceed 80.6 thousand, of which almost 42 thousand of visitors arrive on working days and 38.6 thousand of visitors arrive on non-working days. The estimated monthly average reaches almost 7.5 thousand visitors; the daily average accounts for approximately 244 visitors.

Discussion

Determining the best procedures, methods, and techniques of visitor arrival monitoring is crucial for evaluation of the impact of tourism on natural areas of high conservation value (Wolf et al. 2012). These techniques can be employed in the monitoring of visitor arrivals at forests in the Czech Republic, mostly at peri-urban forests (see Janowsky, von Berker 2003).

Conclusion

This paper focused on visitor arrival monitoring using an automatic field counting device, specifically a pyroelectric sensor (a pyro sensor).

The objective of the article was to analyse the number of visitors arriving at the selected area of the Training Forest Enterprise Masaryk Forest in Křtiny. The project task was to monitor visitor arrivals at Ressl Forest Road between Kopaniny and Ressl Gamekeeper's Lodge.

Overall, 68,410 passages in both the directions IN and OUT were recorded during the whole period of monitoring in the Ressl Forest Road locality. The monthly average of records was 6,310, the daily average was 207 (all days counted in), and the hourly average number of records was 9. The daily maximum of 1,088 passages of Saturday 29 April is linked to the weekend prolonged by the bank holiday of 1 May. The day of the week with the most frequent passages was Sunday. The daily average of passages on non-working days accounts for 1.5 multiple of all days' average and for twice the average of working days. Compared with the direction to Brno, the number of path users moving in the direction to Bílovice is higher by more than 25%.

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Souhrn
Cílem výzkumného úkolu bylo zjištění počtu návštěvníků na vybraném území ŠLP ML Křtiny. Řešení úkolu spočívalo v monitoringu návštěvnosti lesní cesty Resslova v úseku Kopaniny – Resslova hájenka v období od 1. 1. 2017 do 26. 11. 2017.
Měření návštěvnosti bylo realizováno specializovanou firmou, která na vybranou lokalitu umístila pyroelektrický senzor (automatický sčítač). Automatický sčítač byl umístěn na lesní cestě vedoucí od rozcestí Kopaniny přes Resslovu hájovnu do Bílovic nad Svitavou. Povrch této 4m široké cesty je mlatový a cesta je využívána cyklisty, pěšími a v omezené míře i automobily pro práci v lese. U všech uživatelů stezky byl zaznamenáván směr pohybu. Po cestě je vedena cyklotrasa č. 5005, tzv. Brněnské kolečko, zelená turistická značka a naučná stezka Hády a údolím Říčky.
V lokalitě Resslova bylo v celém sledovaném období zaznamenáno 68 410 průchodů ve směru IN a OUT. Měsíční průměr záznamů činil 6 310, denní průměr při započítání všech dnů 207 a průměrný hodinový počet záznamů 9. Denní maximum v sobotu 29. dubna s počtem 1088 průchodů souvisí s víkendem prodlouženým o státní svátek 1.5. Nejfrekventovanějším dnem týdne byla neděle. Denní průměr průchodů v nepracovní dny činí 1,5násobek průměru za všechny dny a 2násobek průměru za dny pracovní. Počet uživatelů stezky ve směru do Bílovic je o více než 25% vyšší oproti směru do Brna.
Při přepočtu dat kalibračními koeficienty (IN=1,15; OUT=1,24) činí celková odhadovaná návštěvnost přes 80,6 tis., z toho téměř 42 tis. v pracovní dny a 38,6 tis. ve dny nepracovní. Odhadovaný měsíční průměr dosahuje téměř 7,5 tis. návštěvníků a denní dosahuje přibližně 244 návštěvníků.

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ANALYSIS THE PROTECTION OF COMMON JUNIPER (*JUNIPERUS COMMUNIS L.*) IN THE DEVÍNSKA KOBYLA PROTECTED AREA

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Abstract
The contribution provides an assessment the level of common juniper (Juniperus communis L.) protection in the conditions of the Devínska Kobyla protected area. In the first part the protection of the common juniper was evaluated with regard to national legislation and then the evaluation was focused on the allocation of management categories of protected areas based on international standards - International Union for Conservation of Nature and Natural Resources (IUCN), on which its practical protection is based. In Annex No. 4, i.e. "List of species of European interest and species of national importance", of Decree no. 24/2003 Coll., which implements Act No. 543/2002 Coll. on nature and landscape protection, no common juniper was found. Stands of common juniper were found in the "List of habitats of European significance", but within the IUCN management categories, the mountain Small Carpathians was classified as "V" category with a lower protection where the conservation of species and habitats is not specified. On the basis of the analysis, it can be stated that, in the context of practical management, common juniper may not be currently under the protection within Devínska Kobyla protected area.

Key words: common juniper, Devínska Kobyla, management categories, protected areas,

Introduction

Protected areas in Slovakia currently face a whole range of organisational and legislative problems. The targeted and effective protection of flora, fauna and landscape structures in the conditions of Slovakia is primarily a matter of national legislation, covering territorial protection in five levels as well as species protection. The crucial aspect of the protection of biota and fauna is the management of the particular territory.

The system of protected areas management with special and rare values of flora and fauna is based on the Act no. 543/2002 Coll. on nature and landscape protection, as amended, which also sets out the conditions of selected areas protection. The subsequent national document is Decree of the Ministry of Environment no. 24/2003 Coll., through which Act no. 543/2002 Coll. is implemented in practice. Mentioned legislative documents constitute the basic national framework for the protection of the most threatened species and habitats, and increasingly are being used in the context of ecosystem services. Protected areas may have a varied form, from strictly protected areas to the different types of traditionally used landscape that has been shaped by man to date, and which at the same time ensure a high level of biodiversity. The way of management results from the purpose of declaring the site as a protected area and from the objectives which given site performs within the set of protected areas and the resulting management objectives. From the view of practical management, it is a certain protection regime that should ensure the sustainable use of the protected area.

At the national level the current management approaches do not correspond with categories of protected areas designated at international level by the International Union for the Conservation of Nature and Natural Resources (IUCN), which leads to the need to reassessment the protection not only protected areas, but also individual species and habitats.

Materials and methods

The aim of this paper is to assess the level of common juniper in terms of Devinska Kobyla protected area. In the first step, protection of common juniper in national legislation is evaluated and subsequently the assessment is focused on the allocation of management categories of the protected area on the basis of international standards - IUCN (Kadlečík, 2014), from which their practical protection unfolds.

Characteristics of the national nature reservation (NNR) Devínska Kobyla

The area of European importance Devínska Kobyla is part of the Small Carpathians protected landscape area and simultaneously it belongs to the NATURA 2000 protected areas. Devínska Kobyla National Reservation was proclaimed in 1964 (Table 1) to protect the southernmost headland of the Small Carpathians. The geological base is very rich, with the most significant massif being made of carbonate rocks (www.sopsr.sk).

Tab. 1: Identification of the National Nature Reservation Devínska Kobyla

National Nature Reservation Devínska Kobyla	
Year of the proclamation:	1964 – Protected site Sanberg (25.60 ha)
	1965 – State Nature Reservation Devínska Kobyla (27.97 ha)
	1986 – State Nature Reservation Devínska Kobyla (102.00 ha)
	1995 – National Nature Reservation Devínska Kobyla (102.00 ha)
Definition:	Deforestated southern to western slopes of the Devínska Kobyla massif between Devín and Devínska Nová Ves.
	The maximum length of the protected area is 2 880 m, the maximum width of the area is 825 m (in Merice part).
	Altitude 138 – 311 m.
The reason for protection:	From the nature science perspective i tis significant territory with abundant thermophilic flora and fauna in the southernmost limestone headland of Small Carpathians.
	The world-known geological and paleontological site Sandberg with the occurrence of rare sand-like species.
	One of the most known sites of the orchid plant species occurrence in Slovakia.
Protection conditions:	The highest level of nature and landscape protection no. 543/2002 Coll. on nature and landscape protection.
	On the territory of nature reservation it is prohibited to move outside the marked paths, to base fire, smoke, camp, disturb the peace and quiet, collect plants, animals, minerals and fossils.

The actual state of non-woody vegetation in Devínska Kobyle was affected by many historical events, which have stimulated also the emergence of new vegetation structures. The original vegetation consisted of oak-hornbeam forests on limestone subsoil, xeroterm oak stands with downy oak (Quercus pubescens Willd.), and floristic rich grassland and rock communities, which have been partially preserved, and after cutting down forests they have expanded despite further anthropic interventions. In the area with a longterm tradition of agriculture and pastoralism, the current form of meadows and pastures at the boundary of the forest was changed

over centuries. At the foot of the slopes, the change of cultures in the past constituted the planting of vineyards, orchards and management of permanent grasslands, which were maintained by mowing, burning and, above all, grazing of sheep, goats and cattle (Hegedùšová, et al., 2010).
This form of meadows and pastures management created ideal conditions for spontaneous spreading of common juniper and has contributed to the creation of valuable habitats of European importance. In the middle of the last century, however, the grazing has slowly ceased, and today we can say that the meadows, pastures and rocky biotopes of Devínska Kobyla account for about 6% of the area where the common juniper still occures (Figure 1). The absence of traditional management of the deforested slopes of Devínska Kobyla in the 1990s was manifested by successive changes. The status of the protected species and their communities has deteriorated considerably which led to a reassessment of the methods of the given territoty protection in the form of targeted managed with aim to change of vegetation (Senko et al., 2008).

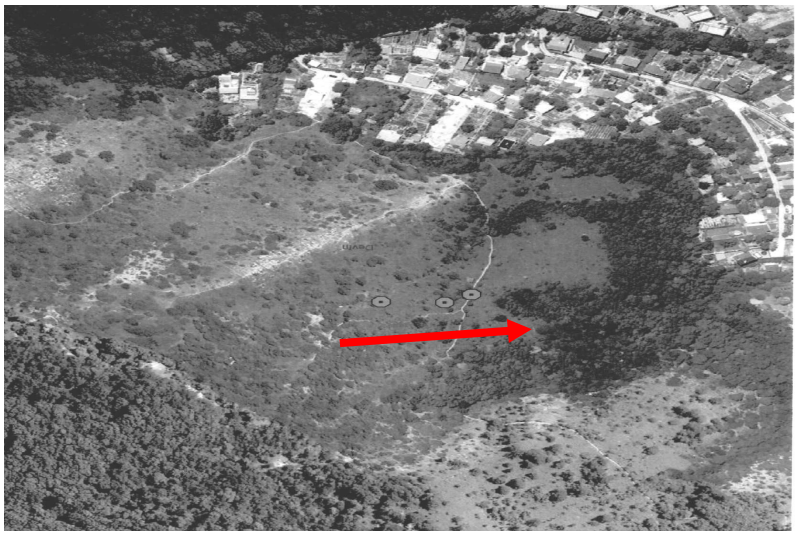

Fig. 1: The location of the occurrence of common juniper on Devínska Kobyla (2016)

Common juniper is bound to stable habitat conditions and does not belong to adaptable species which are able adapt to disturbed conditions. At the same time, it can be classified as a easily vulnerable species with low reproductive capacity because only females produce fruits. In the case of a change of the original habitat due to succession and the emergence of new competitors (wood invasive species) there can occure its significant suppression and consequently a loss or extinction. Its natural habitats at Devínska Kobyla are mainly steep slopes with a slope above 20° with little weakly ragged short valleys. It is located at the foot of the slopes of former vineyards, orchards and pastures around 350 m above sea level, mainly southern and south-west exposed, where at present thermophilous and lime-like plants occure (Pekárová et. al., 2016, 2017).
Since 2013, after more than 50 years, goat grazing and large-scale woodcutting have begun to dominate. Within the practical care of specially protected parts of this site State Nature Protection (state institution) performs regulatory interventions, especially excavation of seeding trees, mowing, removal of biomass, fencing and

removal of invasive species. According to the information on the planned intervention in the this protected area, available at the DAPHNE-IAE websites, the subject of excavation in 2015 were mainly non-native species such as black locust (Robinia pseudoacacia L.), manna ash (Fraxinus ornus L.), black pine (Pinus nigra), and too much shading trees. On the contrary, the original non-aggressive species, such as downy oak (Quercus pubescens Willd.), cherry mahalebka (Prunus mahaleb L., syn. Cerasus mahaleb L.), and cornelian cherry (Cornus mas L.), should be kept.

Common juniper has thus become a victim of the current "controlled management" and during the years 2016 and 2017 by intensive grazing was almost destroyed (surrounding of Wait quarry, 48° 11,532' of north latitude, 16° 58,984' of east longitude). We do not have any information whether prior to goats grazing has been carried out an inventory research to conserve the common juniper with regard to valid legislation. The focusing of the current management on the removal of non-forest habitats led to the destruction of young stands and other non-invasive trees. The disruption of the soil cover has also been observed, which can lead to surface erosion and total destruction not only of vulnerable xeroterm habitats, but also of other soil cover vegetation (Fig.2a,2b).

Fig. 2a: Common juniper in the Devínska Kobyla protected area before grazing by goats in 2015

Fig. 2b: Devastated common juniper and erosion-threatened soil after the grazing the large number of goats in the Devínska Kobyla protected area in 2017

Results and discussion

Assessment of common juniper protection at national level

Act of the National Council of the Slovak Republic no. 543/2002 Coll. on nature and landscape protection is characterized by the extension of the nature conservation content, which, in view of global environmental problems, is understood as part of landscape care. This act regulates the competence of state administration bodies and municipalities, as well as the rights and obligations of legal entities and individuals at nature and landscape conservation in order to contribute to preserve the diversity of flora and fauna. This legal document creates the basic prerequisites for the sustainable maintenance, restoration and rational use of natural resources, preservation of the natural heritage and the typical landscape appearance, as well as the conditions for the achievement and mantenance of ecological stability. Part of mentioned legal document are also categories of protected areas, including the introduction of new concepts such as habitat protection or favorable status of species and habitats.

Pursuant to Act no. 543/2002 Coll., Devínska Kobyla protected area belongs to the sites of European importance for the protection of habitats and species within the NATURA 2000 network in the Small Carpathians (Annex 1, List of territories of European importance, site code SKUEV0280) with an area of 649.26 ha.
Common juniper is not included in the List of species of European and national importance published in Annex no. 4 of the Decree of Ministry of Environment no. 24/2003 Coll. which implements Act no. 543/2002 Coll. In that list only savin juniper (Juniperus sabina L.) is registered. In this context, it should be noted that the common juniper is not yet included in the "Forest species list" (Annex No. 1 to Act no. 138/2010 Coll. on forest reproductive material), nor in Government Regulation no. 221/2016 Coll., laying down the requirements for the marketing of fruit plant propagating material and fruit plants intended for fruit production (Annex 4, List of genera and species of this Regulation).
Common juniper populations (code Kr2) are found in the "List of habitats of European importance", but within the IUCN management categories, the Small Carpathians are included in the "V" category with less protection level, where the conservation of species and habitats is not specified. For practical management it means that the common juniper does not have to be the subject of protection in Devínska Kobyla. The preparation of the goat grazing project had a positively set target corresponding to the "V" category, but the insufficient legislative protection of common juniper is the consequence of its devastation and, at the same time, the decline of this important species.

Assessment under international protection
In relation to the allocation of management categories of protected areas under the IUCN (Kadlečík ed. 2014) and its respective methodology (Dudley ed., 2008), the selection of individual categories is based on the primary objective of the protected area management. In the Small Carpathians, the primary management objective within the framework of the above methodology is applied at least 75% of the protected area, including specific zones. The IUCN methodology admits that 25% of the area of the protected area can be managed for other purposes if they are compatible with the primary objective of the protected area.
When applying international categories, the priority step is to verify whether the protected site meets the definition of the protected area, and only afterwards the most suitable category is chosen. Because the concept of protected area is not defined in Act no. 543/2002 Coll., it can lead to free interpretation and problems at implementation of this act. The problem of the basic definition and purpose of the protected area can thus be reflected in inappropriate nature conservation approaches not only within decision-making bodies but also in stakeholders which perform the conservation management.

According to the IUCN definition (Dudley ed., 2008), the protected area is "a clearly defined geographical area that is accepted, specialized and care for that is ensured (by legal or other effective means) so that nature conservation, together with associated ecosystem services and cultural values, is guaranteed in the long term." The definition of a protected area is to be understood in the context of other relevant principles:
- The IUCN accepts as the protected areas only those in which the main objective is the nature protection; these may also include other territories with other objectives at the same level of importance, but in the case of conflict of interest, nature conservation must be a priority.

- In the protected areas it is necessary to exclude any ways of exploitation or management that would be detrimental to the objectives which led to proclamation of these areas.
- The choice of category of protected area should be based on the primary objective; however, sometimes these objectives are not defined for particular site and so they must be derived from other regulations (nature and landscape conservation act and other legislative documents).
- Category of protected area should be changed if assessment shows that stated long-term goals do not meet the objectives assigned to that category.
- Usually, the aim of protected areas is to maintain or ideally, increase the degree of "naturalness" of ecosystems which are protected in given area.

Small Carpathians, on the base on the IUCN management categories were, as a large - scale protected area, classified as ***"V - protected landscape".***

The main specification of this category is to preserve the traditional system of resource management for the maintenance of cultural significance, the values of which should be associated with "great natural values".The "V" category also characterizes the flora and fauna territory reflecting the unique or traditional use of local customs and livelihoods.
Because the Devínska Kobyla is part of the Small Carpathians protected area, the introduction of traditional grazing of goats is not contrary to the legislative protection of this category within international standards.
In the case of greater interest in the protection of a specific site, it is possible to include Devínska Kobyla in the management category "***IV - habitat / species care area"***, which is characterized by securing and maintaining the habitat conditions which are necessary for the conservation and restoration of important species and biotic communities. However, the inclusion of Devínska Kobyla in that category would mean stricter or more consistent protection of this territory, including common juniper.
With regard to the IUCN management criteria, the key condition for declaring protected areas is that in the declared territory there are mainly ecosystems that have been **very few or have not been altered** by human or settlement use.
When assessing the level of protection in Devínska Kobyla there is a question whether this protected area is also a protected one according to an international definition, because the management in connection with the authorization of activities and projects is not in harmony with the priorities of conservation.

Conclusions
The results of the assessment focused to the level of common juniper protection in the Devínska Kobyla protected area point to the need for changes of approaches to protection and management of protected areas in Slovakia following the international IUCN standards resulting from the International Convention for the Protection of Biodiversity by 2020 and the Action Plan for the implementation of the measures resulting from National Biodiversity Conservation Strategy by 2020, approved by the Government of the Slovak Republic. Improving the protection system requires first of all a changes in legislation on nature and landscape protection, in which the implementation of international standards under the IUCN should be a key change.
At proclamation or revision of Devínska Kobyla protected area it is necessary to set not only primary but also secondary objectives of protection. Assignment to IUCN

management categories of protected areas should be reflected in further territorial care through such activities and projects whose management direction will meet the protection for a given category of protected area, with the protection of the common juniper being clearly declared.

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Souhrn

Článek se zabývá posouzením úrovně ochrany jalovce obecního (Juniper communis L.) v podmínkach chráněného území Devínska Kobyla. Vzhledem k tomu, že na Slovensku jsou pro tuto významnou dřevinu vhodné půdně-klimatické podmínky, její výskyt v přirozených podmínkach výrazně klesá. Přimárním důvodem je jej nejednoznační legislativní zařazení, kterého důsledkem je zánik lokalit s hromadním výskytem jalovca obecního.

Prezentovaná analýza ochrany dané dřeviny a přístup k samotnímu posouzení chráněného území jsou důležitým podnětem k přijetí vhodnějších legislativních opatření ke zlepšení současné situace. Z výsledků analýzy vybraného chráněného území Devínské Kobyly lze obecně konstatovat potřebu změny přístupu k ochraně a manažmentu chráněných území na Slovensku. Návrhy řešení spočívají predevším

v nadvázaní na medzinárodné standardy hodnocení a kategorizace chráněných území podle IUCN, které je potřebné zavést do metodických předpisů národní legislativy ochrany přírody a krajiny. V rámci praktického manažmentu příspěvek poukazuje na skutečnost, že jalovec obecní, kterí byl za poslední dva roky hromadním pasením velikého počtu koz na vybranom území téměř zlikvidován, je odrazem nedostatečné národní legislativy.

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ANTHROPOGENICALLY CREATED HISTORICAL GEOLOGICAL SURFACE LOCATIONS (GEOSITES) AND THEIR PROTECTION

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Abstract
Since the beginning of the settlement of present-day territory of Slovakia, man has acquired inorganic material from the terrain, especially stone, which led to the emergence of the first anthropogenic outcrops in the Early Stone Age. The establishment of the first larger quarries – historical surface geological localities – can be noted in Slovakia apart from the second half of the 13th century. Since this period, sites of this type have been created in connection with the construction of the stone castles. The whole area of castle hills, including the castle itself, began to create interesting anthropogenic historical geological locations (geosites). Such a character has, for example, the Spiš Castle, which has been registered on the UNESCO World Heritage List since 1993.
In the modern era (up to the 20th century), there were dozens of stone quarries opened in the territory of Slovakia (Upper Hungary), which are currently protected thanks to their geological uniqueness as Natural or National Natural Monuments (e.g. Travertines of Gánovce, Gate of Kysuce, Dolomites Quarry of Nitra, Rössler´s Quarry). Many are also included in Nature Reserves, e.g. Devínska kobyla, Dreveník, Príboj, Šomoška. Amongst interesting anthropogenic geological localities are National Monuments of the Natural Heritage, for example, the Herľany geyser and the oil spring of Korňa. For all these sites it is typical that, in addition to the open, unique geological structure, they also bring significant context related to Paleontology, minerals, Archaeology and the like.
The mentioned sites currently represent important anthropogenically created historical geosites, which are attractive and unique objects of evolving Geotourism.

Key words: historical surface mining, quarries, nature protection, small-scale protected areas, anthropogenic geosites

Introduction

The geological structure of a part of the landscape, or its uniqueness and quality, creates the prerequisites for the opening of an anthropogenic outcrop - the quarry. The natural form of a landscape without human intervention does not have to create unique elements that would come to the attention of nature conservation. After the opening of the quarry in the country, the quarry´s wall and the quarry´s court become automatically a geological locality. From the local geological structure, tectonics or other "added" natural values (e.g. structural, petrological, geochemical, mineralogical, paleontological, hydrogeological, sedimentological, pedological, geomorphological or living nature) and also anthropogenic values (e.g. archaeological, religious, cultural, historical and social) depends from the attractiveness and uniqueness of the site in terms of nature conservation. Another important factor is the time horizon, which plays an important role, especially by the human created added values of the concrete site. Typically, prehistoric artifacts are the most precious, then Medieval, Modern and contemporary, which are essentially in an ordinary state (Hronček 2012).

Geological heritage sites (geosites) are valued not only for landscape protection but also for Geotourism, as long as there is an outcrop on the site, which allows seeing inside into the earth's crust, i.e. in the cut. Geosites are parts of the geosphere, which represent a significant means of understanding the history of the Earth (Goudie ed., 2004). Geosites are defined as geological locations that have acquired scientific, aesthetic, cultural-historical, but also economic and social value due to human perception, or use by human society. It is typical of them that they are quite sharply and precisely defined from the surrounding countryside and are distinguished from the vicinity by their uniqueness.
The importance of anthropogenic outcrop in the country or of geosites depends on its position in relation to the geological structure of the earth's crust. It allows observing part of the lithosphere. The exposed rocks and the geological phenomena on the wall of the quarry cannot be replaced by any photo, the picture or a detailed description. It is the original visual 3D form - it is material and can be touched in situ. The advantage of the anthropogenic wall compared to the natural outcrop is that the rocks are usually less affected by sprocket processes and are therefore solid, colored and have a concrete form. Another advantage is that while natural outcrops are mostly in inaccessible places (shores of streams, gulches, upheavals on steep slopes, etc.), to anthropogenic outcrop - the quarry, always leads access communication.
The anthropogenic outcrop - the wall of the quarry is generally large in size, allowing simultaneous observation of the entirety and also of details of the uncovered geological structure (Galvánek 2008). In many places, have been discovered just on the quarry walls the phenomena, which have shifted forward our knowledge of the geological structure not only of the Earth but also of the local areas (Bozalková, Galvánek, Slivka 1979). Excavated walls present significant geological phenomena, e.g. wrinkles, breaks, landslides, various types of rocks separations, layers of rocks which gain in importance in the context of the geology of the surrounding land. Such quarries are also protected as important small-scale areas, directly thanks to their uniqueness.
Since the beginning of the settlement of today's territory of Slovakia, man has acquired inorganic material from the country, especially stone, which led to the creation of the first anthropogenic outcrops in the early Stone Age. The first real quarries, as such understood by contemporary science, originated in south-western Slovakia near Bratislava and Devin at the turn of the eras, during the Roman age (Hronček et al., 2018). About the establishment of the first larger quarries - historical surface geological localities can be said in Slovakia from the second half of the 13th century. Since this period, sites of this type have been built in connection with the construction of stone castles and rich mining and commercial medieval towns. A specific type of historical anthropogenic outcrops are the numerous sites of castle´s hills, including the castle itself. Thus were created interesting anthropogenic historical surface geological locations (anthropogenic historical geosites). Of such a character is, for example, the Spiš Castle, which has been registered on the UNESCO World Heritage List since 1993.

Anthropogenically created outcrops and nature conservation

From the point of view of anthropogenic outcrops´ protection plays an important role the Act on Nature and Landscape Protection no. 543/2002 Coll., which allows their protection and also promotion. Their protection is either targeted – as an important landscape features of a normally non-living nature. Or is indirect – within small-scale protected areas (nature reserve, natural monument), where protection of other

landscape values is preferred. In small-scale protected areas, the most stringent protective degrees are used i.e. fifth and fourth.
The Act of the National Council of the Slovak Republic on Nature and Landscape Protection no. 543/2002 Coll. understands as a nature reserve (PR) a smaller area generally up to 1000 hectares representing the original or by the anthropogenic activity less altered biotopes of European or national significance. The most stringent fourth or fifth degree of protection applies in the nature reserve. The Nature Monument (PP) is a point, line or another small-scale ecosystem, its components or elements (often inorganic) having a scientific, cultural, ecological, aesthetic or landscaping meaning up to 50 hectares (Nature and Landscape Protection Act 2002). More important landscape areas are more strictly protected under the National Nature Reserve (NPR) or National Nature Monument (NPP) category.
On the territory of Slovakia anthropogenic outcrops – quarries are protected intentionally as important geological, geomorphological, paleontological or archaeological sites (Hronček 2011, 2012). Sandberg quarry in Devínska Nová Ves (NPR Devínska Kobyla) is of such character and is protected as a significant geological and palaeontological site. As well as a granite quarry in Bratislava under hill Kamzík - Rössler´s Quarry (PP Rösslerov lom), protected as a significant geological, botanical and entomological site. Limestone quarry at Devín (PR Štokerauská vápenka) is protected from the point of view of geological and botanical values. In Nitra is protected a dolomite quarry in the city center in the category Nature Monument (Nitriansky dolomitový lom). The protection was declared with the aim to protect the geological profile, which is exposed in the quarry as a model of the Tríbeč geological structure. Near the town Krupina towards Žibritov village, there is the Nature Monument Šeňská stráň, where the object of protection is the historical quarry in shape of opened columnar five-sided separation of pyroxenic andesite.
In Kysuce region there is protected sandstone quarry Milošová-Megonka with a typical and rare ball-separation of sandstone (PP Megonka).Nature Monument Zolniansky lahar is protected in Zvolen´s basin. Protection has been declared with the aim to spare the Neogene lahar flow with paleontological findings (Dublan et al., 1997). The added value of the site – interest – lies in that from the 13th century, an easy-workable volcanic material was extracted from the lahar body. From this was built the Early Gothic church in Zolná originated from the end of the 13th century, decorated with rare frescoes, which is a National Cultural Monument.
Several quarries are protected in Cerova uplands as important geological sites. Sandpit at Lipany (Natural Monument Lipovianske pieskovce), sandpit near Čakanovce (PP Čakanovský profile) and Šomoška basalt quarry (stone waterfall) on the northern slope of the castle hill where the columnar six-sided separate of basalt (NPP Šomoška) is exposed. The stone waterfall was most likely to have been created in the modern times during the exploitation of the basalt on the northern slopes of the castle hill for the purpose of rebuilding the nearby Šomoška Castle within its fortification against the Turkish expansion.
Several quarries are also protected in Spiš region. In the Nature Reserve Čingovské hradisko is a protected limestone quarry that reveals the typical profile of the geological structure of the eastern part of the Slovak Paradise. Protected are also historical travertine quarries within National Nature Reserve Dreveník, where are protected the travertine mound, its morphology and typical vegetation and flora, as well as an archaeological site. The similar character has the National Nature Reserve Gánovské travertiny, where was found the casting of the Neanderthal cranial and the National Nature Reserve Sivá Brada.

A specific group represents the medieval spot of mining on the castle hills, which are nowadays protected and create unique and interesting geosites. E.g. NPR Šarišský hradný vrch, NPR Šomoška, NPR Čachtický hradný vrch, NPR Turniansky hradný vrch, NPR Cigánka with castle Muráň, PR Hajnáčský hradný vrch, PR Kapušiansky hradný vrch, PR Viniansky hradný vrch, PR Zborovský hradný vrch, NPP Devínska hradná skala and castle Devín, NPP Spišský hradný vrch, PP Oravské hradné bralo or PP Podhorodský hradný vrch.
The quarries generating ecological conditions for plant and animal biotopes are protected, for example, the Protected Area (CHA) of Nižnočajská pieskovňa in the village Nižný Čaj nearby town Košice, where is significant rookery of European bee-eater (Merops apiaster), CHA Plavečské Štrkoviská as water biotopes of European beaver (Castor fiber). Also protected is PR Zamarovské jamy in the vicinity of town Trenčín as important marshland biotopes and biotopes for water birds. From the point of view of nature conservation and Geotourism also interesting is the anthropogenic outcrop on the left bank of river Hron (PP profile Kamenický sprašový profil), in a north-west direction from village Kamenica nad Hronom with nesting colonies of European bee-eater (Merops apiaster).
Among interesting historical geosites of anthropogenic origin belong geyser NPP Herľanský gejzír and oil spring PP Korniansky ropný prameň. The well in Herľany (district of Košice – okolie) was drilled as a source of water for the local spa in the years 1870 - 1875 to a depth of 404, 5 meters. The geyser is one of the few cold geysers in Europe and since 1987 has been protected as a National Nature Monument called the Herľany Geyser. Another interesting site is the relic of the historic drilling remained after a geological survey focused on oil exploration near Korňa village in the district of Čadca. The economically unusable well, made in the early 20th century, was not hermetically sealed and oil flow occurs from it. Nowadays is denoted as the oil springs. This significant geosite, which is unique not only in Slovakia but also in the European or world context, was proclaimed in 1973 as a Nature Monument.

Protection of anthropogenic outcrops (quarries) through musealization
An important, even if rather exceptional and rare, a form of protection of anthropogenic outcrops (not only historical) is their musealization. As an example from the world, we can mention the historic andesite quarries on the Wdžar hill, which are part of the local geosites Wdžar Hill in neighboring Poland (Rybár, Baláž, Štrba 2010). Part of the gold mining museum as a natural exposition is the Waihi Martha Golden Open Pit on the eastern coast of North Island in New Zealand at Waihi Beach.
Part of the Slovak Mining Museum in Banská Štiavnica is also the exposition of open-air museum. Museum was founded in 1974. Exposition of quarrying is part of the surface area of the open-air museum. Musealization of the old abandoned quarry´s wall (opened probably already in the 18th century) took place in the early 1990s when the Exposition of quarrying (Labuda et al., 2011) was just established here.
Interesting musealized geosite is also a travertine quarry at the southern outskirts of village Vyšné Ružbachy, which has gradually been transformed since 1964 into an open-air gallery of travertine sculptures. At present, after annual sculpture symposia, there are 104 statues installed by sculptors from 14 countries. Grounds of the gallery located in nature was declared by the Ministry of Culture of the Slovak Republic as a cultural monument on July 1, 1997.

As part of the NPR Devínska kobyla, a geological open-air museum was established in the stone quarry on the northern edge of village Devín. In 2001, the Geological Museum (Bizubova 2008) was opened here, which is currently inoperable and gradually overgrowing by vegetation.

Anthropogenic outcrops as part of large-scale protected areas

An important function quarry fulfills also in large-scale protected areas, where large-scale probes allow the view of the interior of the earth. Probably the most typical example is the volcanic mountain range, especially the Cerova vrchovina Mountains. In the 19th century, there were opened a number of quarries (Bulhary, Konrádovce, Hodejov, Šomoška, Šiatorošská Bukovina, Mačacia), presenting in detail all the specifics associated with volcanic activity - various types of separability, stratification (Hronček et al., 2018). These quarries were, at the time of their establishment, one of the largest in former Hungary, and they were the place of production of cobblestones for Budapest.

Interesting quarries are also found in other volcanic or core mountains in Slovakia. As an example of the unique geosite in Slovakia, where the quarry is part of the geological site, we can mention the basalt stone of Brehy - Putikov vŕšok hill in the landscape park Štiavnické vrchy. The abandoned wall-quarry is open on the northern slope to the front of the lava flow. It is a basic type of lava, which is characterized by a very high temperature and a slower hardening, which allows the lava stream to flow even on the gentle slopes, as it was in this case. The lava flow was poured out in Quaternary at the end of the riss period, or in the next Interglacial Period of about 120,000 years ago (Šimon, Pauditš, Kráľ 2002, Lacika 2008, Jasénka 2011). The length of the lava flow is 3.2 km and the maximum thickness is 15 m and is deposited on the riss sediments of the river Hron (Bizubova 2008). The lava stream was poured out from a crater over 100 m high at the bottom of the Chválenský brook valley (Lacika 2008). Putikov vrch is the youngest known volcano in Slovakia and throughout Central Europe. It is a volcano of the Stromboli-Hawaiian type (Šimon, Németh 2009). The cinder´s crater of hill Putikov vŕšok (477 meters above sea level), together with unique volcanic shapes, was declared a Nature Monument in 1997. The most significant morphological volcanic form is the pseudo-karst cave Sezam on its southern slope.

Conclusion

The quarries, especially those of large-scale, established in the 20th century, are often understood as terrain scars in the landscape. They reveal, however, the subterranean curiosities that the human eye cannot otherwise see. The geological profiles are often found in the quarries, there are the fossils of plants and animals, and they contain minerals and the like. However, the promotion, propagation, and visibility of quarries as anthropogenic outcrops and important geosites for Geotourism must point to these attractions and uniqueness. The significance of such geosites is multiplied if we can identify or combine them with historical socio-cultural-technical phenomena. For example, if there is a cultural monument in its immediate vicinity (Spiš canonry and castle, Bratislava castle, etc.).

A particular phenomenon is the flooded parts of the quarries that create lakes, making them interesting for Geotourism and Mining Tourism clients. Such geosites are particularly important in Slovakia, where there are no natural lakes. At present, new extreme and adrenaline sports (climbing, motocross, and cyclo-cross, deep diving) get to the fore and the clients of unorganized Mining Tourism begin to discover them.

We can state that the use of historical quarries as historical geosites in Slovakia within Mining Tourism has still limited possibilities due to the absence of research, promotion, and accessibility for tourists. The quarries are still only interesting for a narrow group of Geotourism and Mining Tourism clients, especially from the ranks of experts in Geology, Geomorphology, Mining sciences, and other disciplines. Here, however, one needs to know and respect their protection, since the number of such anthropogenic outcrops are so unique that is protected as a single landscape element in form of the small-scale protected area. Or, they are part of large-scale protected areas. Here we have to realize that in the small-scale areas the highest levels of protection apply and the visitor is not allowed anything.
At the very end of the paper, we afford an example of how the anthropogenic geosite – the quarry changed the view of world history and art when quarry mining uncovered one of the most precious artifacts of the world 's cultural heritage of mankind. In 1868, during the mining in the limestone quarry near Santillana del Mar in Cantabria, northern Spain, took place blasting. The shake caused the landslide that opened the entrance to the previously unknown Altamira Cave. Subsequently, in 1879, Marcelino Sanz de Sautuola, with his daughter Maria, discovered in the distance of 30 meters from the entrance of the cave precious wall paintings of ancient animals.

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Souhrn
Člověk od prvopočátků osídlení dnešního území Slovenska získával ze země anorganický materiál, zejména kámen, což vedlo ke vzniku prvních antropogenních odkrývá již v mladší době kamenné. O vzniku prvních rozsáhlejších kamenolomů - historických povrchových geologických lokalitách můžeme na Slovensku hovořit od druhé poloviny 13. století. Od tohoto období vznikaly lokality tohoto typu v souvislosti z výstavbou kamenných hradů. Celé areály hradních kopců, včetně samotného hradu začaly vytvářet zajímavé antropogenní historické povrchové geologické lokality (antropogenní historické geosites). Takového charakteru je např. areál Spišského hradu, který je od roku 1993 zapsán na Seznamu světového dědictví UNESCO. V období novověku (do 20. století) byly na území Slovenska (Horních Uher) otevřené desítky kamenolomů, které jsou v současnosti díky své geologické jedinečnosti chráněny jako přírodní či národní přírodní památky (např. Gánovská travertiny, Čakanovský profil, Kysucká brána, Ústecký dolomitový lom, Rössler lom, Štokeravská vápenka). Mnohé jsou také součástí Přírodních rezervací, jako např. Devínska kobyla, Dreveník, Příboj, Šomoška. Zajímavými antropogenními geologickými lokalitami jsou i národní přírodní památky herlanské gejzír a korňanský ropný pramen. Pro všechny tyto lokality je typické, že kromě otevřené jedinečné geologické stavby přinášejí i významné prvky palentológie, minerálů, archeologie apod.
Dané zkoumané lokality v současnosti vytvářejí důležité antropogenní historické geosites, které jsou atraktivními a jedinečnými objekty rozvíjejícího se geoturizmu.

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ASSESSMENT OF ANTHROPOGENIC LANDFORMS FOR THE GEOTOURISM PURPOSES (CASE STUDY: VELKÉ OPATOVICE FORTIFICATION SITE, ARCHDIOCESE OF OLOMOUC, CZECH REPUBLIC)

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Abstract
The human impact on the relief is often very devastating: natural landforms are modified, damaged or destroyed and the intensity of human-induced processes even surpasses the natural ones. However, people also create new landforms which are interesting from geoconservation, educational, cultural and historical points of view. Thanks to these aspects, they also have a potential for geotourism, geoeducation and recreation. For the assessment of anthropogenic landforms (respectively anthropogenic geosites and geomorphosites), a method based on the concept of geomorphosties and taking into account the holistic approach to geotourism, is proposed. The article presents an example of anthropogenic landforms on geo-cultural site "Velké Opatovice fortification site" situated in the western part of the Archdiocese of Olomouc. Based on the detailed fieldwork, the inventory of landforms and other features, the assessment and some proposals for geotourist use of the site are presented.

Key words: geo(morpho)sites, geoeducation, recreation, cultural heritage, Archdiocese of Olomouc

Introduction

People have always influenced the landforms and landscapes and the impacts of human activity are often very destructive (Szabó, Dávid, Lóczi eds. 2010). However, people also create new, interesting landforms (e.g. quarries, communication cuttings or water management landforms) which are attractive from scientific, educational, cultural and historical point of view and which show geoscience features that would normally remain hidden (Osborne, 2000) or which allow to trace the evidences of human impact on the relief in the past.

These landforms (which are displayed within particular geomorphosites) are important from the geoconservation point of view, they contribute to the extension of Earth-science knowledge and also, they reach high geohistorical values (landforms as witnesses of landscape changes and development, cultural, architectonical, artistic and technical aspects related to the landforms etc.). Due to these and other aspects, they have a potential for geotourism, geoeducation and recreation as discussed in various papers (e.g. Lóczy 2010, Petersen 2002, Hose 2017, Kubalíková et al. 2017, Evans et al. 2018).

Thanks to the high geohistorical and cultural values and thanks to the existence of these values together with natural ones at one simple site, anthropogenic landforms can be considered a part of cultural heritage too (Kirchner et al. 2017). Thus, anthropogenic landforms lie on the border of natural and cultural heritage as they

are related both to the natural (geological, geomorphological, ecological, pedological, hydrological features) and cultural aspects (mining history, relations to industrial development, land use).
Within the article, a method for assessing the potential of anthropogenic landforms (respectively anthropogenic sites) for geotourism and recreation purposes is presented and applied on the example from Archdiocese of Olomouc (Czech Republic).

Conceptual background

Anthropogenic landforms can be viewed as particular examples of secondary geodiversity (Kubalíková et al. 2016) which is defined as "the range/diversity of the man-made/anthropogenic landforms, including their assemblages, relationships, structures and systems". This definition is based on the definition of natural geodiversity presented by Gray (2013) and it presents geodiversity as a value-free entity; those elements of geodiversity that are of significant value to humans, are called "geoheritage" (Sharples 2002, Dingwall 2005) which is represented by specific geological and geomorphological sites (Cleal 2007), respectively geosites and geomorphosites. Anthropogenic landforms (together with anthropogenic processes and other issues) are displayed (or represented) just within these sites.
For the ensemble of anthropogenic landforms (respectively anthropogenic geosites and geomorphosites) which form a part of geoheritage, a term "anthropogenic geoheritage" can be used.
As indicated in the Introduction, anthropogenic landforms can be considered a part of cultural heritage as there are strong links between geoheritage in general and culture (Panizza and Piacente 2005). The origin and formation of the distinctive anthropogenic landforms is often related to the driving forces of particular cultural periods, war events or technical and scientific development. Identification, assessment, monitoring and explanation of the anthropogenic landforms form an indisputable part of the knowledge of the landscape relief and they are a subject of geomorphological mapping. Important anthropogenic landforms form the part of material cultural heritage, which includes the sites with man-made features or features of combined origin (both natural and man-made) that have exceptional world value from the historical point of view. The detailed research of these landforms is necessary for the complex perception of natural and cultural heritage and they help to understand the role of secondary geodiversity features within the landscape diversity. Significant and remarkable anthropogenic landforms are often a part of the sites of tourist interest (particular geosites, geomorphosites) which possess the potential for geoconservation and geotourism activities.

Methods

To assess the potential of the anthropogenic landforms for the geotourism purposes, the specific procedure is carried out. Particular steps were discussed in various papers (e.g. Coratza and Giusti 2005, Pralong 2005, Reynard et al. 2007, Pereira and Pereira 2010, Fuertes-Gutiérrez and Fernández-Martínez 2012, Kubalíková 2013, Reynard et al. 2016, Kubalíková and Kirchner 2016, Brilha 2016, 2018, Rypl et al. 2016, Štrba et al. 2015). Generally, the assessment comes out from the concept of geomorphosites (Panizza 2001, Panizza and Reynard 2005).
The assessment is based on the identification and description of the particular site where the anthropogenic landforms and processes can be observed. The criteria come out from already used methods and concerning the specific character of

anthropogenic landforms, some of the criteria are modified (especially the scope of "cultural values" is significantly extended).
The proposed method represents an integrated approach and it takes into account wide spectrum of possible values of the site according to the currently accepted holistic concept of geotourism (Dowling and Newsome eds. 2010, Dowling 2013). The complexity of the assessment method is important for understanding the landscape development, it helps to recognize and appreciate the role of landscape memory and understand the relations between natural aspects of the landform and its geohistorical and cultural importance. Based on the assessment, particular management measures can be proposed which can contribute to the rational use of the natural and cultural heritage in the future.
The method is designed as a set of questions (qualitative assessment) and it can be used as a simple tool for the assessment of the geotourist potential of specific sites. The specific values and criteria/questions are proposed in Table 1 (see bellow) together with inventory/description and assessment of the particular site.
Based on this assessment, the last step (synthesis) is done – it includes particular proposals for the rational use of geotourism potential and management measures.

Study area: Archdiocese of Olomouc

The Archdiocese of Olomouc covers most of the Moravia region (area of 10 018 km^2). It is linked to the Morava River which represents an axis of the study area and it lies within its basin. The study area is enlarged in the NNW-SSE direction from the source area of Morava River within the mountainous relief of Kralický Sněžník up to the plain or slightly rugged relief of Dolnomoravský úval Graben near Hodonín.
Within the study area, nearly all the types of the relief of the Czech Republic are represented (mountains, highlands and hillylands both on the crystaline rocks of the Bohemian Massif and sedimentary flysch rocks of the Outer Western Carpathians) to the flat relief of the Hornomoravský úval Graben and Dolnomoravský úval Graben and other depressions (e.g. Moravská brána Gate).
Prehistorically and historically, the area was settled and cultivated, thanks to its position and relief, it had an important passage function as it connected the North and South of Europe (Amber Route) and West and East as well (respectively Bohemia and Moravia). Thanks to these circumstances, the relief of the study area was strongly influenced by human activity, which left the traces in the numerous anthropogenic landforms of various genesis and age.
As an example, the Velké Opatovice fortification site is presented. It lies in the NW part of Archdiocese of Olomouc in the Svitavy Deanery within the Moravskotřebovská pahorkatina Hilly land (Demek and Mackovčin eds. 2014).

Results: Inventory, description and assessment

Velké Opatovice fortification site (area of 1,8 ha) is situated near Velké Opatovice municipality at 514 m. a.s.l. on the remarkable sandstone ridge. Besides the natural and anthropogenic landforms, there are features that are important from historical, cultural and artistic point of view (Figure 1).

Fig. 1: Morphologically significant rampart of Velké Opatovice fortification site (left photo). The relief of J. B. Foerster composer head on the natural sandstone outcrop near Velké Opatovice fortification site - right photo (Photo: K. Kirchner, 2017).

Detailed inventory/description and assessment is presented in Table 1. It is based on the study of literature (Demek et al. 1991, Vítek 2005) and maps and detailed field survey.

Discussion and conclusions: Proposals for the geotourist use of the anthropogenic landforms, respectively anthropogenic geo(morpho)sites

The example of Velké Opatovice foritfication site shows that anthropogenic landforms are important both from the Earth-science and historical point of view. There are strong links between geomorphology and historical aspects (remarkable sandstone ridge was suitable for the construction of the hillfort) and the anthropogenic landforms (ramparts and ditches) very well illustrate the shape of the hillfort and function of the fortification systems. In addition, natural sandstone features near hillfort represent typical examples of the sandstone weathering mezoforms and microforms with considerable scientific and educational value. The presence of springs and spas offer an evidence of using the natural resources in the past. The engravings by K. Otáhal represent important and attractive added value of the site.

As there are numerous different natural and historical features at one site, Velké Opatovice fortification site has undoubtely the potential for geotourism development according to the present holistic concept of geotourism. In addition, the site has a high value for understanding the landscape memory and historical evolution of the surrounding area.

Tab. 1: Inventory, description and assessment of the Velké Opatovice fortification site

1) Scientific value	
a) Diversity and uniqueness: What is the diversity of specific Earth-science features? (anthropogenic landforms, natural landforms). Is the site unique or is it current within study area?	Remains of banks, ramparts and trenches (horse-shoe shape), remarkable sandstone ridge and sandstone outcrops (e.g. Rýbrcoulovo srdce) with typical weathering mezoforms and microforms (honeycombs, rock niches). The site is not unique (there is Mařín fortification site nearby with similar landforms, the sandstone mezoforms and microforms are common), but it is important from the historical point of view.
b) Educational value: Are the landforms recognizable and visible? Are there any educational facilities?	Both anthropogenic and natural landforms on the site are recognizable and visible, there is an information panel on the site and educational trail „Hanýsek“ is leading through the site.
c) Other natural features: Are there any other important natural (ecological, hydrological, pedological) features on the site?	The area is covered with mixed forest, on the western slope, there are several springs (e.g. Františkův and Antonínův pramen) and abandoned spa in Velká Roudka.
2) Tourist value	
a) Accessibility: Is the site accessible or is the access limited?	The site is accessible on foot (marked path), there are no limitations.
b) Safety: Is the site safe for the visitors?	The site is safe, there are no significant risks.
c) Presence of infrastructure: Is the site and its surroundings equiped with tourist infrastructure? (marked paths, catering and accommodation services, tourist shelters etc.)	Complete tourist infrastructure can be found in Velké Opatovice (cca 5 km north of the site).
3) Cultural value	
a) Age of the anthropogenic landforms: How old are the landforms or when the human impact on the site began?	The site was probably influenced by human activities already during the Early Bronze age (Věteřov Culture).
b) Historical and archaeological aspects: Are there any of them?	Significant traces of settlement and archaeological findings from the Bronze Age (Věteřov Culture, Urnfield Culture) and the Iron Age (Hallstatt Culture). Later, the site was used by Slavs (in the 9th century). The site is one of the most important within western Moravia.
c) Artistic aspect: Is the site present in the artistic expression? (e.g. paintings, poetry, myths)	On the rock outcrops, there are engraving of the poet Petr Bezruč and composer Josef Bohuslav Foerster – both by Moravian sculptor Karel Otáhal – created in 1952. Also, there are several myths about the site.
4) Conservation value	
a) Existing legislative protection: Is the site legally protected? (declared as monument, reservation)	The site is not legally protected or declared as a monument or reservation.
b) Current threats: Are there any threats that can endanger the site, respectively anthropogenic landforms on the site? Are these threats predicted or managed?	There are no natural threats to the site, anthropogenic landforms on the site are covered with vegetation, however, they are still well visible.

Source authors

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Souhrn
Antropogenní tvary reliéfu doplňují geodiverzitu krajiny a jsou označovány jako sekundární geodiverzita. Identifikace, hodnocení, pozorování a vysvětlení těchto antropogenních tvarů jsou nezbytnými kroky ke komplexnímu vnímání přírodního i kulturního dědictví a pomáhají pochopit význam sekundární geodiverzity v rámci geodiverzity krajiny. Antropogenní tvary společně antropogenními procesy a jejich výsledky jsou často základním reprezentačním znakem geo-lokalit. Pro soubor

antropogenních tvarů (tedy antropogenní geo-lokality a geomorfo-lokality), které jsou součástí dědictví neživé přírody může být použit termín antropogenní geo-dědictví. Tyto lokality mohou být vhodně využity při směrování geoturismu, včetně poznání kulturního dědictví krajiny

Předložený příspěvek prezentuje příklad antropogenních tvarů na geo-kulturní lokalitě Opatovické hradisko v západní části Arcidiecéze olomoucké. Na základě terénních průzkumů, inventarizace tvarů a dalších vlastností krajiny bylo provedeno hodnocení lokality s ohledem na geoturistické využití.

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BARK STRIPPING BY RED DEER: THE POSSIBLE EFFECT OF RECREATIONAL USE OF THE LANDSCAPE

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Abstract
We studied the effect of recreational use of the landscape on the intensity of red deer bark damage to spruce forest stands. We determined the damage in two recreationally attractive areas: Beskydy Mountains (Beskydy) and Ore Mountains (Ore). In total we studied 31 forest stands (Beskydy: 17, Ore: 14) with 1379 trees. The aim was to find out whether the tourism can reduce the intensity of deer damage in forest stands located in tourist attractive areas. Three scenarios have been considered: 1) the long term disturbances by tourists lead to lower density of deer and lower damage, 2) the disturbances by tourists lead only to avoiding the most disturbed places by deer. The local population of deer concentrate in less disturbed places and cause here extensive damage and 3) disturbance of deer results in longer presence of deer in dense spruce stands. Deer consume higher proportion of spruce bark and the extent of the damage per one deer is higher.
The results proved the validity of the scenario 1. It can be concluded that the deer adapted to intense tourist pressure by adjusting its spatial behaviour and focuses its occurrence on areas where it is not so stressed.

Key words: forest damage, tourism, wildlife management, forest stand, spruce

Introduction

Forestry is strongly influenced by damage caused by large herbivores. Herbivore damage significantly reduce wood production economy and change diversity and stability of forest stands (Gill 1992). Herbivores damage trees especially by the browsing (which reduces the time and cost of restoring forest stands and which can also have a serious impact on the presence and growth of some attractive tree species. Second main type of damage is the peeling and gnawing of the bark in the older forest stands with coniferous and deciduous trees. Bark removal is not lethal in most cases for trees and the growth and yield of the wood mass of damaged trees cold be similar to undamaged trees. Despite this the economic impact of this type of damage on forest stands can be very important. Main effect of this primary damage is to enable the infection of the secondary factors (fungal diseases), which can cause staining, discoloration and decomposition of wood (Kiffner et al. 2008). Infected trees have low wood quality in the lower, most valuable part of the trunk (Vasiliauskas 2001), and great susceptibility to breaking (Knigge 1975). Bark stripping also cause some complications in forest restoring and upbringing in heavily damages stands (Ando et al. 2003). Minimizing the number of damaged trees is therefore one of the main tasks of forest management.
Leisure activities of the citizens and tourism are an integral part of our environment that affects the behavioural habits of the game and its welfare. Some species have adapted to this pressure, others are intensely disturbed and exposed to stress. This can affect the concentration in an environment with good cover conditions, where it can cause various forest damage. Interference can play a key role in the choice of game local concentrations but also in the intensity of tree damage. This study aimed

to evaluate the impact of tourist interference on the distribution of red deer (*Cervus elaphus*) in younger and middle-aged spruce forest stands (*Picea abies*) and on the intensity of bark damage on spruce.

Materials and methods

We determined the damage in two recreationally attractive areas: Beskydy Mountains (Beskydy) and Ore Mountains (Ore). Both areas are occupied by the red deer (*Cervus elaphus*). In total we studied 31 forest stands (Beskydy: 17, Ore: 14) with 1379 trees. Age of studied forests was 14–35 years. In these stands we evaluated in all living trees damaged and undamaged trees. The number of red deer faecal pellet group (FPG) was counted in every forest stand. FPG expressed the intensity of visiting the stands by deer (attendance and abundance). The intensity of deer attendance was expressed through the density of FPG (200 m^2). The intensity of the damage was expressed through the percentage of damaged trees (%). The intensity of tourism was expressed through the distance from the tourist attractive places and the number of visitors on the scale: 1-5, where 1 was a place with very intense disturbance and 5 without the influence of tourism.

Results

The results confirmed that with the decreasing intensity of tourism, the number of FPGs found in forest stands increased (Fig. 1). The deer avoided these potentially suitable forest stands (sheltered and quiet). Among these variables was a moderate relationship ($r = 0{,}477$; $p < 0{,}001$).

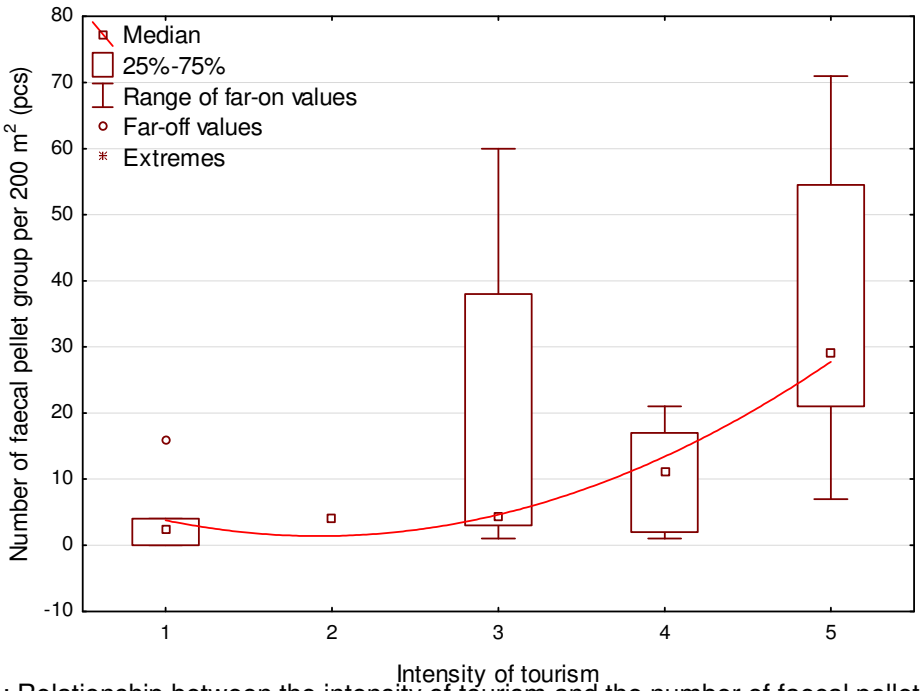

Fig. 1: Relationship between the intensity of tourism and the number of faecal pellet groups

A similar relationship was between the intensity of tourism and the proportion of damaged trees in the forest stands. With the difference that the relationship between

these variables was very strong (r = 0,931; p < 0,001). It follows that younger and middle-aged spruce forest stands in the vicinity of attractive tourist sites are not damaged and searched by red deer. Human disturbance by leisure activities therefore play a significant role in the distribution of deer in our mountains and forests and affect the health status of forest stand (including forest management costs).

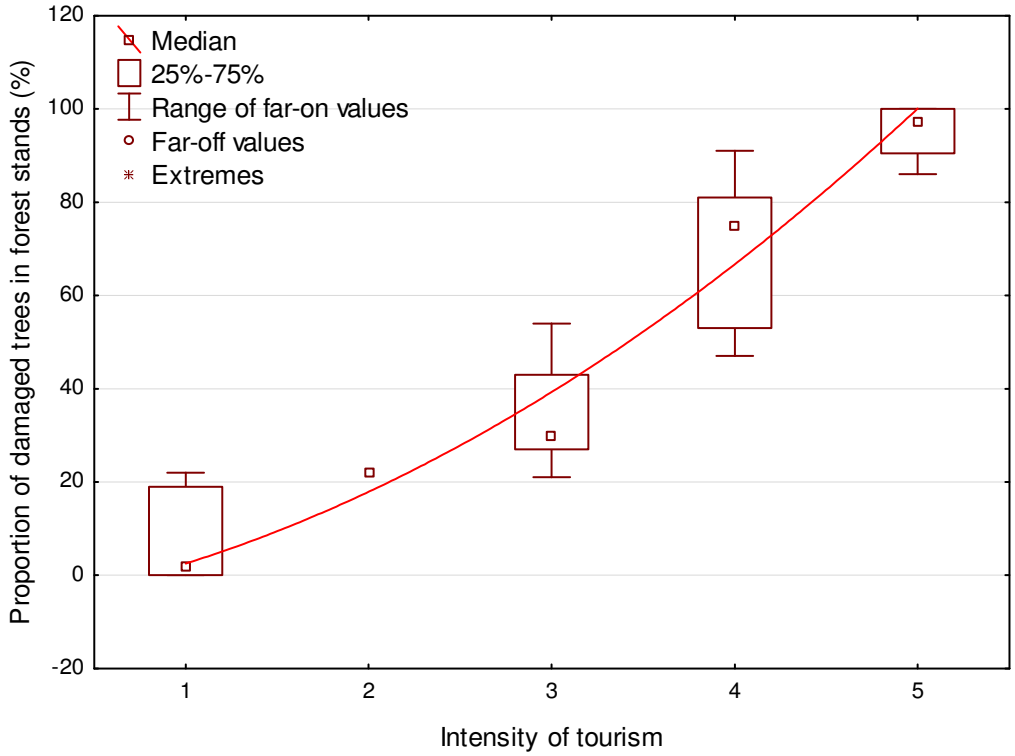

Fig. 2: Relationship between intensity of tourism and the proportion of damaged trees

Discussion

Three scenarios have been considered: 1) the long term disturbances by tourists lead to lower density of deer and lower damage, 2) the disturbances by tourists lead only to avoiding the most disturbed places by deer. The local population of deer concentrate in less disturbed places and cause here extensive damage and 3) disturbance of deer results in longer presence of deer in dense spruce stands. Deer consume higher proportion of spruce bark and the extent of the damage per one deer is higher. The results proved the validity of the scenario 1. It can be concluded that the deer has adapted to intense tourist pressure by adjusting its spatial behaviour and focuses its occurrence on areas where it is not so stressed.

Conclusion

Leisure activities of the citizens and tourism are an integral part of our environment which affects the behavioural habits of the game and its welfare. Younger and middle-aged spruce forest stands in the vicinity of attractive tourist sites are not damaged and searched by red deer. Human leisure activities therefore play a

significant role in the distribution of deer in our mountains and forests and affect the health status of forest stand.

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Souhrn

Na dvou významných rekreačně aktivních území CHKO Beskydy (CHKOB) a Krušné hory (KH) byla zpracována studie zabývající se vlivem turistického ruchu na poškození smrkových lesních porostů ohryzem a loupáním kůry jelení zvěří. K danému účelu bylo vybráno 31 lesních porostů (CHKOB: 17 lesních porostů, KH: 14 lesních porostů) s 1379 stromy v různých částech zmíněných lokalit. Cílem bylo zjistit, zda vlivem turistického ruchu dochází ke snížení rizikové koncentrace jelení zvěře v lesních porostech umístěných v turisticky atraktivních oblastech. Byly uvažovány tři scénáře: 1) zvěř se daným porostům vyhýbá a koncentraci v nich minimalizuje (nulové škody), 2) zvěř se v porostech zdržuje, ale porosty nepoškozuje, a 3) zvěř se v porostech zdržuje a vlivem intenzivního rušení dochází k poškozování kůry stromů. Hodnocen byl podíl poškozených porostů, denzita jeleního trusu a intenzita turistického ruchu (na škále: 1 – s intenzivním rekreačním tlakem… 5 – bez vlivu rekreace). V případě platnosti scénáře 2 nebo 3 by mohlo dojít k minimalizaci nákladů na ochranu lesních porostů v rekreačně aktivních oblastech. Výsledky prokázaly platnost scénáře 1, tedy minimální výskyt zvěře v těchto porostech a minimální podíl poškozených stromů ohryzem kůry. Lze usuzovat, že zvěř se intenzivnímu turistickému tlaku přizpůsobila úpravou svých prostorových návyků a svůj výskyt soustřeďuje do oblastí, kde není tolik stresována. Problém může nastat v případě vytyčení nových turistických tras, kdy zvěř na nový podnět reaguje stresovým chováním v podobě intenzivního poškozování lesních porostů.

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

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Abstract
The article presents final results of Local Small Scale Project of the Czech Republic Development Cooperation no. 11-17PH01. In frame of the project implementation there were identified and then marked 6 touristic trails in the area of Gintubdan, Negros Island, Philippines starting from two different starting points. Their length is 19.5 km in total. The trails were equipped by the marks, marking posts, basic stabilization objects and relaxing points. All the works which were done in frame of the project were in the level of ideas compromises among the different requirements (nature conditions, nature protection, local specifics, requirements of municipal and nature protection authorities etc.). The system of touristic trails was developed on the base of cooperation of Mendel University in Brno, La Salle University in Bacolod and local communities in the area of Gintubdan.

Key words: touristic trails, marking of touristic trails, stabilization of touristic trails, Negros, Philippines

Introduction

The paper presents final results of Local Small Scale Project of the Czech Republic Development Cooperation no. 11-17PH01 named the same as is the title of the article.
The main aim of the project was to create a network of hiking trails in a lesser known nature park of Northern Negros following the methodology of the Czech Tourist Club. The project had to support not only the development of the area, but by leading the visitors only on well defined paths had to also inhibit the use of unauthorized hiking trails. The trails, leading through the protected Nature Park was intended to show the importance of nature preservation, protection of local species as well as the consequences of nature damage to the visitors. All the trails are now marked as the foot paths with respect to surrounding environment.
Project was elaborated in cooperation between La Salle University Bacolod and Mendel University in Brno with support of Municipality La Carlota, DENR Bago and local people from Gintubdan and Guimaras Island. By that were in fact assured the other particular aims of the project, strengthening of cooperation between Mendel University in Brno and local partners in North Negros as well as the support of local communities.

Materials and methods

The project site was the locality situated in the area surrounding Gintubdan village located in The National Park Mt. Kanlaon, Negros occidental, Philippines. Organizationally the project site belongs under the responsibility of La Carlota Municipality, as for the state authority and DENR (Department of Environment and Natural Resources) branch in Bago, as for the nature protection authority.

Methodological phases of the project solution were as follows:

1. Identification of suitable hiking trails
2. Marking the trails in the terrain, placing the marking posts and signposts and relaxing places
3. Stabilization of destroyed, instable and danger sections of the trails
4. Determination of the positions of the hiking trails using GPS locators
5. Processing the collected data, creating maps and elevation profiles of the trails

The identification of suitable hiking trails was realized in cooperation with local authorities, especially La Carlota City Municipality, DENR (Department of Environment and Natural Resources) Bago and local guides.

Marking the trails in the terrain and placing the marking posts and signposts and relaxing places were physically done by the students of MENDELU in Brno in cooperation with La Salle University and local people from Gintubdan. The technology of the trails marking was transferred from the reference book Basic Rules for Marking Touristic Trails and for establishing Touristic Signs (Czech Tourist Club, 1999). Concerning the fact there is a strict prohibition of any tree damage (including marking), bamboo sticks were chosen for the marking of these routes. So each trail was in terrain marked by the set of bamboo sticks approximately 1.5 m high thrust into the ground painted by the marks of relevant colour (green, yellow, red or blue). The mark consists of three vertical stripes, two surrounding are white, central is of color which is used for the specific trail marking (green, yellow, red or blue). In the trails crossing points were installed small signposts constructed as the bamboo stick approximately 1.7 m high thrust into the ground with direction arrows marked by the color which is used for the specific trail. Guideposts in total number of three as well as the relaxing points were designed by students of MENDELU constructed by the local carpenters from Guimaras Island then transported from Guimaras to Negros and finally built into the ground with using the concrete bases by local people from Gintubdan.

Stabilization constructions were also designed by students of MENDELU. All of them were then constructed directly in Gintubdan by the local people and students of MENDELU as well. The basic used constructions were as follows: cross steps and stairs, lengthwise lateral bamboo stabilizations of paths edges, bamboo ladders, top rope constructions, ground stairs and stairways etc.

Determination of the positions of the hiking trails using GPS locators (Juno) was the final terrain phase of the project implementation. The goal of this phase was to measure relevant position and altitude data of the trails as the base for their following processing. The first task was to find out the length of particular trails and total length of whole network. The second task was to prepare the GPS dataset for following GIS processing and creation the maps.

The data obtained using the GPS locators in terrain were then processed by the GIS software ArcGIS and the final map of the trails localization was created in the space of mentioned software as well.

Results

Using the methodology mentioned above finally six trails were marked in the area of Gintubdan (see table 1), positioned and fixed in the map (see figure 1) and terrain (see figure 2).

Tab. 1: Overview of the marked touristic trails in the locality of Gintubdan

Starting point	Trail name	Colour	Length (km)
Ecoutouristic Trails	Oro fall	yellow	1.4
	Buslugan fall	red	4
	Salas Pavillion	blue	0.8
	MENDELU Trail	green	7.5
Adventure Trails	Ezy fall	blue	1.7
	Twin falls	green	4.1
Total			**19,5**

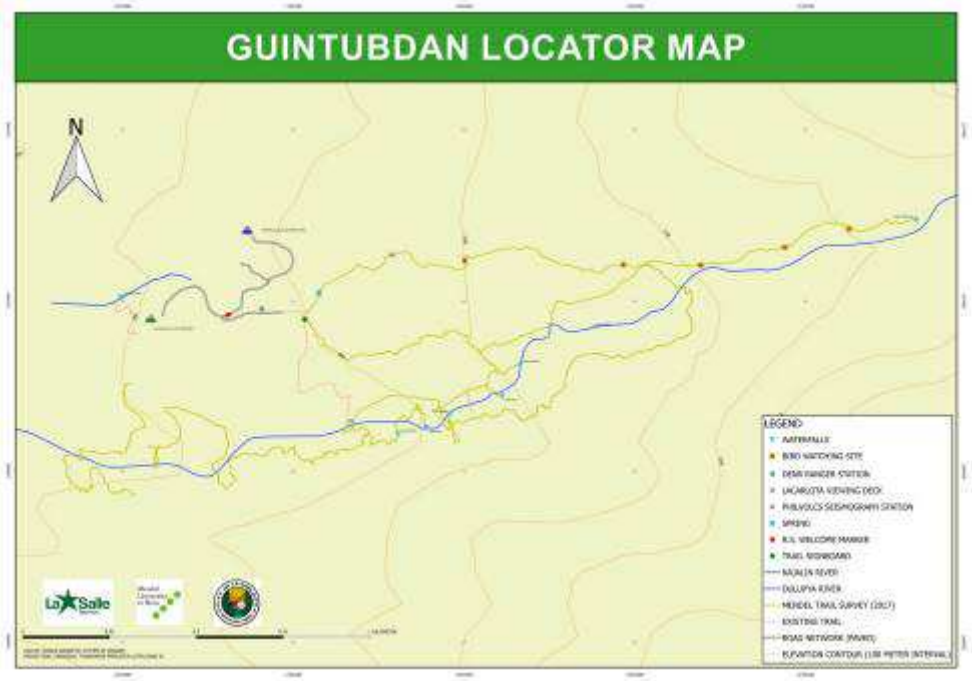

Fig. 1: Draft of final map of the area of Gintubdan including the touristic trails

Fig. 2: Marking the trails: Final installation of marking bamboo stick, Final installation of marking posts

Guideposts were made of woody materials (hardwood, plywood) and equipped by the small roofs as prevention against the tropical climate conditions were installed in the terrain then (see figure 3).

Fig. 3: Placing the guideposts: Adventure Trails guidepost, Ecotouristic Trails guidepost

The final phase of touristic trails equipping consists of the fixing the relaxing points and the stabilization of instable and damaged parts of the trails bodies (see figure 4 and 5).

Fig. 4: Relaxing points: Construction of light roofed relaxing point, Installation of light bench in terrain (by the river)

Fig. 5: Stabilization of the trails: Bamboo ladder (bottom of the river valley), Using secure top-rope construction, Lengthwise lateral bamboo stabilizations of path stairs

Discussion and conclusions

All the trails were marked so to show interesting nature exhibits and specific nature of National Park Mt. Kanlaon as well. The longest trail reaches the length 7.5 km, it is marked by green color and named the same as the Mendel University, Mendel trail (Ecotouristic starting point). Along this trail visitors can see the Balagakay spring, the Abaga fall, the Mayor fall and the Salong fall. Other trail leads to the highest waterfalls – Twin falls is marked by blue color and it is 4.1 km long (Adventure trails starting point). A part of this trail passes through the Bor Edie river so tourists can use this trail only during a dry season with the light fording. The trail reaching the Ezy fall is marked by green color and is relatively short (1.7 km) (Adventure trails starting point). The shortest (0.8 km) and easiest trail is marked by yellow and leads from the Ecotouristic trails starting point to the Salas Pavillion. The red color marked trail starting in Ecotouristic trails starting point is leaded to the Buslugan fall in the distance of 4.0 km. The last trail starting in Ecotouristic trails starting point reaches the distance 1.4 km and its target is Oro fall.

GPS locators were used to determine the positions of all hiking trails in the terrain and on the basis of the collected data the maps are processing.

Except the touristic trails identification, marking in terrain and equipping them by different types of construction; partial goal of the project included also the transfer and implementation of the unique technology of marking hiking trails used by the Czech Tourist Club to the conditions of Philippines supporting the tourism potential of northern Negros.

The sustainability of the project lies mainly in the assumption that local communities identify with the project and will 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. Because the trails will be formed for the way of individual hiking their influence to the nature will be lower than in case of guided group hiking. It can help to save the unique nature of Northern Negros, Philippines.

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Anonymus 1999: Basic Rules for Marking Touristic Trails and for establishing Touristic Signs. Czech Tourist Club, Prague

Acknowledgement
This paper was written thanks to support of the Czech Ministry of International Affairs, Local Small Scale Project of the Czech Republic Development Cooperation no. 11-17PH01. Special thanks belong also to all the participants of the project especially to valuated colleagues from the University de La Salle Bacolod, participating students of MENDELU and Larry and Ray - our always ready field guides.

Souhrn
V rámci malého lokálního projektu podpořeného z prostředků Ministerstvem zahraničí České republiky z prostředků fondu rozvojové spolupráce byly na filipínském ostrově Negros v národním parku Mt. Kanlaon v okolí obce Gintubdan vyznačeny turistické trasy podle metodiky, kterou značí turistické trasy v ČR Klub českých turistů. Projekt byl realizován ve spolupráci Mendelovy univerzity v Brně, University de La Salle Bacolod a místních komunit z okolí Gintubdanu. Jeho smyslem bylo mimo přenosu technologie značení tras, rozvoje spolupráce MENDELU a University de La Salle především posílení rekreačního potenciálu a tím i pracovních příležitostí pro místní komunitu v Gintubdanu. Zcela zásadním cílem projektu bylo rovněž zajistit dostatečné turistické zpřístupnění lokality při zajištění ochrany přírody v oblasti s podporou řízené individuální rekreace. V rámci projektu byly nejen vyznačeny turistické trasy a k nim vytvořena mapa jejich lokalizace, ale řešena byla i stabilizace poškozených či nebezpečných míst na nich se nacházejících. V souhrnu bylo vyznačeno téměř 20 km v šesti značených turistických trasách vycházejících ze dvou výchozích bodů.

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CONTRIBUTION TO AVALANCHE MODELLING IN THE VEĽKÁ FATRA NATIONAL PARK, AN EXAMPLE OF THE KRÍŽNA-MASSIF

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Abstract

The paper analysis the facts about snow and avalanches assembled with the aid of a geographic information system. Based on a digital terrain model and landscape cover mapping, we have identified the major topographic features enabling us to locate the release points for the avalanches. These ones were consequently used as entry data for a dynamic avalanche model. For the modelling, we choose the area Krížna in the National Park Veľká Fatra where the avalanche prevention is required very much. In the second part of this work we discuss eighteen avalanches with smaller release zones, with a release depth of one meter, simulated, by the ELBA+ model. The outcomes of these simulations are a map for potential release zones and evaluations of the potential avalanche paths for the chosen release parameters. These tools can serve as an appropriate basis for landscape planning with the aim to prevent catastrophes caused by avalanches in Krížna. With modified parameters, the same can be implemented for other mountains in Slovakia.

Key words: snow conditions, snow pack, ELBA+, release zone

Introduction

The Krížna sector of the National Park Veľká Fatra has preserved its original forest mountains status in a mosaic pattern only. Relatively big forest areas display impacts from the heavy logging interventions in the past, meeting the requirements of the mining colonisation. During the Walachian colonisation, the highest situated parts of the Veľká Fatra Mts were converted into mountain pastures. The upper forest line had been shifted downwards drastically, the forest structure was disturbed, complying needs of intensive alpine farming (BUKOVČAN 1960; LONGAUER *et al.* 2015). The result was that as early as in the 15-th century, our ancestors had to withstood direct danger of snow avalanches. Apart from life and estate losses, the avalanches cause considerable modifications to the terrain ion high mountains. The avalanche-induced effects are: soil destruction, alluvial soil grinding and accelerated erosion. Under regularly repeated occurrence of avalanches, this all can even result in soil cover removal. The bad thing is that at present there occur massive destruction and decline of forest stands over large plots, induced by airborne pollution (MINĎÁŠ, ŠKVARENINA 1995; FAZEKAŠOVÁ *et al.* 2016), climate changes (VILČEK *et al.* 2016) acting as drought episodes (VIDO *et al.* 2015; 2016) wind calamities and insect outbreaks (MEZEI *et al.* 2014; 2017), and deteriorated water-management functions of forests and their ecosystem functions (BARTÍK *et al.* 2014; FLEISCHER *et al.* 2017). This paper deals with simulation and attributes of avalanches in the Krížna massive with slopes belonging to the ones with the most frequent and extensive avalanche occurrence in Slovakia – documented with the

rich occurrence history as well as occurrence of the most-killing avalanche recorded for the SR territory (LONGAUER *et al*. 2015).

Materials and methods

Study area

The Krížna Mt is the third highest peak in the National Park Veľká Fatra (1, 574 m a. s. l.) (Fig.1). Its steep avalanche cauldrons descent downwards to the valleys Dedošová (Turiec region), Veľká and Malá Ramžiná, Rybô (Pohronie region) and Suchá (Liptov region). The rocks building the Veľká Fatra massive vary in their origin, evolution and age as well as their resistance against exogenous and geomorphological agents. Dominant ones are rocks from the Lower Tertiary period, with calpionel limestone, grey marlstone and marlaceous limestone, together with darker organogenic, locally sandy limestones (LONGAUER *et al*. 2015). The local mean annual air temperature is 2 – 4 °C, the local mean annual rainfall sum is 1000 – 1200 mm (ŠKVARENINA *et al.* 2004; ZELEŇÁKOVÁ *et al*. 2017). Massive snow cover on the top parts occurs as early as at the very winter beginning. The cover is commonly connected, thanks to the moderate terrain. At the ridge, the cover depths is 1 meter, in the adjacent valleys 2 meters and more. The cover persists until March when rapid melting starts. LONGAUER *et al*. (2015) report for avalanche release zones an average cover depth of 1 m. Phytocoenologically, the discussed territory belongs to the 4. to 7. forest vegetation tier, (Medio-European limestone beech forests) with the potential vegetation associations: *Fagetum dealpinum*, *Piceeto-Abietum dealpinum, Fageto-Piceetum, Acereto–Piceetum* up to the Carpathian subalpine mountain pine scrub.

Identification of avalanche sites and avalanche simulation in the model ELBA+

The release zones were identified with a model working with morphometric parameters and with terrain roughness. The data source was a digital terrain model and the derived morphometric characteristics. The whole model processing was realised in the programme ArcMap 10. The basic input parameter was a digital terrain model. The next step was the creation of a land cover map with categories necessary for obtaining the roughness coefficient incorporated in the model. The background for the land cover map was ortho-photos scanned in 2006. The avalanche release zones were detected with the most possible precision enabled by digitalising the map from the avalanche cadastre, free accessible on the internet. The modelling started with delineating the territory (watershed) for the avalanche modelling. After the simulation, the calculated values were exported into the particular raster layers in the ArcMap 10 environment.

Results and discussion

From the total number of 132 release zones with a total area of 524 ha in the Veťká Fatra Mts, we identified 46 release zones in the Krížna massive (Fig. 2). According to our assessment, Krížna makes 112 ha from the total release area.

The biggest independent release zone has an area of 10.7 ha. This zone is situated in the locality Malá Ramžiná. The smallest zones are located in narrow ravines between the settlements Turecká and Rybô. The highest situated ravine spot is at an altitude of 1562 m n. m., the lowest is at 800 m n. m. For the current situation, we have simulated 18 avalanches: 10 for the water catchment Turecká, 4 for Rybô, 2 for Liptovské Revúce and 2 for the Gaderská dolina mountain valley (Fig. 3). The avalanche with the biggest area, making 75 ha has been modelled for Veľká Ramžiná. This avalanche size directly reflects also its release zone size, the biggest

among the other ones (27.8 ha). This feature also determines the avalanche's extent, falling rate and deposit thickness making up to 22.8 m. In the annuals of the Centre for Avalanche Prevention, the locality Veľká Ramžiná has never been omitted. The longest avalanche reported in these annuals had a length of 1700 m, in our modelled case it is as much as 2718 m. This simulated value seem realistic, as MIDRIAK (1971) reports for avalanche tracks length in the group Krížna a value of 2000 – 3000 m. An attraction is an avalanche we have simulated for the Líška locality. The size of this avalanche is by one half and the size of its release zone five times smaller than the corresponding values for the avalanche in Veľká Ramžiná. Nevertheless, the avalanche in Líška snatched away by five times more forested area – 17.6 ha. The simulated track contains also 9 technical subjects (cottages). From all the simulated avalanches, this one seems the most disastrous one, despite its parameters do not reach the biggest values among the other avalanches. It is also necessary to notice that the disastrous potential of an avalanche noticeably increases with the amount of alien material the avalanche uptakes during its movement over the ground (BUKOVČAN 1960).

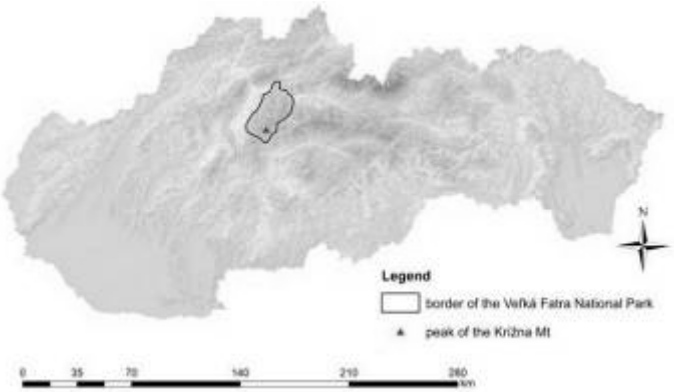

Fig. 1: Position of the Veľká Fatra National Park and peak of the Krížna Mt

Fig. 2: Avalanche release zone

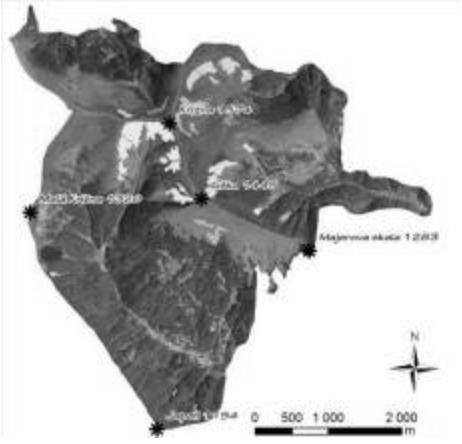

Fig. 3: Simulated avalanche path with release depth 1 m

The simulation in the locality Úplaz is situated in a relatively symmetrical and narrow ravine. This simulation is specific with evolving the biggest pressure, reaching at maximum up to 600 kPa. From this viewpoint, this avalanche can be considered as a very dangerous one. BUKOVČAN (1960) mentions that the pressure developed at the avalanche's head is progressing forwards, upwards and to the sides. This pressure decreases with increasing avalanche area. Noteworthy are avalanche ravines beginning under the top of Japeň and ending in Turecká. Simulation labelled as Turecká 2 exerts negative impacts not only on forest stands and soil cover but it also endangers directly the houses in the village. The avalanche danger for the Turecká settlement from north slopes of Japeň has also been noted by MILAN (2006). The avalanche from December 19, 1981 buried the road and three houses. The major cause for forming this avalanche spot has been clear cutting. According to KŇAZOVICKÝ (1967), the catchment area of Turecká comprises 100 ha endangered by avalanches. This is in accord with our simulations. BUKOVČAN (1960) reports the Rybô settlement with adjacent avalanche ravines as one of the most avalanche-endangered areas in the Veľká Fatra Mts and, at the same time, one of the most tragic in Slovakia. Our simulations have resulted in much less danger for the Rybô settlement. The model ELBA+ even suggests that under a snow release depth of 1m, the settlement itself is protected against avalanches. This situation is the result of applying biological and technical testing measures when the major part of the release territory was possible to forest and stabilise. However, there have been, to-this-date, remained ca 40 ha soil surface destructed and 6 ha forest area endangered. The simulations labelled Liptovské Revúce 1 and 2 belong to the biggest ones, there is, curiously, only a little, 0.41 ha, damaged forest area. This is thanks to the so called avalanche border of the forest. The avalanches in this locality are frequent and the local forest has not enough potential to develop aver affected areas. This regular grinding results in permanent destroyed 6.6 ha of soil surface.

Conclusion

The Veľká Fatra Mts, one of the high mountain ranges in Slovakia, displays a very varying topography. As such, it is endangered to a large extent, not only by soil-destruction processes but also by avalanches. The danger from avalanches has noticeably been aggravated due to the upper forest line shifted downwards in the past and due to intensive use of mountain pastures resulting in forming ideal slide surfaces for avalanches. Consequently, this situation requires to consider seriously anti-avalanche protective measures. One way is using simulation models providing the parameters for potential avalanches.

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Souhrn
V naší práci jsme simulovali ohrožení horského prostředí v masivu Krížna, které bylo i v minulosti svědkem nejtragičtější lavinové události. Naším cílem bylo zjištění odtrhových zón lavin a jejich následné modelování v prostředí ELBA +. V masívu

Krížna jsme namodelovali 46 odtrhových zón s celkovou rozlohou 112 ha. Největší plocha odtrhu má velikost 10,7 ha v lokalitě Malá Ramžiná. Při současných podmínkách (scénář výšky odtrhu 1 m) jsme největší lavinu namodelovali ve Velké Ramžinej s celkovou rozlohou 75 ha. Jak nejničivější lavinu považujeme lavinu v lokalitě Líška, která by potenciálně strhla 18 ha lesa a zasáhla 9 budov. Lavina s největším tlakem (600 kPa) byla simulována v lavinovém žlabu Úplaz. Simulace Liptovské Revúce 1 a 2 patří mezi největší, paradoxně však poškozují nejméně lesního porostu, což je způsobeno každoročním uvolňováním lavin této oblasti, které zabraňují přirozenému vývinu lesa.

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COPPICE-WITH-STANDARDS – BETWEEN URBANIZATION AND RURAL DEVELOPMENT OF FORESTRY

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Abstract

Coppice forests (coppice-with-standards and simple coppice) may play a key role in the adaptation of tree species to climate change in the future. It is known that the role of coppice forests in maintaining forest biodiversity is high. Urbanized forests are more prone to the invasion by exotic species. It is important to conserve our historic landscape heritage. Based on that, research sites have been established at the Training Forest Enterprise Masaryk Forest with the aim to convert high forest to coppice-with-standards with the dominant presence of *Quercus petraea* (Matt.) Liebl. We can say that coppice-with-standards joins the advantages of simple coppice and high forest, meaning that the production of firewood and valuable assortments are ensured simultaneously. It has been recorded that 100-year-old sessile oaks of vegetative origin can respond to strong releases by a significant increase in basal area in a very short time after thinning. We evaluated the response of standards to climatic characteristics and different thinning intensities in the early stage of conversion into coppice-with-standards.

Key words: sessile oak, urban forestry, landscape, thinning, increment

Introduction

Coppice-with-standards have been unwisely forgotten even though it is one of the oldest ways of forest management. This way of management is part of historic landscape heritage. Coppice forests, landscape and society coexisted in the history but coexist also nowadays. Coppice-with-standards consists of a) lower even-aged story and b) an upper story of uneven-aged standards. In France and Italy, it is a very common way of forest management.

Recently, the re-introduction of traditional management has gained interest because of biological, economic and social reasons. Selected standards are kept to provide quality timber and great wildlife habitat.

It is known that vegetation response was positively correlated with thinning intensity in coppice-with-standards (Vild et al., 2013). Urbanized forests are more prone to the invasion by exotic species. Unexpectedly, high floristic losses in a rural landscape were recorded (Van Calster et al., 2008). It is assumed that coppice-with-standards and simple coppice could play a key role in the adaptation of tree species to climate change in the future (Stojanović et al., 2017). Due to these facts a wider restoration of this management is recommended.

Three different thinning intensities with different number of standards (100, 140 and 180 per hectare) were applied on the experimental plots, and the effect of various openness on the standards was examined.

Material and methods

The experimental plots Hády a Soběšice are situated at Training Forest Enterprise Masaryk Forest Křtiny. The plots are situated 290–410 m above sea level. The mean annual air temperature is 7.5 °C and the total annual precipitation around 550–650 mm. The predominant forest type is 2H2 (loamy beech-oak forest on plateaus and gentle slopes with *Carex pilosa*) at Hády plot and 1B1 (rich oak-hornbeam forest with meadow-grass and soft leaved sedge on plateau and rounded ridges) at Soběšice plot.

The 200×200 m (4 ha) plots were established according to the methodology Kadavý et al. (2011) in the even-aged oak forest stands located nearby the Brno city and.

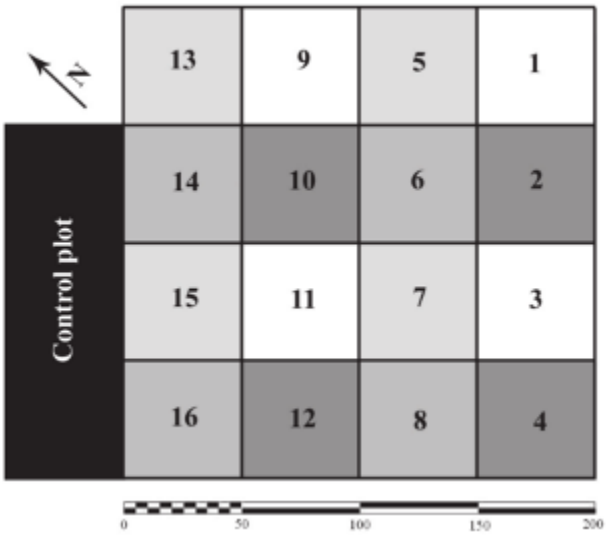

Fig. 1: Schematic layout of areas 50×50 m at experimental plots (Kadavý et al., 2015)

The inventory of each experimental plot was done at twelve square areas (areas 1, 3, 9, and 11 were clear-cut (simple coppice was established here) and were not measured for this purpose). Areas 2, 4, 10 and 12 were released with the lowest intensity, so there remained the most potential standards per unit area. Areas 6, 8, 14 and 16 were released with moderate intensity, and areas 5, 7, 13 and 15 were released most strongly (see Figure 1).

Each oak standard was assigned with a unique number and its position was recorded using the Field-Map system (IFER, Jílové u Prahy, CZ). At the beginning and at the end of the growing seasons 2008/2009 and 2017, the diameter at breast height were measured and the diameter measurement points were signed with a blue horizontal line. Diameter at breast height was measured for 235 standards at the research plot Hády and for 403 standards at the research plot Soběšice respectively (Table 1). Mean annual diameter increment of sessile oak standards was calculated by the equation

$$Idbh_i = (dbh_{i(t)} - dbh_{i(t-n)})/n \quad (1)$$

$Idbh_i$ – mean annual diameter increment of tree i, dbh_i – diameter at breast height of i_{th} tree at time t or t-n, n – the length of the period.

Two-way ANOVA with interaction was used for the comparison of mean values of the mean annual diameter increment of sessile oak standards on two research plots

(with different climate characteristics) and with three levels of thinning intensity. Data analysis was performed by Statistica 13 software (TIBCO Software Inc. 2017). The results were evaluated at level of significance α = 0.05.

Tab. 1: Number of sessile oak standards on research plots

Research plot	n (low intensity)	n (medium intensity)	n (high intensity)	Σ n
Hády	97	89	49	235
Soběšice	173	138	92	403

n – number of sessile oak standards

Results

Two-way ANOVA with interaction (Figure 2) revealed that mean values of the mean annual diameter increment of standards were statistically different only between two research plots, which were characterised by different climate characteristics (F value = 60.940, DF = 1, p value < 0.0001). According to this, we can say, that different climate characteristics influenced the mean annual diameter increment of sessile oak standards. Either the effect of thinning intensity (F value = 1.490, DF = 2, p value = 0.2261), or the interaction of both evaluated factors (F value = 1.632, DF = 2, p value = 0.1964) were statistically insignificant.

At the research plot Hády there were higher values of the mean annual diameter increment of standards. Mean annual diameter increment was about 50.28 % higher (regardless of thinning intensity). If the difference between research plots was expressed also in terms of thinning intensity, the mean annual diameter increment of standards on Hády plot increased at low intensity areas by 65.56 %, at medium intensity areas by 34.35 % and at high intensity areas by 52.61 %. Mean values (with 95 % confidence levels) of the mean annual diameter increment of sessile oak standards on both research plots are shown in figure 2.

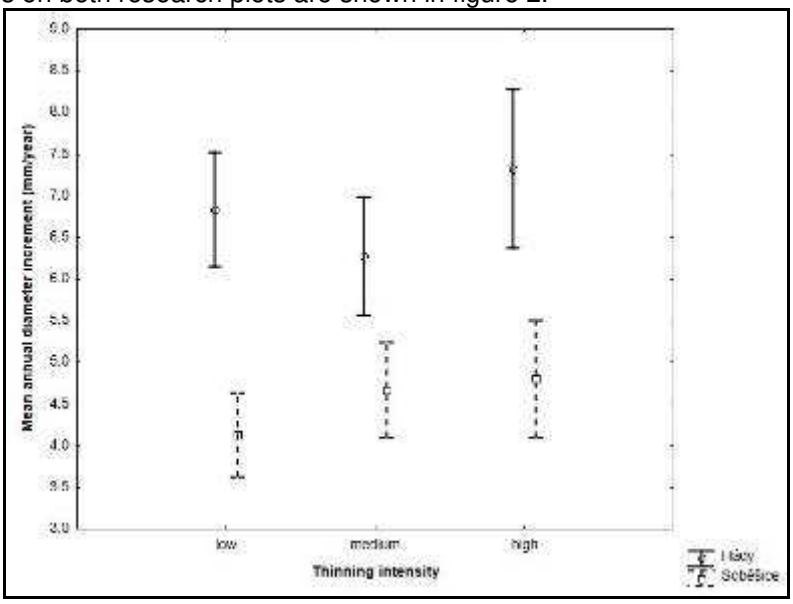

Fig. 2: Mean values of the mean annual diameter increment (with 95 % confidence levels) of sessile oak standards in relation to thinning intensity on two research plots with different climate characteristics

Discussion

According to our results, three different thinning intensities (different number of left standards on the plot) did not influenced the mean annual diameter increment of sessile oak standards. On the contrary, climate characteristics influenced the mean annual diameter increment of sessile oak standards. The growth response was stronger in the year with more precipitation (Knott et al., 2014).

If we had a look at Italy, which represents the country where coppice-with-standards is actively managed, the coppice-with-standards would be one of the most extensive type of forest management, occupying 42 % of the forest area in Italy. This is, therefore, the common forest management that is privately owned. 80% of the coppices in Italy are coppices-with-standards. The minimum number of standards due to the classification of terrain is given by law. In Italy, big areas with hilly and mountainous terrain can be found, so it is important to protect soil and hydrological regime. So, for *Castanea sativa* Mill. and *Robinia pseudoacacia* L., 0–30 standards are given per hectare, for *Fagus sylvatica* L., *Quercus* sp. and other species 60–100 standards per hectare. In the Tuscany region, 60 per hectare is rule standards for oak trees. If the owner leaves less standards, then the penalty is 15 000 € (Regolamento forestale della Toscana).

Current research shows that, rather than the number of standards, their spatial dispersion is more important. Nowadays, the homogeneous dispersion of the standards is predominant, but new findings show that a group dispersion of standards is much more appropriate. The group dispersion means a small area with standards that are not harvested, and ecological niche is created – place with a greater biodiversity of species. The main advantage of this dispersion is therefore a much more enhanced ecological function of the stands (Savini et al., 2015). The first stands where the group dispersion occurs are in the Umbria region.

Conclusion

In conclusion, coppice-with-standards is an efficient forest management which provides large and small dimension timber simultaneously. This type of management has important biological and aesthetic advantages for the landscape. From the economic point of view different thinning intensities had no statistically significant effect on the growth of the oak standards.

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Souhrn
Výmladkové lesy (les nízký a střední) by mohly hrát v budoucnu klíčovou roli v adaptační strategii přizpůsobení stromů na změnu klimatu. Je známo, že úloha lesních porostů při udržování biologické rozmanitosti lesů je vysoká. Urbanizované lesy jsou náchylnější k invazi nepůvodních až exotických druhů. Je důležité zachovat naše historické krajinné dědictví. Na základě toho byly na Školním lesním podniku "Masarykův les" Křtiny založeny výzkumné plochy s cílem převodu vysokého lesa na les střední s dominantním zastoupením *Quercus petraea* (Matt.) Liebl. Můžeme konstatovat, že les střední (sdružený) spojuje výhody lesa vysokého v produkci cenných sortimentů a výhody lesa nízkého v produkci palivového dříví. Je známo, že 100leté duby vegetativního původu mohou reagovat na silné uvolnění výrazným nárůstem kruhové základny ve velmi krátkém čase po těžebním zásahu. V naší studii jsme hodnotili reakci výmladků na klimatické charakteristiky a různé intenzity uvolňování v počáteční fázi převodu lesa vysokého na les střední.

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CURRENT CHALLENGE OF LAND CONSOLIDATION IN THE RURAL DEVELOPMENT

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Abstract

Land consolidation, historically carried out in any country or state, has always been a reflection of the current political, economic, financial, social, and legal conditions and has been an effective instruments of implementing agricultural policy in the hands of ruling layers. Land consolidation is a set of legal, economic and technical measures, necessary to carry out a more favourable arrangement of a given territory in order to increase the economic efficiency of agriculture, with an impact on all the systems that exist in the country.

At present, the purpose of land consolidation is shifted to the widest possible situation. It is not "just" about creating conditions for the rational management of individual owners and land tenants, but at the same time providing conditions for improving the environment, protecting and regenerating the land fund, improving the state of water management and increasing the ecological stability of the landscape.

The issue of land consolidation thus carries with it a conceptual solution to rural development involving greater environmental awareness and a wide range of non-agricultural impacts. Emphasis on land consolidation projects has shifted in recent years from a narrow focus on restructuring agriculture to achieving the most effective multipurpose use of landscape and protecting its values. The implementation of land consolidation includes activities related to the regeneration of municipalities and rural space, ideally in line with other changes in the conceptual approach to rural development.

Key words: common facilities, soil and water protection, interconnection of the territory, recreational potential

Introduction

Land consolidation is understood as an instrument for creating conditions for the rational arrangement of ownership relations to agricultural and forested land with respect to the land use and the needs of the landscape (Filip, Podhrázská, 2010). The realization of common facilities as part of these adjustments means new dirt tracks, pools, greenery in the landscape and erosion limiting. The developer of the land consolidations are the individual Land Registry offices, which also cover the full costs (Konečná, 2013).

Without dealing with the ownership relationships to the land, it is not possible realize the necessary ecological, soil-protection or landscape cultivating measures in the area. The only method to address this state are land consolidations dealing with the entire area comprehensibly, that arrange plots in the public interest in terms of space and function, creating the conditions for rational land use, both in the sense of agriculture, and to renew the country landscape for the more pleasant life of its inhabitants and visitors (Kyselka a kol.2015).

The targets of land consolidation primarily are (ZoPÚ 39/2002):

- the specification of ownership concerning size and location
- improving the accessibility of land plots by creating a network of dirt tracks
- the opportunity of joining land plots and their free demarcation in the terrain
- the opportunity to split joint ownership
- the alteration of land plot shape
- the increase in land prices
- the opportunity to start using owned land (which was inaccessible before the land consolidations)
- the measures for stabilising and improvement of the state of the environment and of the water regime in the landscape, the planning of anti-erosion and water management measures – the reduction of landslide, flood, loss of agricultural land and other risks
- the transferral of most of the land plots under the proposed common facilities to the ownership of the municipality, which leads to easier future realization from state funds.

Land consolidation is an opportunity to create not only accessible and well-marked land plots, but also areas prepared for cycle routes, bio-corridors, anti-erosion elements protecting agricultural land and other elements for the protection and use of the landscape, the improvement of environment attractivity and the improvement of tourism.

Material

Throughout the past twenty years of the existence of land consolidation the lay public has often regarded it in the sense of terrain adjustments, or land reform ("expropriation"). The effort to get the public to understand the reasons, objectives and results of the land consolidations lead to organizing of a competition with the aim of informing of the lay and expert public with the scope and level of the realization of the common facilities proposed under the land consolidation. Another objective is to positively appreciate the well-executed work of the branches of the regional Land Registries, the Land Registries themselves, the designers and the contractors, thus raising their prestige in the field. The competition was first run in 2006 under the title "Common Facility of the Year". Ten further years of the competition ran under this title (SPÚ2018).

There were three categories in the competition:

- category – Measures for the better accessibility of land plots
- category – Anti-erosion and water management measures
- category – Measures for the protection and creation of the environment

Since 2018, the competition is newly held under the brand Prize of the Czech Landscape, organized by the Ministry of the Environment. Its title is Living in Nature and has two categories:

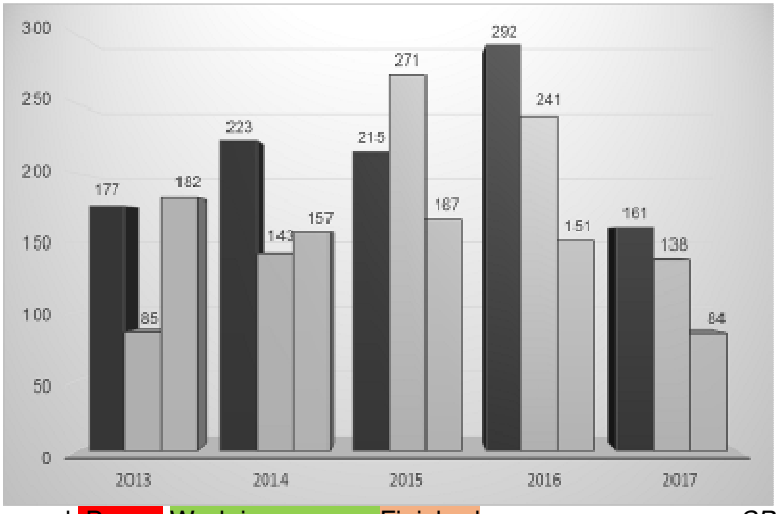
- Green and transport infrastructure
- Creation and protection of the landscape

Green and transport infrastructure deals with assessing the construction of dirt tracks and the planting of bio-corridors, windbreaks and interaction points in the landscape. Anti-erosion and water management measures are assessed in the Creation and protection of the landscape category. A board consisting of academics

and researchers and practical experts were chosen for each category. Selected projects are given points via an online form. The assessment criteria are:

- General criteria, dealing with the broader territorial context, polyfunctionality, integration into the terrain, public utility, technical difficulty, connection with landscape creation, economic effectivity etc.,
- Specific criteria for the individual categories, which rate the continuity to the network of measures, keeping to norms and technological regulations, the originality of the solution and of the used materials, the management of the materials (the balance of the earthworks) and others

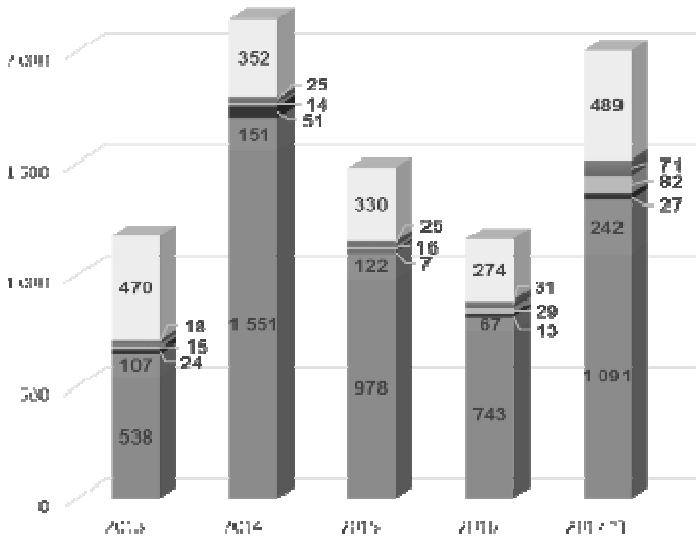
The number of finished land consolidations rises every year, as does the quality and building difficulty of the common facilities. In the Czech Republic, there are a total of 13,100 cadastral areas, out of which 4,720 finished comprehensive land consolidations. The following graphs show the development of land consolidations over the past five years, and the use of financial means for the individual common facilities also between 2013 and 2017.



Legend: Begun Work in progress Finished *source: SPÚ*

Fig. 1: The development of comprehensive land consolidations
source: SPÚ

The graph shows that the greatest financial volumes were used for the building of dirt tracks, because it is a relatively financially expensive measure and it is a priority for the local councils. (Podhrázská et al, 2015) Apart from facilitating easier transport of agriculture machinery and creating traffic diversion from the urban areas, the paved tracks fulfil other important functions – the connection between neighbouring municipalities, the greater permeability of agricultural land, making the area more attractive for cycle tourism and for the movement of local inhabitants, making sightseeing and otherwise interesting places more accessible. Water management measures serve the purpose of water accumulation in the landscape.



source: SPÚ

legend: proposal other measures ecological measures anti-erosion measures Water management measures paths

Fig. 2: The use of financial funds for the common facilities

Results

Under the criteria described in chapter 2, the best projects and realisations that fulfil all the requirements and represent a multi-functional solution to the land use for agricultural produce, the needs of the locals and visitors, and the safekeeping of natural resources and improvement of the area, were selected.

Successful projects from the accessibility of land plots category.

The presented projects are chosen from the SPÚ database and represent individual types of common facilities.

- K.ú. Dolní Morava, Červený potok, Horní Lipka, Ústí nad Orlicí region (Common facility of the year 2013)

The purpose of the structure was to improve the accessibility of land plots, the diversion of agricultural transport from local roads, making the landscape more permeable – a large-scale merging of land plots had been carried out in the past.

A side effect is the utilisation of paths for the local inhabitants – the connection of neighbouring municipalities and making the recreational area Kralický Sněžník more attractive (tourism, cycling, there is a maintained cross-country skiing route in winter)

The combination of path surfaces was an appropriate alternative to fulfilling the requirements in the protected region NATURA 2000 (a bird area, presence of the Corn Crake) see fig.3.

Fig. 3: path before and after realisation

- k.ú.Prakšice a Pašovice na Moravě, Uherské Hradiště region (anti-erosion and water management measures)

A system of two water containment facilities with its retention lowers the culmination flow in the municipality and captures a decisive amount of residue from the part of the basin above the facilities, which helps to stop local floods and currently protects the already existing retention facility inside the urban area from intensive clogging. The facility is very delicately incorporated into the landscape, thus merging with it. The constant retention of water also creates space for a plethora of new plants and animals, which increases the diversity and value of the surrounding landscape. A place that is both favourable for wildlife and a pleasant place for man was created. The location has become a favourite spot for walks, thus enriching not only the natural, but also the cultural value of the municipality (fig.4a,b).

Fig. 4 a,b: State before realisation (left) and after realization (right)

- Chrlice cadastre, Brno – City region (biocentre, measures for the improvement of the environment)

It is a complex of facilities including: a water retention facility, the planting of greenery and three paved dirt tracks. The water retention facility has an acreage of 4,3 ha, with an average depth of 3 m. A stone tier was reconstructed in the flow of the Ivanovický brook. The tributary facility ensures both the replacement of water loss caused by

evaporation, and the cooling of the water that would otherwise be quickly heated in the shallow basin. The drainage device serves the purpose of regulating the water level. The realisation of this measure improves the aesthetic and ecological value of the environment, which is very much needed, especially in the relatively drab suburban landscape. (fig. 5a,b).

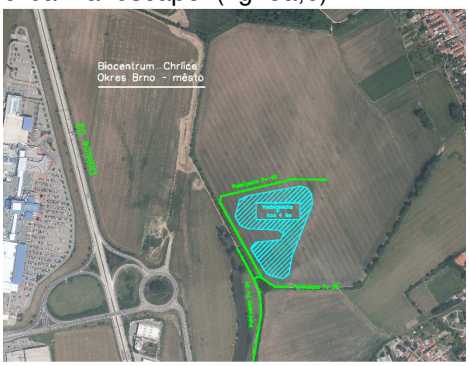


Fig. 5a: – before the realization 5b:- after the realization

Conclusion

Land consolidation is a great means for the studied territory to appropriately settle the ownership titles to the land plots, thus allowing the owners that could not previously access, for varied reasons, to use their land. They are also a rare and historic chance for the landscape of the Czech Republic. Projects of comprehensive land consolidation, territorial plans and urbanistic studies can enter the issues of planning in the countryside. This changing of the landscape requires closer cooperation and greater involvement from the local action groups, municipalities and other local initiatives in the preparation process of the land consolidations. If we want to help with the reparation, then we must support those healing initiatives that originate in the countryside themselves. A perfectly carried out comprehensive land consolidation in its designing state, and in the power of the proposed measures in the common facilities plan has an enormous achieving and motivational influence.

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Podhrázská,J. et al. (2016): Evaluation of Land Consolidation Process by Rural Stakeholders. European countryside Published Online: 2016-09-22 | DOI: https://doi.org/10.1515/euco-2015-0010 ISSN: 1803-8417Zákon č. 139/2002 Sb.Zákon o pozemkových úpravách a pozemkových úřadech a o změně zákona č. 229/1991 Sb., o úpravě vlastnických vztahů k půdě a jinému zemědělskému majetku, ve znění pozdějších předpisů

http://www.spucr.cz/pozemkove-upravy/uspesne-projekty

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Souhrn
Článek se zabývá významem pozemkových úprav pro rozvoj venkova, jejich obsahem a multifunkčním využíváním výsledků komplexních pozemkových úprav, zejména prvků plánů společných zařízení. Realizací těchto opatření lze významným způsobem ovlivnit tvář české krajiny. V článku jsou uvedeny informace o dokončených pozemkových úpravách, o jejich finanční náročnosti a prezentovány jednotlivé prvky společných zařízení. Společná zařízení sestávají z opatření ke zpřístupnění pozemků, opatření vodohospodářských a protierozních a opatřeních ke zlepšení životního prostředí. Realizované prvky slouží nejen pro potřeby zemědělské výroby, ochranu půdy a vody, ale spoluvytvářejí nový obraz venkovské krajiny. Zvyšuje se tím atraktivita území, jeho využitelnost pro podporu turistiky, zlepšení života obyvatel území, zlepšuje se vztah lidí ke krajině.

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DESIGNING ENVIRONMENTAL EDUCATION LANDSCAPES: CASE STUDY DROPIE, SLOVAKIA

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Abstract
Designing environmental education landscapes is an important task of landscape architects. The Department of Garden and Landscape Architecture of the Slovak University of Agriculture in Nitra has been commissioned by the Slovak Environment Agency to develop different student designs concepts for the Environmental Education Centre (EEC) DROPIE, located in Žitný ostrov, the largest river island of Europe. The article presents diverse design ideas, approaches and solutions developed by students within three design studios led by teachers of our department. Following the methodology of research by design, the article identifies the main design approaches and key principles applied by students in their design solutions.

Key words: great bustard, landscape architecture, research by design, NATURA 2000

Introduction

Education landscapes represent an important part of contemporary landscape architecture (Lička, Grimm, 2015). However, their share in design projects is much smaller, when compared to public space and private garden design projects. Open spaces of educational institutions form a specific category of special green spaces (Feriancová, 2008), which enable to introduce additional natural elements into urban landscapes (Supuka, 2003). These areas have usually an institutional character with a clearly defined programme and group of users, although some educational facilities might also have the character of public open spaces (Feriancová and Rendošová, 2011), which is typical especially for universities. The most common objects of education landscape design are nurseries and kindergartens, primary and secondary school gardens and yards, as well as public and semi-public university areas. In all these objects, environmental education should be one of the major design principles (Duží, 2012; Duží, Stojanov, 2013), which can be synergically combined for instance with project teaching in ecological education (Kubíčková, Fialová, 2014). From this point of view, environmental education centres (EEC) stand for extraordinary objects, where environmental education should not only be a “mere” design principle, but much rather the main design strategy, which leads to fostering the relationship between humans and their environment in the sense of cultural ecology (Lapka et al., 2012). The aim of this article is to present diverse design ideas, approaches and solutions developed by students of landscape architecture, within three design studios working on the landscape architectural design of the EEC DROPIE of the Slovak Environment Agency. This cooperative initiative of the university and the agency was promoted by radio (Rádio Regina, 2017) and television (RTVS, 2017) broadcasting.

Material and methods

The **object of design** was the Environmental Education Centre (EEC) DROPIE of the Slovak Environment Agency, which is an organisational unit of the Ministry of Environment of the Slovak Republic, located in the rural settlement Zemianska Olča, in southwestern Slovakia. Administratively, it belongs to Komárno District and Nitra Region. Geographically, it is located in Žitný ostrov, the largest river island of Europe and the largest resource of potable water in Central Europe. It has a lowland landscape character with an originally scattered type of urban development (a system of farms, so called "taňa"). The EEC is surrounded by Special Protection Area Ostrovné lúky, a NATURA 2000 site. It offers accommodation, camping, creative workshops and diverse outdoor activities. There is a semi-natural pond, an imitation of a bottomland forest, an informational centre of the great bustard (*Otis tarda* L.) and several elements of site furniture for outdoor activities, resting and playing. Moreover, there is a small farm with domestic animals, which help to manage the grasslands.

Fig. 1: Aerial view of EEC DROPIE (on the left), its localisation within Slovakia and Nitra Region (on the right top), and in the context of surrounding Bird Directive Sites (Special Protection Areas - SPA) Ostrovné Lúky and Dolné Považie (on the right bottom) (figure: Tóth, 2018; aerial photo: SEV Dropie; map data: European Environment Agency).

The **design process** began with **on-site field mapping** and discussion with local stakeholders. The discussion led to formulation of the overall design aim and specification of particular design goals and objectives. The **analytical part** of the design built upon the material gained during field mapping (drawings and maps created on site) and on targeted reviews conducted by students afterwards. The analyses focused on wider relations, functions, spatial composition, landscape context and features, and vegetation. The **design part** consisted of a conceptual design for the overall site, a more detailed landscape architectural design and design details. The **interaction** with local stakeholders consisted of an initial interview during the field visit, a midterm design review and critics and a final presentation. The article implements **research by design** as defined by Deming and Swaffield (2011) and van den Brink et al. (2017) as a tool to analyse design principles applied by students.

Results

The results of the design process consist in three different design concepts full of many creative ideas and solutions. Students introduced new activities and elements of environmental education and recreation.

Students made efforts to connect the site with its surrounding landscape through wooden lookouts and by increasing the transparency of fencing.

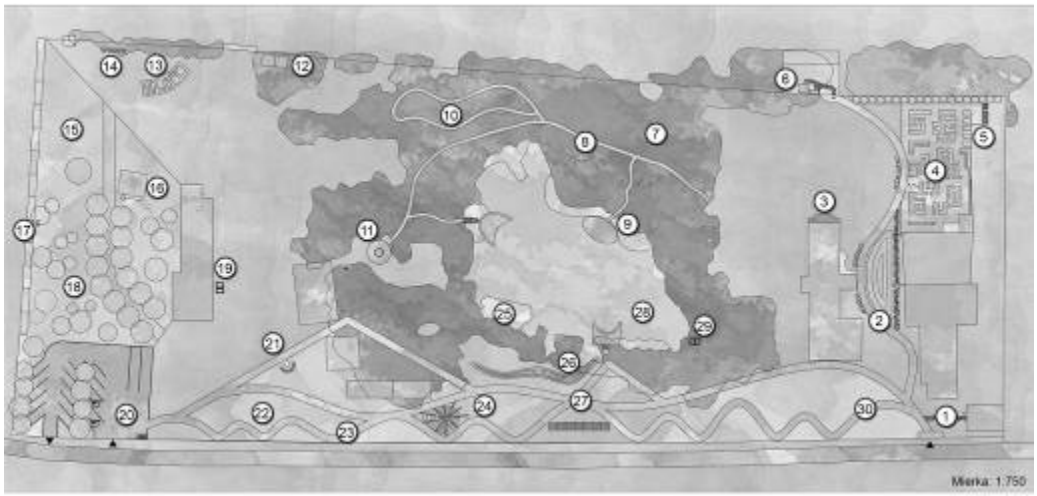

Fig. 2: Site plan of the landscape architectural design developed by students (authors: Anna Kubičárová, Denis Marek, Hana Kráľová, Ketrin Markovičová, teacher / head of the design studio: Mária Bihuňová)

Fig. 3: A good overview of the site is provided by wooden lookouts (on the left). The on-site biodiversity is enhanced by flower meadows, while a wooden shadoof (on the right) creates a symbolic linkage with the past (authors: Ján Ďurica, Martina Laktišová, Janka Melišková, Peter Mezej, teacher / head of the design studio: Attila Tóth).

Woodland of knowledge and relax

Some of the design solutions included woodland walks with educational elements on the fauna and flora of the woodland and the surrounding landscape. Students also introduced sensory walkways, colourful tents hanging on the trees and different small-scale rope courses for active and passive relax.

Fig. 4: Colourful tents hanging on the trees in the woodland (authors: Ján Ďurica, Martina Laktišová, Janka Melišková, Peter Mezej, teacher / head of the design studio: Attila Tóth)

"Waterful" design

Students integrated water in their designs in different ways. They improved the views on the existing lake and made it possible to engage with the water on a small wooden pier. This would provide an attractive experience of walking on water and getting closer to it. Small willow structures and pollard willows on the waterfront make a nice visual reference to the traditional landscape character of the area. Water and wetland plants show the amazing diversity of aquatic and hydrophilic plants. Water is also involved in diverse playing elements for children. A historic reference to water is made by a characteristic regional landmark – a shadoof (a traditional beam well). Improving the water cycle is one of the key design principles.

Improving the accessibility and telling the story through senses

Students aimed to improve the accessibility and barrier-free experience through interactive and sensory walkways that make the site more inclusive, accessible and attractive for users. The interactive walkway for instance combines accessibility with education. Visitors learn about the surrounding landscape of Žitný ostrov, trees, wildlife and water in a playful, yet educative way. Visitors learn to recognise trees, based on their overall habitus, bark, branches, leaves or fruits. They learn to recognize animals living in the surrounding landscape, from small insects, through birds, up to deer. Interactive walkways and other educative elements tell the story to visitors, who perceive it through their sense of smell, taste, hearing, touch and sight.

Farming, reusing and recycling

A reference to the farming character of the surrounding landscape with a scattered settlement character the so called "taňa" farms is made through a small production garden for education purposes, with raised beds, herbal plants, vegetable and fruit production and a small farm of typical domestic animals. The stylized farm is barrier-free, in order to include all user groups. A specific attention is dedicated to bees. Another important design principle consists in reusing and recycling materials and resources, such as water or waste. Water is collected in rain gardens, while eco toilets help manage local sewage. Compost walls not only help recycling the green waste, but at the same time they teach the visitors about the importance and techniques of composting.

Fig. 5: Wooden constructions with green roofs for domestic animals (authors: Anna Kubičárová, Denis Marek, Hana Kráľová, Ketrin Markovičová, teacher / head of the design studio: Mária Bihuňová).

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Souhrn
Projektování krajinné ekologické výchovy je důležitým úkolem krajinných architektů. Katedru zahradní a krajinné architektury Slovenské zemědělské univerzity v Nitře pověřila Slovenská agentúra pro životní prostředí vypracováním různých koncepcí studentských projektů pro Středisko ekologické výchovy (DROPIE), které se nachází na Žitném ostrově, největším říčním ostrově Evropy. Článek představuje různé návrhové nápady, přístupy a řešení vyvinuté studenty v rámci tří designových studií vedených třemi učiteli našeho oddělení. V návaznosti na metodologii vědeckého výzkumu je v článku popsán hlavní návrhový přístup a klíčové principy, které žáci používají při navrhování řešení.

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DETERMINATION OF THE TIME OF OCCURRENCE OF SELECTED ALLERGENS WITH USING LONG-TERM PHENOLOGICAL SERIES

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Abstract
The article evaluates long-term phenological series (1991–2012) of small-leaved lime (SLL) (*Tillia cordata*) and goat willow (GW) (*Salix caprea*) in the context of pollen season. Pollen of SLL and GW belong to medium-sized plants from the point of view of allergology. The data of direct phenological observations in localities Březina and Český Rudolec (the Czech Republic, Central Europe) were evaluated. The article deals with phenological phases in which pollen grains are released: the beginning of flowering (10, 50 and 100%) and the end of flowering. Phenological data shows great variability in individual years caused by the particular meteorological conditions of the year. The allergen of GW can appear from the 61st to the 125th day of the year (from 2nd March to 5th May). SLL pollen can appear in the air from 163rd to 215th day of the year (from 12th June to 3rd August). The Mann-Kendall's test suggested that phenological phases of SLL tend to show an earlier onset of beginning of flowering.

Key words: small-leaved lime, goat willow, phenological observation, flowering period

Introduction

Allergic diseases are said to belong to civilization diseases because several factors are involved in the onset of the disease, such as hereditary predisposition as well as influence of the external environment (Rieger, 1996). The most problematic plants in this aspect seem to be represented mainly by anemophilous plants, grasses, weeds and some trees whose pollen grains are transmitted by wind over long distances and sometimes indirectly by insects (Vacková, 1997). León et al. (2015) state that climate change will result in an increase in *Poaceae* pollen in the range of 28.5% to 44.3% by 2070.

Nekovář (2007) states that analysed species belong to the category of plants of medium significance allergens.

Small-leaved lime (SLL) has medium sized pollen grains (22 to 33 µm) which are round with three very short crevices and three pores surrounded by a very prominent wide ring. Pollen production of SLL is relatively large. Its pollen grains are very heavy and fall to the ground mostly in the vicinity of the flowering tree and usually do not spread into larger distances by wind (Rybníček et al., 1997). In the environment of the Czech landscape, SLL is found abundantly, mainly as an admixture of floodplain forests, in lighter groves, fallow forests and slopes, from lowlands up to 600 m above sea level (Hájková, 2012).

Pollen grains of goat willow (GW) are small, round to ovate-long, with significant mesh sculpture and three long crevices. The size of the pollen grain is very varied. It ranges from 14 to 30 µm. Pollen production is relatively large, the spread of pollen by air is very inefficient (Rybníček, 1997).

Materials and methods

The article evaluates the data from phenological observations of the Czech Hydrometeorological Institute (CHMI). The analysis was carried out for a long term period of 1991–2012 for SLL and GW. The investigation analysed phenological phases in which the release of pollen allergens occurs: the **beginning of flowering** (three levels of this phenophase are observed according to the proportion of developed flowers on the plant: 10 %, 50 % and 100 %) (BF 10, BF 50, BF 100) and the **end of flowering** (EF). The length of flowering (LF) of the trees was further defined. The analysis was carried out for two locations: Český Rudolec (540 MASL, mean annual air temperature 6–7°C, mean annual precipitation total 600–650 mm) and Březina (450 MASL, mean annual air temperature 7–8°C, mean annual precipitation total 550–600 mm). The Mann-Kendall test was used to identify trends within time series.

Results

Phenological data for individual years and stations show great variability. This variability resulted from the meteorological conditions of the particular year.

Goat willow (GW)

The earliest BF 10 of GW was recorded at Český Rudolec station on the 61st day of the year (2nd March) 1998 and at the latest BF 10 was recorded in 1996 on the 106th day of the year (16th April). The longest LF was found in 2008, namely 30 days, and the shortest one in 2006 and 2009, 12 days (Fig. 1). For Český Rudolec, the average values were found as follows: BF 10 on the 84th day of the year (25th March), EF on the 103rd day of the year (13th April), the average LF is 19 days long (Fig. 5).

In Březina, the BF 10 of GW was recorded in 2008 on the 79th day of the year (20th March). The latest BF 10 was recorded on the 96th day (6th April). The shortest LF was the same as in Český Rudolec, i.e. 12 days in 2009, 2010, 2011 and the longest LF was seen in 1996, i.e. 36 days (Fig. 2). The average values for Březina are as follows: BF 10 on the 88th day of the year (29th March), EF on the 111th day of the year (21st April), LF is 23 days long (Fig. 5).

Small-leaved lime (SLL)

In Český Rudolec, the earliest BF10 occurred in 2003, namely on the 170th day of the year (19th June). SLL the latest BF 10 on the 199th day of the year (18th July) in year 1991. The shortest LF was measured in 1992 and took 9 days, the longest LF period of 22 days was recorded in 1996 (Fig. 3). The average values for SLL in Český Rudolec are as follows: BF 10 on the 186th day of the year (5th July), EF on the 200th day of the year (19th July), the average LF was 14 days long (Fig. 5).

In Březina, the BF 10 of SLL occurred in 2003 on the 163rd day of the year (12th June). On the contrary, in 1991 and 1996, SLL did not start to blossom until the 196th day of the year (15th July). The shortest LF was measured in 1991 and took 12 days, longest LF was recorded in 2010 and 2011 and took 30 days (Fig. 4). The average values for Březina are as follows: BF 10 on the 178th day of the year (27th June), the EF on the 198th day of the year (17th July), the average LF was 20 days long (Fig. 5).

Mann-Kendall trend test

In the framework of the trend analysis, it was found that the phenological phases in GW currently occur earlier in the year, i.e. BF 10 (17 days earlier in Březina, 9 days

earlier in Český Rudolec) and BF 50 (17 days earlier in Březina, 10 days earlier in Český Rudolec). It was found that in Březina, LF of SLL was extended by 14 days. In case of GW, a significant statistical trend was observed in EF, namely that the EF started earlier by 14 days compared to the data from 1991. In addition, GW has been found to reduce LF by 15 days (Tab. 1).

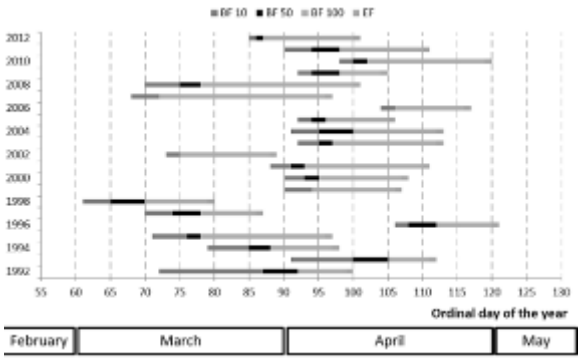

Fig. 1: Onset of selected phenological phases for goat willow at station Český Rudolec

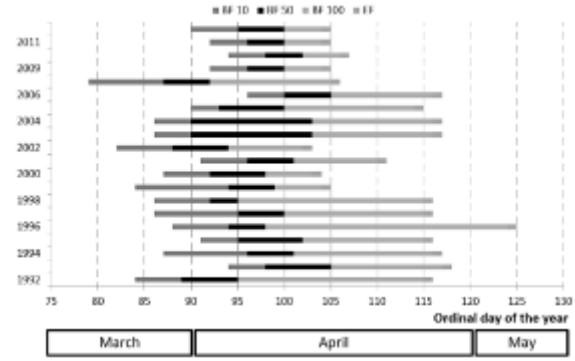

Fig. 2: Onset of selected phenological phases for goat willow at station Březina

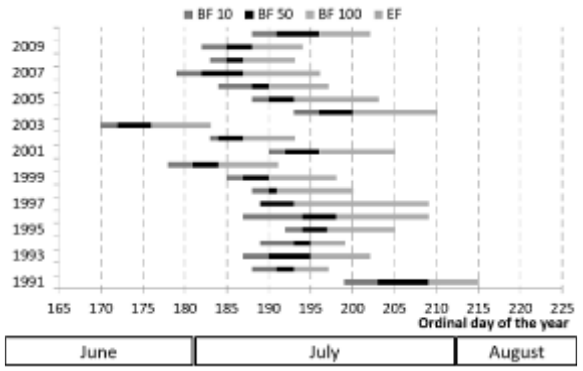

Fig. 3: Onset of selected phenological phases for small-leaved lime at station Český Rudolec

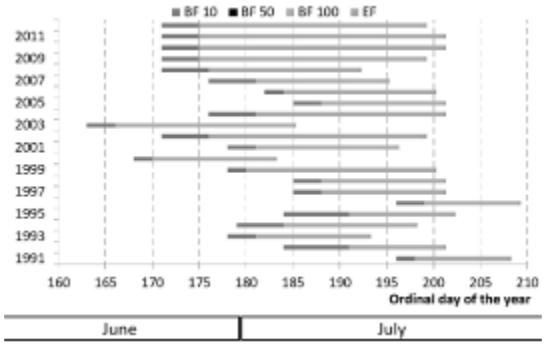

Fig. 4: Onset of selected phenological phases for small-leaved lime at station Březina

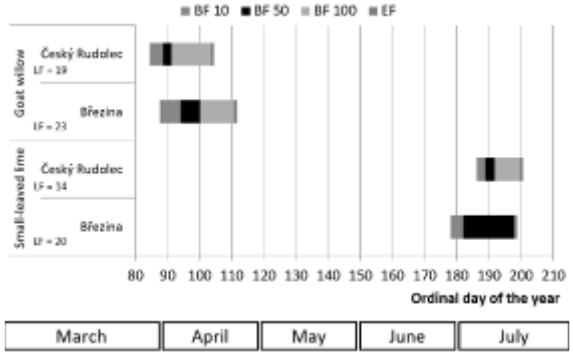

Fig. 5: Average values of the phenological phases analyzed at the stations Český Rudolec and Březina

Tab. 1: Values of the Mann-Kendal´s test

Mann-Kendal test for the period 1991–2012				
Trees species	**Small-leaved lime**		**Goat willow**	
Station	**Březina**	**Český Rudolec**	**Březina**	**Český Rudolec**
BF 10	0.003	0.037	0.605	0.347
BF 50	0.001	0.027	0.715	0.716
BF 100	-	0.079	0.927	0.525
EF	0.262	0.084	0.017	0.380
Flowering lenght	0.0003	0.717	0.011	1.000

Explanatory notes

P<0.01	A highly statistically significant trend
P<0.05	A statistically significant trend

Discussion

Škvarenina (2009), Hrvoľ et al. (2009), Vilcek et al. (2016) or Středová et al. (2015) describe bioclimate conditions, their development and specifics in different height zones in the Czech and Slovak Republic. Hájková (2012) states, that the flowering time of SLL is different for different height zones. She indicates that the LF for each height zone lasts 15 to 18 days. Total 9 years falls within this interval in Březina. The

remaining years have either a shorter or LF period than 15–18 days. In Český Rudolec there are only five years with LF within the range of 15 to 18 days. Hájková (2012) also states that LF of GW lasts 20 to 23 days on average. This average value is applicable for 6 years in case of the station in Český Rudolec and 4 years in case of Březina station from the total of 22 analysed years. The variability of the data is rather high and it is therefore appropriate to combine the long-term phenological observations in the allergen monitoring with the pollen calendar issued by the Pollen Information Service. This calendar is constantly updated according to the conditions of the particular year.

Conclusion

GW and SLL both belong to the plants of medium significance allergenic plants. Both of the plants have significant presence within the territory of the Czech Republic. The GW allergen can appear from 61st to the 125th day of the year (from 2nd March to 5th May). Pollen SLL can appear in the air from 163rd to 215th day of the year (from 12th June to 3rd August). Phenological data shows great variability in the individual years depending on the meteorological conditions of the particular year. As a result of this, long-term phenological observations should be supplemented by data from the pollen calendar which is constantly updated.

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Souhrn
Příspěvek řeší výskyt pylových alergenů lípy srdčité a vrby jívy. Pyly lípy a vrby patří alergologicky mezi středně významné rostliny. Pro vymezení termínu výskytu těchto alergenů byly použity dlouhodobé fenologické řady (1991–2012). V práci byla hodnocena data z přímých fenologických pozorování pro stanice Březina a Český Rudolec. Byly hodnoceny fenologické fáze, při kterých dochází k uvolňování pylových zrn: počátek kvetení (10, 50 a 100 %) a konec kvetení. Fenologická data vykazují v jednotlivých letech velkou variabilitu, která je způsobena meteorologickými podmínkami daného roku. Alergen vrby jívy se může objevovat od 61. do 125. dne v roce tj. od 2.3. do 5.5. Pyly lípy srdčité se mohou objevit v ovzduší od 163. do 215. dne v roce tj. od 12.6. do 3.8. Test trendu ukázal, že u lípy srdčité dochází v současnosti k dřívějšímu nástupu fenologických fází počátek kvetení 10% (Březina o 17 dnů, Český Rudolec o 9 dnů) a počátek kvetení 50% (Březina o 17 dnů, Český Rudolec 10 dnů). U vrby jívy byl statisticky významný trend zjištěn u fenologické fáze konec kvetení, takže dochází k dřívějšímu nástupu této fenologické fáze a to o 14 dnů v porovnání s rokem 1991.

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DEVELOPMENTAL TRENDS OF CLIMATIC CONDITIONS AND BIOTA IN THE HIGH TATRAS WITH THEIR CONSEQUENCES FOR TOURISM

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Abstract
The Tatra National Park (TANAP) is one of the most visited touristic destinations in Slovakia. The paper deals with changes in climatic conditions and in biota after the extensive wind calamity in 2004. There were evaluated the courses of air temperature and precipitation during the vegetation period (May-August) and the mean annual values for the localities Tatranská Javorina (1 014 m a.s.l.) and Tatranská Polianka (968 m a.s.l.) for the years 1987–2015. There were detected statistically significant increasing trends in the air temperature characteristics as well as in the precipitation characteristics. The only exception was the number of frost days showing a statistically significant decreasing trend. Mild winters, dry and hot summers and earlier onset of warmer springs during the monitored period offer favourable conditions for spruce bark beetle propagation and outbreaks.

Key words: Tatra National Park (TANAP), climatic conditions, windstorm, pests

Introduction

The Tatra National Park (TANAP) is one of the most frequently visited nature reserves in Slovakia. Its broken and distinct terrain provides appropriate conditions for hiking, mountain climbing and recreational activities in general. As such, it can be declared as a unique national hereditary. Nevertheless, repeated clear cuts followed by foresting with alien material caused that the local forest stands have become more prone to damage by natural agents, mainly wind, insects and fire (Fleischer *et al.* 2017).

In recent times, climatic conditions and climate change are topics treated with more and more attention (IPCC 2014, Škvarenina *et al.* 2004), not only at the global level but also in regional context (Ďurský *et al.* 2006, Střelcová *et al.* 2009). The TANAP climate shows several specific properties (Bartík *et al.* 2014, 2016, Vido *et al.* 2015, Šustek *et al.* 2013, 2017) determining decisively the conditions for the base and development of natural ecosystems and the associated environmental and social-economic phenomena. The climate monitoring in the TANAP territory has had a long history, fostered by the establishment of climatic spas in the 19-the century. Recently, there has been recorded increasing occurrence of extreme events such as torrential rains, above-normal heats and windstorms, having serious impacts on the natural environment (Mezei *et al.* 2017a, Škvarenina *et al.* 2009). The most disastrous windstorm occurred on November 19, in 2004, having devastated a more than 30 km long strip from the settlement Podbanské to the settlement Tatranská kotlina, with a total area surpassing 12 600 ha. The resulting large-area disturbance of natural ecosystems in the TANAP territory has provided prerequisites for study and recording of the climatic and bioclimatic factors subsequent to the disturbance and decisively determining the local conditions after the calamity (Mezei *et al.* 2014, 2017b, Střelcová *et al.* 2009). This contribution focuses on study of long-term

changes to the local climatic conditions and to biota in the affected TANAP area after the wind calamity in 2004.

Materials and methods

The TANAP territory consists of three mountain ranges: the High Tatras, the Belianske Tatras and the Western Tatras. Recurring glaciations had given this territory its unique high-mountain character with rocky depressions, basins, steep ridges and moraines (Nemčok *et al*., 1994).

The climatic conditions and their variability over the TANAP territory were assessed based on selected meteorological data assembled at two climatological stations belonging to the Slovak Hydro-meteorological Institute (SHMI): Tatranská Javorina (1 014 m a.s.l.) and Tatranská Polianka (968 m a.s.l.). The long-term mean values (1951–1980) for air temperature and rainfall total for the station Tatranská Javorina are 4.0°C and 1197 mm, respectively. The long-term mean values (1951–1980) for air temperature and rainfall total for the station Tatranská Polianka are 4.6°C and 867 mm, respectively. For the period 1987–2015, there has been investigated the history of air temperature and precipitation amount during the growing season (from May to August) and the mean annual values of these two variables. The values of air temperature and precipitation amount for the periodic 1987–2015 were compared with the corresponding long-term values. The comparison was made with the aid of a modified termo-pluvio-graph. In addition, there was studied the variation in number of tropical days (with maximum day air temperature 30 °C and more), number of summer days (with maximum day value 25 °C and more), number of frost days (minimum day temperature below 0.0 °C) and number of arctic days (maximum day temperature lower than 0.0 °C).

Results and discussion

Air temperature and precipitation belong to the principal climatic variables determining the climatic character of regions. Graphical representation of the history of mean air temperature values during growing season (from May to August) and the mean annual air temperature values over the years 1987–2015 at the climatic stations reveals statistically significant linear increasing trends in the temperature values for both stations (Fig. 1 a, b). The station Tatranská Polianka has on average by 2 °C temperature than the more northward situated station Tatranská Javorina. The results of comparing the air temperature values with the long-term values show increasing air temperature in the growing season and in higher situated zones (Collective, 2012). The comparison between the precipitation values limited to the growing seasons and the annual precipitation totals over the period 1987–2015 at the climatic stations suggests a slightly increasing or levelled-off trends in precipitation (Fig. 2 a, b). The station Tatranská Javorina shows on average by 40 % more precipitation than the more southern situated Tatranská Polianka. Several-year observations have confirmed a precipitation sum increment by 115 mm per 100 m on south-facing slopes, while the average increment in annual precipitation sum represents 70 mm per 100 m (Šamaj, 2010).

The relation between the course of air temperature and precipitation at the climatic stations in the growing seasons from 1987 to 2015 was expressed with the aid of a thermo-pluvio-graph (Fig. 3). For the station Tatranská Javorina, the most frequent were dry and warm years: 1988, 1992, 1994, 1999, 2000, 2003, 2007, 2012, 2013 and 2015. For the station Tatranská Polianka, the proportion of wet and warm years was 41 %, and the most frequent were, similar to Tatranská Javorina, with a proportion more than 51 %, dry and warm years: 1987, 1991, 1992–1994, 1998–

2000, 2003, 2006-2008, 2012, 2013 and 2015. The referred „dry and warm“ years were often discussed, primarily in relation to the mountain spruce forest decline in the TANAP and in relation to their impact on spruce bark beetle calamity outbreaks (Sitková, 2011). It is obvious that the continual dry period of years 2005–2008 provided favourable conditions for development and propagation of bark beetles. The spring beginning shifted to earlier dates with higher temperatures was responded by earlier dates of spruced bark beetle swarming. As the result of earlier swarming, there were several insect generations possible to mature.

The number of tropical and summer days in the period 1987–2015 exhibited an increasing trend, both in Tatranská Javorina and in Tatranská Polianka. On the other hand, the trend of frost and arctic days in 1987–2015 was decreasing (Fig. 4 a, b).

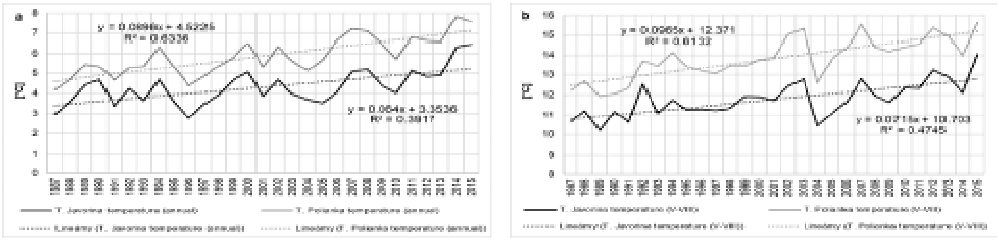

Fig. 1: Mean annual air temperature values (a) and mean air temperature values in the growing seasons (b) in years 1987–2015 in Tatranská Javorina and in Tatranská Polianka

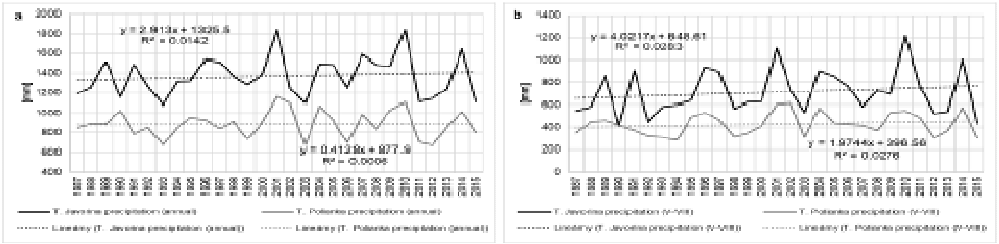

Fig. 2: Mean annual precipitation sums (a) and mean precipitation sums in the growing seasons (b) in years 1987–2015 in Tatranská Javorina and in Tatranská Polianka

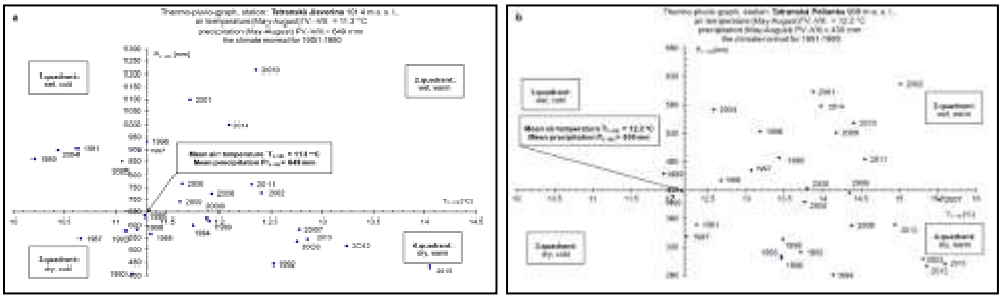

Fig. 3: Thermo-pluvio-graph for the stations Tatranská Javorina (a) and Tatranská Polianka (b) for the period 1987–2015 and the climate normal for 1951–1980

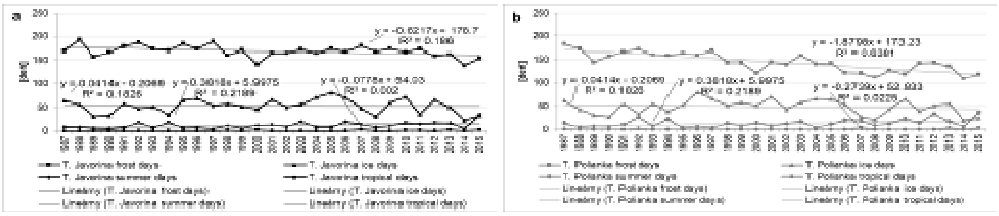

Fig. 4: The number of tropical, summer, frost and arctic days in 1987–2015 in Tatranská Javorina (a) and in Tatranská Polianka (b)

Conclusion

As for travelling activities, the primary potential of the region discussed is its natural potential comprising appropriate hydrological, climatic and geographic conditions and high diverse local flora and fauna. In this contribution we investigated the trends in climatic and biotic variability in the TANAP observed in years 1987–2015, with the focus on the years following the wind disaster in 2004. The significant increase in air temperature together with occurrence of abnormal, even extreme weather fluctuations observed commonly in the recent years were have also been confirmed for the TANAP territory. The continual period of warm and dry years boosted outbreaks of bark beetles – numerous representatives of the TANAP biota.

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Souhrn
Tatranský národní park (TANAP) je jedním z nejvíc navštěvovaných destinací na Slovensku ve všech ročních obdobích. Specifické klimatické charakteristiky v TANAPu vytvářejí rozhodující podmínky pro existenci a vývoj přírodních ekosystémů a environmentálních a socioekonomických jevů. Příspěvek se zabývá změnami v klimatických podmínkách a bioty, zaměřené na vývoj teplot vzduchu a srážek během roku a vegetačního období (květen–srpen) pro lokality Tatranská Javorina (1014 m n. m.) a Tatranská Polianka (968 m n. m.) během roků 1987–2015. Statisticky signifikantní rostoucí trend vykazovali charakteristiky teploty vzduchu i srážek, s výjimkou počtu mrazových dní, které měli statisticky signifikantní klesající trend. Mírné zimy, suché a horké letá umožnili vytvářet příznivé podmínky pro vývoj a rozmnožování podkorního hmyzu.

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DEVELOPMENT OF DROUGHT IN THE PODYJÍ NATIONAL PARK, PRESENT AND OUTLOOK UNTIL 2100

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Abstract
The article analyzes and predicts drought in the Podyjí National Park. Drought is solved trough data of the potential water balance, which appropriately characterizes possible climatic drought. This is a difference between precipitation and the potential evapotranspiration from the reference surface which is in this case the grassland (ie the basic balance of grassland). Potential evapotranspiration was determined based on modified algorithm according to the Penman-Monteith methodology. Moisture conditions are on this site investigation for two time periods – the present and the outlook until 2100, which is modeled according to the A1B emission scenario. Based on the results are identidfed the most vulnerable parts of the ecosystem.

Key words: Podyjí National Park, drought, water balance, potential evapotranspiration

Introduction

Podyji National Park is situated in Vranov nad Dyji cadastral community, South Moravian region. It covers the area of 63 km2, which makes it the smallest national park of the Czech Republic. In Lower Austria the area continues as Thayatal National Park. Podyjí National Park spreads along the river Dyje flowing through a 40 km long, deep, valley meandering between Vranov nad Dyji and Znojmo.
According to Quitt (1971), 4 climatic areas reach into the Podyjí NP territory. The western belongs to the mildly warm region MT9. The central part of the NP lies in the mildly warm region MT11. It is followed by the warm region T2, and the eastern part of the national park belongs to the warm region T4. The average annual air temperature in the western part is approximately 7 °C, while in the eastern part it reaches up to 8.8 °C. The area of the NP i sone of the extremely dry areas in the Czech Republic. The average annual precipitation total is approximately 620 mm (Kacetl, 2011).
Podyji NP is one of the areas with the greatest variety of invertebrates in central Europe. Around 9000 species were discovered. Thermophilous species of the Pannonian steppe as well as typical sub-montane species of the Hercynian forests can be found living next to each other on a relatively small area. As far as flora is concerned, Podyji is one of the richest localities of the Czech Republic (Běťák et al., 2016).
The area of Podyji NP is poor in water bodies. The most important hydrological phenomenon is the river Dyje. Then there are little pools and water bodies, which play a significant role for the development of a number of amphibians and invertebrates (Administration of the Podyjí NP, 2012).
There are altogether 4 national parks in the Czech Republic, all of them very popular with tourists. Podyji NP is situated in the most drought-stricken area of the country. Due to dry periods, the phenomenon of environmental drought occurs there, which is defined as drought caused by a shortage of precipitation and affects natural ecosystems and the environment. The impacts of this phenomenon on Podyji NP are both negative and positive. In 2015, when a dry period started, several

phenomena occurred. Extreme heat and drought of that summer complicated lives of many animal as well as plant species, while other species got the chance they had been expecting for many years. Thus, the tourist visit rate may either decrease due to the regression of some plant species or increase because of the higher attractiveness of the locality thanks to the occurrence of uncommon species.

Materials and methods

Drought is evaluated on the basis of the characteristics of potential evapotranspiration of grass vegetation in the vegetation period (March - September), which represents the total amount of water in mm able to evaporate from the soil, given the current optimum saturation of the soil profile and particular climatic conditions. The data for this research was provided by Czech Hydrometeorological Institute (CHMI). The development of drought at this locality is examined by means of comparison of two eras – present and the prospect of the year 2100. Present is evaluated on the basis of the data from the period 1961 – 2010, while the prospect of 2100 from the data of 2071 – 2100. The values of potential evapotranspiration were processed using a modified Penman-Monteith method, which enables the calculation of vaporization of water from different surfaces. The modified algorithm according to this method is the fundament of agrometeorological model AVISO practised at CHMI, which was modified and adjusted to the conditions in the Czech Republic (Kohut, 2007). The prospect to 2100 is modelled on the basis of emission scenario A1B, which was simulated using the regional climatic model ALADIN – Climate/CZ (Štěpánek et al., 2008). Creating of the technical series of climatic data by CHMI significantly helped the modelling of these characteristics. The series of data presents a database of daily values of climatic elements since 1961 for 787 points around the Czech Republic in the 10 km grid network.

Results

The graphs in fig. 1 and fig. 2 compare the course of evapotranspiration for both eras (present and prospect of 2100). The first graph shows that at the beginning of the vegetation period 1 mm higher evapotranspiration values are to be expected compared to present. In April and May this trend will decrease and a more significant change will occur in June, when the evapotranspiration values in the prospect will increase again and exceed the present values until the end of the vegetation period.

The graph in fig.2 shows cumulative values of potential evapotranspiration, which present the course of the increase of the sum of evaporation in the vegetation period. The most significant growths of the prospect values compared to present are mainly apparent at the end of the vegetation period in August and September.

Tab. 1 shows the amount of water able to evaporate in individual months. A rise of the potential evapotranspiration value from 641 mm to 717.6 mm (by 76.6 mm) is to be expected by the year 2100. As mentioned above, the highest increase will occur in August and September. During these months, an increase by 23 mm can be expected. Contrary to that, April will bet the only month when the evapotranspiration will decrease a little, compared to present.

The river Dyje dominates the water ecosystems in Podyji NP, but overall, this area is poor in wetlands. Altogether, there are 13 lakes, out of which Jejkal lake at Vranov nad Dyji with its wet meadows is the most valuable. Specially protected plant species can be observed in moor meadows. Typical inhabitants of the wood or meadow pools, small lakes and wetlands are amphibians. Drought can be a limited factor here, especially for these ecosystems.

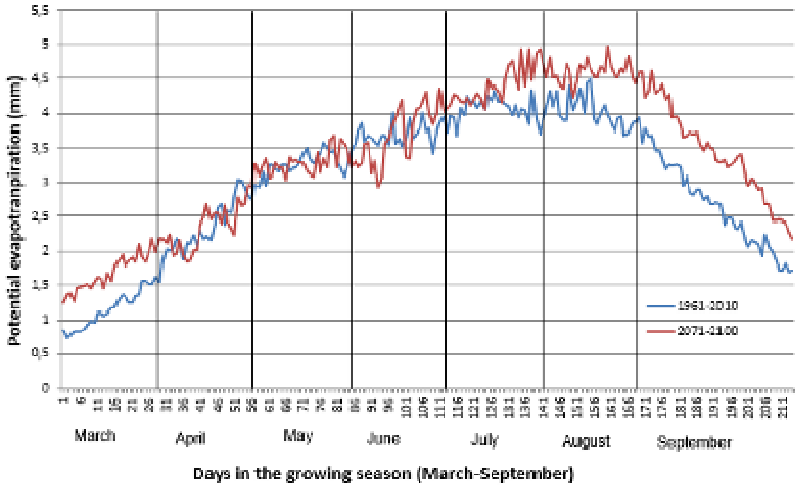

Fig. 1: The course of potential evapotranspiration during the growing season (March-September)

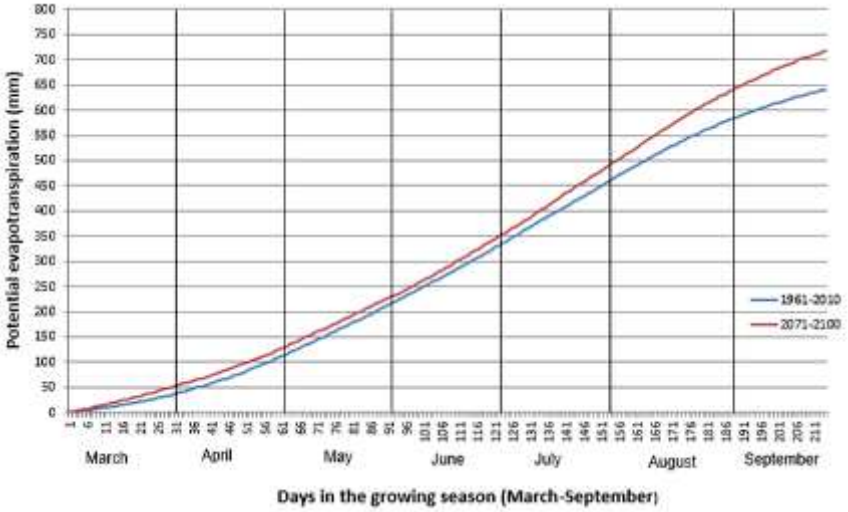

Fig. 2: Cumulative values of potential evapotranspiration

Discussion

By the year 2100 an increase in evapotranspiration and thus an increase in the occurrence of drought can be expected. Similar results were also presented by Kohut, Mužíková and Středa, who observed water balance of the river landscapes in lowland areas, mainly the localities Lednice (167 MASL), Olomouc (217 MASL) and Hradec Králové (230 MASL). Similar method was used for calculation of the evapotranspiration in Podyji NP and these localities. The water balance is defined as the difference between the amount of precipitation and evapotranspiration. The results are shown in Tab. 2.

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

Month	1961-2010	2071-2100	Increase/decrease by 2100
March	37,7	53,5	15,9
April	75,3	75	-0,3
May	105	102,6	-2,5
June	114,2	118,5	4,3
July	126,9	140,7	13,7
August	113,2	136	22,8
September	68,7	91,4	22,7
Total	641	717,6	76,6
Difference	76,6		

Tab. 2: Basic (potential) water balance of grassland in interest sites, average long-term annual sums [mm] in scenario periods including change to normal (reference) period

Screenplay	Grid points representing interest areas		
period	Lednice	Olomouc	Hradec Králové
1961–1990	-176,8	-10,6	14,8
2010–2039	-186	9	-25,5
change (mm)	-9,2	19,6	-40,2
2040–2069	-249,4	-67,9	-127,3
change (mm)	-72,6	-57,3	-142
2070–2099	-346,4	-163,1	-155,2
change (mm)	-169,6	-152,5	-170

Středová and Středa (2015) observed the course of weather in the South Moravia. Their results imply an increase of potential evapotranspiration and thus higher susceptibility of areas of southern Moravia to drought during period 1901 – 2010. Average annual precipitation total doesn't differ significantly. Rather than that, their different distribution during a year and vegetation period is visible.
As a result of a dry period, in 2015 an environmental drought occurred in Podyji NP, causing a number of plant and animal species to perish. Out of the local plants, it was for instance heather, which is normally very drought-resistant. Pine and oak trees suffered the most of the local tree species. Due to the drought, the number of insects also decreased, making the insectivorous bird species unable to feed their young, causing thus a drop in their population. In general, there was a decrease in the species, which are typical for this locality, and it can be said, that due to this, the locality may become less attractive for tourists. But extremely hot and dry weather provides a big chance for a new development. The bald spots where grass used to

be are taken by species unable to compete with it or those species, which need more sunlight and space. The health of the animal population was restored due to the fact that only the strong and sturdy individuals survived. More
over, animal species, whose occurrence is conditioned by extremely hot weather, occurred here (Administration of the Podyjí NP, 2015).

Conclusion

Podyji NP lies in the most drought-stricken area of the Czech Republic. According to the scenario data, by the year 2100 the evapotranspiration in this area will increase by 76.6 mm compared to present. The locality is poor in water bodies, thus this increase could eliminate the contemporary species. This phenomenon was observed in 2015, when a significant drought period started. Some species were eliminated and reduced, but a chance was given to species, which do not normally occur there. The change of the climate will unmistakeably lead to a change in the species composition, which can cause either a decline or an increase in tourism in this area.

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Souhrn
Národní park Podyjí je z pohledu turistiky hojně navštěvovanou oblastí. Tato lokalita se již nyní nachází v suchem nejvíce zasažené oblasti republiky. S probíhající klimatickou změnou, která přináší horké a suché epizody, dochází na této lokalitě ke změnám v druhovém složení fauny a flory. Tento fakt byl patrný např. v roce 2015, kdy zde nastalo tzv. environmentální sucho, které vedlo k úhynu mnoha druhů rostlin a živočichů. Současně byla však zaznamenána přítomnost jiných vzácných druhů, které díky této situaci dostaly šanci pro svůj vývoj. Prostřednictvím dat potenciální vláhové bilance byla analyzována a srovnána současná situace a situace ve výhledu do roku 2100. V současnosti se během vegetační sezony z této lokality odpařuje 641 mm. V roce 2100 by to mělo být až 717,6 mm, tj. nárůst o 76,6 mm. Z výsledků je patrné, že v budoucnu lze na této lokalitě jednoznačně očekávat změnu v druhovém složení živé přírody, což může mít pozitivní i negativní dopady na návštěvnost v tomto národním parku.

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ECOLOGICAL EDUCATION AS A TOOL OF LANDSCAPE PROTECTION IN POLAND

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Abstract

Ecological education is perceived today as an important instrument for the implementation of the eco-development of the state. It is also a form of process whose aim is to shape a positive and responsible attitude of society to the environment. Poland, ratifying the „European Landscape Convention", committed to promoting and teaching values related to landscapes and the issues of their shaping by various educational institutions. Care for high quality landscaping requires cooperation for their protection, management and planning. Landscaping issues within formal education at primary school level in Poland are focused on facilities available in schools' settings. An important role in encouraging further deepening of knowledge about the landscape or positive actions for the environment is attributed to informal ecological education. This type of education can be developed due to the educational material base mainly located in national parks and in forests administrated by the State Forests. The aim of the article is to present positive examples of access and development of basic types of Polish landscape.

Key words: landscape values, ecology, nature education, environmental protection

Introduction

The landscape according to the European Landscape Convention (Journal of Laws from 2006 No. 14, item 98) is an area whose character is the result of action and interaction of natural and / or human factors. One of the goals of landscape protection is shaping the right attitudes of man towards his values through education and various types of information and promotion activities Fortuna-Antoszkiewicz, Łukaszkiewicz (2017). Schools play a major role in the implementation of environmental education in Poland, mainly - basic and cooperating units, because the main group of recipients of activities related to environmental education are children and schoolchildren. Schools run so-called formal ecological education based on the content defined in the core curriculum of general education. Informal ecological education is provided by public administration bodies, administration of areas valuable in terms of nature, organizers of rest and tourism, etc. (Strategy 2001). The aim of the article is to discuss landscape content taken into account in formal education and to show positive examples of access to and development of basic types of Polish landscape. The tourism and recreation infrastructure can in an interesting way be a carrier of information about the cultural and natural values of the landscape, and at the same time make tourists more sensitive to its beauty.

Material and methods

The implementation of the work objective required a detailed analysis of the provisions of the Regulation of the Minister of National Education of 14 February 2017 on the core curriculum of pre-school education and the core curriculum of general education for primary school...(Journal of Laws 2017.0.356). Analysis of the above the ordinance allowed to trace the landscape content taken into account at the various stages of pupils' acquisition of knowledge in primary schools. The next stage was the analysis of internet portals concerning tourism in Poland, presenting the most beautiful Polish landscapes, encouraging to visit unusual places in Poland (eg www.polskiekrajobrazy.pl, www.podroze.se.pl, www. poznajpolske.onet.pl). This information helped to identify positive examples of tourism and recreation infrastructure, supporting informal ecological education for the benefit of landscape protection, its natural, cultural and aesthetic values.

Results

The current core curriculum of general education for eight-grade primary schools (Regulation 2017) is quite broadly related to landscape issues. The analysis of this document shows that the school's tasks in the scope of integrated-early-school education (classes 1-3) include organization of classes supporting the perception of the natural environment (and thus the landscape) and its exploration and the creation of children the opportunity to learn values and interrelationships components of the natural environment. At the level of classes IV-VIII, landscape content is presented mainly in the following subjects: nature, implemented in classes IV-V and geography (classes VI-VIII). The subject of nature is aimed at bringing students closest to the surrounding environment, creating them the opportunity to learn about the components of the landscape and dependencies occurring in nature and sensitizing them to the beauty of nature. The natural knowledge allows students to, among others, assess changes in land use that affect the landscape of the surrounding area. In class V, an important skill is to read the map, indicate the location of geographical regions of Poland and areas with specific landscape features. At this stage, students learn about selected Polish landscapes (alpine, upland, lowland, lake, seaside, metropolitan, urban-industrial, agricultural) and world landscapes, their features and constituent elements. Fifth grade students can indicate the location of certain types of landscapes on the map, present their main features and typical plants and animals. In the next - 6th grade, pupils of students in the geography subject, inter alia, characterize the location, course of the boundaries and the coastline of Europe. In turn, in the seventh grade, the pupils, among others, distinguish types of forests in Poland and explain the spatial diversity of the forest cover indicator of Poland. At this stage, students acquire knowledge about the tourist values of Poland and selected objects from the List of World Cultural and Natural Heritage of Humanity, located in Poland. In the last - 8th grade of elementary school, students will learn about selected problems and geographical regions of Asia, Africa, North and South America, Australia and Oceania and circumpolar areas.

Knowledge about the landscape can also be acquired in an informal way - as a result of informal (non-school) ecological education, conducted in Poland mainly in national parks and forests administered by the State Forest. Non-formal ecological education is conducive to the enormous number of various educational activities, exhibitions and competitions, also an extensive educational material base, which includes: museums, centers and educational chambers, as well as educational paths (Janeczko 2017). The tourism and recreation infrastructure is of great

importance in discovering and learning about the natural and cultural values of Poland, because the landscape is very much related to cognitive tourism, nature tourism as well as cultural tourism (Janeczko 2016). An interesting example of infrastructure showing the basic, characteristic features of, for example, the coastal landscape is built of steel and reinforced concrete in 2009, in the place of the former wooden descent to the beach, a viewing platform that allows tourists to view the Gothic ruins of the church in Trzęsacz. The church, originally located in a place distant from the then edge of the cliff by more than 1m, is the most famous example of the retreating cliff (Migoń 2012). In the coastal landscape of Poland, just cliff sections, as well as fields of coastal dunes are the most characteristic feature, and at the same time the main tourist attraction of the coast. An example of making the dunes available is the nature trail "Orzechowska dune" in the vicinity of Ustka (Ustka Forest District). Educational paths in many places, apart from the presentation of natural phenomena, are made available just by the landscape features of the area. An example of exposing the waterfront landscape can be, for example, an educational path leading to the Czajcze Lake within the Wolinskie National Park (Wolinskie Lake District), where you can learn about the specificity of the Warnowsko-Kołczewskie lakes, as well as the history of the place and its present tourist attraction, which is the so-called. "Beaver Boulder" - one of the numerous boulders brought by the glacier from the areas of present Scandinavia. Erratic boulders are a characteristic element of post-lake landscapes.
In turn, in the plains of Poland, a characteristic element is the Kampinos Forest with dune fields, as well as natural river bed systems - the Narew multi-ridge system and the Bug Valley with a naturally meandering bed and numerous oxbow lakes. An interesting example of the access and development of the Nadnarwiański landscape is the natural footbridge established in 2008 connecting the two villages of Waniewo and Śliwno. Wooden jetties have been led through Narnia's swamps and troughs. There are also four self-service mini-ferries (dinghy platforms, pulled with ropes). Along the paths there are information boards which show tourists the natural and cultural values of the park.
Another example of the tourist and recreational development of the area, and at the same time making the landscape assets available is the Kadzielnia geological reserve in Kielce, with an area of 0.6 ha, created in 1962, where various varieties of Devonian limestone as well as karst forms are well exposed. The reserve together with the existing infrastructure is a successful example of the reclamation of the post-mining excavation. Currently, many of the former mining objects, characteristic for this type of landscape, such as Kadzielnia are made available for the needs of tourism. A characteristic element of the upland landscape are also limestone dwells, as well as numerous caves and other karst forms, attractive for tourists (Migoń 2012). In the uplands, a specific loess sculpture has developed, which is determined by deep, branched ravines. The most spectacular example of an anthropogenic ravine is Korzeniowy Dół near Kazimierz Dolny, also open to the public. In turn, the Polish mountain landscape is open to visitors through the system of tourist trails, educational paths, as well as viewpoints, where you can learn about the panorama of mountain peaks, their history and nature. In many places in the Pieniny, Beskidy mountains or Bieszczady, you can still see the remains of the Huculs, Bojków and Lemkos inhabiting these areas. An interesting example commemorating the old Lemko villages, which as a result of historical turmoil disappeared from the map is the monument "Door to the Lost World" by Natalia Hładyk. The monument in the form of wooden doors symbolizing the now-defunct houses and entire villages, constituting an invitation to the past, is in Radocin and four other villages in the area

(Czarne, Długie, Nieznajowa, Lipna). Each door has a map and a description of the history of the town.

Discussion

The landscape has a significant impact on the quality of human life, and there are many sources posing a threat to its proper functioning (Janeczko 2012). The European Landscape Convention (Journal of Laws from 2006 No. 14, item 98) and the Act on Nature Conservation (Journal of Laws from 2004 No. 92, item 880, as amended), means actions for the preservation and maintaining important or characteristic features of the landscape, so as to direct and harmonize changes that result from social, economic and environmental processes. The first official government document in Poland referring to the problem of full implementation of the Council of Europe Landscape Convention is adopted on December 13, 2011 by way of a resolution of the Concept of Spatial Development of the Country 2030 (Janeczko 2016). One of the objectives of the country's development, mentioned in this document, is "shaping spatial structures supporting the achievement and maintenance of a high quality of the natural environment and landscape values of Poland". Care for high quality of landscapes is also associated with conducting intensive environmental education of society, in order to limit the sources of threats to the landscape, achieve greater care for the order and aesthetics of space and increase the responsibility of people for the place where they live. Poland, ratifying the provisions of the European Landscape Convention, has assumed, among others, the obligation to promote and teach values related to landscapes and issues of their shaping by various educational institutions. The current core curriculum allows students to learn about the landscape adequately to their cognitive abilities. Thanks to that, the information transferred creates a logical sequence of related, extended information about the natural and cultural values of the immediate surroundings, the country, the continent and the world. An important role in encouraging further deepening of knowledge about the landscape or positive actions for the environment is attributable to informal ecological education. Infrastructure, as shown in the above examples can be interesting, original not banal and can give information about the landscape as well as make us sensitive to beauty.

Conclusion

The analysis of landscape content developed in formal education together with the discussion of positive examples of access to and development of basic types of Polish landscape lead to the following conclusions:

- Landscape is a basic component of the natural and cultural heritage of society, hence its protection is one of the challenges for contemporary spatial planning
- Effective landscape protection requires intensive ecological education, both formal and extracurricular
- Tourism and recreation infrastructure is important from the point of view of learning the natural and cultural values of the area and discovering the beauty of the landscape

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Souhrn
Jedním z cílů ochrany krajiny je utváření správných postojů člověka k jeho hodnotám prostřednictvím vzdělávání a různých typů informačních a propagačních činností. Otázky terénní úpravy v rámci formálního vzdělávání na úrovni základní školy v Polsku jsou zaměřeny na zařízení, která jsou k dispozici v školních zařízeních. Důležitou roli v podpoře dalšího prohloubení znalostí o krajině nebo pozitivních činnostech pro životní prostředí přisuzuje neformálnímu ekologickému vzdělávání. Tento druh vzdělávání lze rozvíjet díky základním vzdělávacím materiálům, které se nacházejí převážně v národních parcích a v lesích spravovaných státními lesy. Cílem článku je prezentovat pozitivní příklady přístupu a vývoje základních typů polské krajiny. Infrastruktura může přinášet zajímavým a originálním způsobem informace o kulturních a přírodních hodnotách krajiny a současně zvýšit citlivost na krásu krajiny

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EDUCATION AND RECREATION IN PARKS IN THE CONTEXT OF LANDSCAPE PROTECTION

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Abstract

In the era of globalization, strong urbanization and practically irreversible anthropogenic transformations of the landscape, there is a growing need for recreational areas to serve universal environmental education and promotion of the broader ecological culture. In the landscape architecture of the turn of the 20th and 21st centuries has intensified a specific trend of popularizing ecological knowledge in facilities intended for recreation - both in already existing and planned to establish. In many such places there often occurs the problem of combining conflicting social expectations, ie access to unspoiled nature with simultaneous intensive recreational use of the area. Strong anthropopression is always associated with the degradation of the landscape and natural resources. In order to counteract such phenomena, it is advisable to develop an individual, balanced structure of the program for individual objects/areas - localized and targeted to specific functions, adapted to the expected recreation turnout.

In this paper the authors would like to present selected issues of the development of recreation and education program in selected European parks, supported by representative examples of modern solutions in this field (education with recreation achieved through multi-purpose or specialized cubature objects, as well as pieces of equipment having and supportive qualities).

Key words: recreation and education program in parks, ecological culture, didactic elements

Introduction

Environmental and landscape protection measures regulated in European and national law (such as European Landscape Convention Dz.U. of 2006, no. 14, item 98; Environmental Protection Act Dz.U. of 2004, no. 92, item 880 as amended) for years have been accompanied by public environmental educational activities as well as shaping of a broadly understood ecological sensitivity. Only knowledge and understanding of natural phenomena and recognition of consequences of human activity allow real and effective protection of valuable natural and landscape assets.

Parks and gardens, a product of human ingenuity and power of nature, by their very character provide numerous opportunities for broadly understood education. This function is very important for public sites, especially those located in urban areas (New Athens Charter 1998) or in their close proximity — heavily utilised areas with high daily and weekend traffic.

Material and methods

To identify modern means of providing recreational and educational functions in parks, authors have presented some sample initiatives from selected European

sites. Research is based on own observations carried out between 2012 and 2017. The following features were analysed: type and form of programme elements, their placement and spatial context, availability, user profile, use intensity, effectiveness.

Results

In recent years a trend of introducing new programme elements in garden spaces can be seen — these range form specialised educational and utility structures to small educational features — which decidedly increase the attractiveness of these sites and expand their educational function.

New structures and buildings are introduced into existing parks (mainly large-area ones) with the goal of providing, often new, features (Fortuna-Antoszkiewicz, Łukaszkiewicz 2017). Some examples include:

- *Orchid House* in Łańcut Castle Museum — historical site (19th/20th century), rebuild and modernised (2007-2009); collects historical species and varieties of orchids from the pre-war count Potocki collection as well as contemporary bastard varieties and natural botanical orchids (https://www.zamek-lancut.pl...);
- A tree root system observation station, Forstbotanischer Garten Eberswalde, Germany — the garden plays an important part in preserving endangered natural areas and ecological education; man-controlled tree cultivation stations allowing observation of tree development have been set up. (http://www.hnee.de...);
- *Rhizotron* and *Xstrata Treetop Walkway* (2008 r.), The Royal Botanic Gardens, Kew, England — education on soil life around tree-roots (*Rhizotron*); observation of tree crown structure, education on tree life and their significance for the ecosystem (*Xstrata Treetop Walkway* — an observation walkway running at tree crown height, 18.0 m above ground level, 200.0 m long; designed by Marks Barfield Architects) (http://www.kew.org/visit-kew-gardens/explore/attractions/treetop-walkway);
- *Davies Alpine House* (2006 r.), The Royal Botanic Gardens, Kew, England — small site (16.0 m long, 10.0 m high) providing optimal display of alpine vegetation (natural air flow is ensured by appropriate shape of the roof and a ventilation system; indoor air temperature approx. 20°C throughout the year; automatic shading system protects vegetation from overheating) (http://www.kew.org/visit-kew-gardens/explore/attractions/davies-alpine-house);
- *The Great Glasshouse* (2005 r., designed by arch. Peter van der Toorn Vrijthoff, area 3,000 m^2), RHS Garden Wisley, Surrey, England — showcasing highest horticultural standards, providing public education; cultivation of over 5,000 plants (such as palms, tree ferns, lianas, cactuses, exotic water lilies) as well as of collections of plants from 3 climatic zones: dry, moist, tropical (https://www.rhs.org.uk/gardens/wisley/garden-highlights/the-glasshouse);
- *Millenium Seed Bank* (2000 r.), The Royal Botanic Gardens, Wakehurst Place, Sussex, England — a modern scientific facility with an area exceeding 0.5 ha was erected in place of former storage cold rooms; in 2010 seeds of 10% of all naturally growing flowering plans (approx. 30 thousand species) have been collected; it is estimated that by 2020 bank resources will cover 25% of global species (http://www.kew.org/visit-wakehurst/explore/attractions/millennium-seed-bank).

These sites are highly specialised and aimed at scientific research into floristics while at the same time making them available to the public (Fig. 1). They are

designed so as to blend in with their surroundings and utilise newest technologies and engineering solutions.

Fig. 1: Specialised scientific and exposition facilities: A/ *Storczykarnia* (*Orchid House*) in Łańcut, Poland; B/ a tree root system observation station, Forstbotanischer Garten Eberswalde, Germany; C/ *Rhizotron and Xstrata Treetop Walkway*, RBG Kew, England; D/ *Davies Alpine House,* RBG Kew, England; E/ *The Great Glasshouse,* Wisley, England; F/ *Millenium Seed Bank,* Wakehurst, England (photo: J. Łukaszkiewicz, P. Wiśniewski, 2012-2015)

One example of a different kind of structure (designed for a park with an area of approx. 600 ha) is "Elka" cable railway in Silesia Park (Chorzów, Poland). Commissioned in 1967 it was the longest low-land cable railway in Europe (5539 m long). Modernised from ground up in 2013 (on *Silesia Stadium – Silesia Fair* section, 2210 m long) it provides not only means of transport around the Park but also constitutes sort of a mobile "observation deck" which gives an overview of the landscape of the Park and its environs (Fig. 2) as well as allows observation of nearby tree crowns (Fortuna-Antoszkiewicz, Łukaszkiewicz, Wiśniewski 2016).

A-B

Fig. 2: “Elka” cable railway after modernization: A/ cable gondolas over the Rose Garden; B/ view from the level of the cable gondola - to the park and the city in the background (photo: P. Wiśniewski, 2014)

Apart from theses specialised (but also expensive) structures various smaller facilities are erected within Parks. Those include inspiring playgrounds, recreational and educational areas — made available in an organised and attractive fashion. Proposed recreational facilities also serve an educational purpose: recognition of tree species and wood types (Fig. 3), plant physiology, animal behaviour (Fig. 4), etc. For this purpose local conditions and materials are used such as various species of trees windthrown or cut for maintenance reasons. These are used, among other, to build various entertainment and agility installations, showcasing arrangements, garden furniture.

A relatively new but already widespread trend are the so called rope courses – agility courses made of footbridges, tunnels, nets, ladders, etc. suspended on special structures or trees. Such creative outdoor activity structures also provide education — close contact with tress and animals (such as insects), a “birds eye view”, etc.

A-B

C-D

Fig. 3: The log trail created from fallen trees of different species: A-C/ RBG Kew; D/ The National Arboretum at Westonbirt, Gloucestershire (photo: B. Fortuna-Antoszkiewicz, J. Łukaszkiewicz, P. Wiśniewski, 2015)

Fig. 4: Elements of infrastructure and equipment with didactic values: A/ scheme of functioning of the root system of the tree, *Rhizotron*, RBG Kew; B/ presentation of the internal tree structure, RBG Kew; C-D/ garden furniture made of local trees, RGB Wakehurst; E/ viewpoint for nature observation, RBG Kew; F/ fitness facility and viewpoint, Hillier Arboretum; structures for living space and observation of insects: G/ Botanic Garden, Lviv, Ukraine; H/ RBG Kew; I/ *Badger Sett*, RBG Kew; J/ rope park structures, Park Śląski, Chorzów
(photo: B. Fortuna-Antoszkiewicz, J. Łukaszkiewicz, P. Wiśniewski, 2015, 2016)

Observation of park vegetation and landscape, appreciation of views — has the effect of rising awareness and broadening knowledge of the surrounding world. Artistic forms introduced in this context enrich spatial arrangements and underline qualities of the surrounding area. Sculptures and spatial installations utilising organic materials (wood, wicker) as well as unremoved dead trees (Fig. 5) are also valuable in rising awareness. Their theme varies, but often hints at surrounding nature — symbolically or using examples of animal and plant species present in a given area.

A-C

D-E

Fig. 5: Sculptures made using not removed dead trees and wood from trees felled: A/ RBG Wakehurst, B/ RHS Garden Wisley; C/ Parco Civico Villa Ciani, Lugano, Switzerland; D/ RBG Kew; E/ wicker's installations, RBG Wakehurst (photo: B. Fortuna-Antoszkiewicz, J. Łukaszkiewicz, P. Wiśniewski, 2013, 2015)

Discussion

Parks and gardens have always provided space for appreciation of nature. 20th century has seen an expansion of their user base, and public availability has to an extend modified their function — currently they are equally usable as a space for recreation as for in-depth education. Due to access route isochrone urban parks are of special importance; with site area and its character being a limiting factor when selecting scope and type of new programme elements.

Conclusions

Observing current trends in European parks it can in general be noted that:

- range of possible educational facilities is basically unlimited;
- preference for high-tech solutions and high-quality is common - both in terms of design and aesthetics as well as in terms of used materials and workmanship;
- well thought out placement and selection of type, form and number of programme elements considering available park area and its character (landscape reference) is important.

Deliberate development of park functional programme, introduction of interesting, even if minute, elements clearly expands site educational potential while at the same time augments its recreational function and this translates into rising popular consciousness and ensures direct engagement in nature and landscape protection measures.

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Souhrn

V tomto příspěvku by autoři chtěli představit vybrané otázky rozvoje rekreačního a vzdělávacího programu ve vybraných evropských parcích, podporované reprezentativními příklady moderních řešení v této oblasti (vzdělávání s rekreací dosaženo prostřednictvím víceúčelových nebo specializovaných objektů kubatury, stejně jako jako součásti zařízení s podpůrnými vlastnostmi).

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EFFECTS OF URBANIZATION ON THE LANDSCAPE OF A MODERN CITY IN GHANA: A CASE STUDY OF SUNYANI

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Abstract

According to the fifth assessment report of the Intergovernmental Panel on Climate Change, changes in land use through urbanization and agriculture are the key anthropogenic effects of climate change. Thus, the preservation of natural environment of urban areas is essential for conserving water and soil, while still adjusting the microclimatic variables (temperature, precipitation, relative humidity, etc.) and stabilizing the natural ecological system from destruction. It has been observed that most parts of city's green vegetation have been lost due to housing developments and commercial activities. This study was carried out to assess the effect of the change in land use on a modern city like Sunyani, by observing the significant changes in vegetation cover from LANDSAT TM imagery over a 31-year period (1986 – 2017). From the study, there was significant decline of vegetation cover from 1986 to 1999, and no significant change from 1999 to 2017. There were also significant changes in the built-up areas from 1986 to 1999 and no significant change from 1999 to 2017. Adoption of sustainable and environmentally friendly technologies that maintain open green vegetation is recommended for future city planning.

Key words: Climate change, green vegetation, LANDSAT, open green spaces, urbanization

Introduction

Urbanization has proved to be the most significant factor in both developed and developing countries, for the past and present century, affecting global change. This shift from a rural to urban life has severe impacts on energy consumption, food security, human progress and the environment at large. As such poorly planned urbanization potentially generate economic disorder, congestion, pollution and environmental degradation at various scales (World Cities Report, 2016). Rapid expansion of these urban cities around the world will continue to have negative effects on the environment and climate through land use changes. Land degradation affects the quality of land available for cultivation. Thus, the need to investigate, monitor and better understand its implications with respect to environmental factors like reduction in vegetation cover, loss of farm/agricultural lands and climate over local and regional scales (Alphan, 2003). It's worth noting that, the vulnerability of such urban cities to climate change also depends urban planning and disaster preparedness.

Statistics have also shown that more than 90% of the future population growth will be accounted for by the large cities in the developing countries, especially Africa (White et al., 2008). This trend will be accompanied by increased pressure on the environment due to the accelerated demand for basic amenities like infrastructure, jobs, agriculture and industries. Leading to loss of agricultural lands, open green spaces and ecologically sensitive habitats in and around these African urban areas. With the high concentration of people, infrastructures, housing and economic activities, most African cities as a result of poor integrated and holistic approaches in regional planning, have shown signs of vulnerability to the impacts of climate change and natural disasters (Anane, 2013). Since ecosystems are strongly influenced by anthropogenic activities from urbanization, there is the need for more studies that seek to suggest ways through which urban resilience can be built to avoid human, social and economic losses, while improving the sustainability of urbanization through the preservation and protection of the environment in mitigating disaster risk and climate change (Mohan et al., 2011). The preservation of the natural environment and green spaces will maintain the ecological balance within these cities and build resource efficient communities that will ensure greater productivity and innovation with lower costs and reduced environmental impacts. Hence, improving our understanding of the various impacts of human activities on the overall ecological state of the environment, especially in developing countries like Ghana (World Cities Report, 2016).

In sub- Saharan countries like Ghana, there is a mass migration of people from rural to urban areas and from smaller towns to big cities like Sunyani. Consequently, forests have been cleared, with farmlands ploughed, razed and encroached upon to meet the rising needs and demands of the expanding cities. This study was conducted to assess the effects of urbanization on the Sunyani city from 1986 – 2017. Sunyani is one of the fastest growing cities in Ghana. According to the Population and Housing Census (PHC) of 2000, the city's population has increased from 38, 634 in 1984 to 61, 992 in 2000 and further grew to about 123, 224 in 2010. The trend poses serious environmental and developmental challenges to the city, which was once well known for its greater percentage of green scenery (Anane, 2013). Consequently, such unplanned expansions will continue to have direct impact on quality of urban environments affecting the efficiency of the inhabitants and their productivity in the socio- economic development (Netzband & Rahman, 2007).

Recent studies considering the impact of urbanization to key socio- economic sectors in Ghana have used Remote Sensing (RS) applications to study urban change analysis and the modeling of urban growth through land use land change evaluation. Obahoundje et al. (2017) modeled the impacts of hydropower production in Western Africa from land use land changes under climate change. Kabo-bah & Mensah (2018) in their review, outlined effects of climate change on the construction of hydropower dams (like the Bui hydropower dam) to meet the energy demand of such expanding cities in Ghana. Anane (2013) also investigated the environmental challenges facing a growing city like Sunyani by analysing some economic indicators and its effects on the life of the inhabitants. Incorporating green spaces like parks and gardens into the physical scene of urban communities will be critical in the future urban planning of the city. This will reap great benefits to the urban environment and further serve as an upgrade to the recreational needs of urban inhabitants whiles enhancing the beauty of the environment, improving air quality and keeping the community cool (Baycan-Levent et al., 2009).

This study used archival records from the LANDSAT images to assess the changes in the green vegetation cover backed with relevant population and land degradation statistics.

Study Area

The study was conducted in Sunyani to investigate the extent of reduction in green vegetation cover due to urbanization. Sunyani is the capital city of the Brong Ahafo Region in Ghana and lies within the middle belt of Ghana between 750 feet (229 meters) to 1235 feet (376 meters) above sea level. It is geographically situated within latitude 7.3349° N and longitude 2.3123° W (Anane, 2013).

The climate of the city falls within the wet semi- equatorial climatic zone of Ghana and characterized by a double maxima rainfall pattern. The mean annual rainfall is approximately 890mm, with the main rainy season between March and September and the minor between October and December. The mean monthly temperatures also vary between 23°C and 33°C with the lowest observed around August and the highest around March and April. Major cash crops grown within the city include cocoa, kola nuts, cashew and staple foods such maize and yam.

The total population according to the 2010 Population and Housing Census of Ghana show that the population has increased to approximately 123,224. The report further shows that majority of migrants (37, 560 out of 66, 122 migrants) living in the city were born in other regions within the country, whilst the rest were born elsewhere within the Brong Ahafo region (Ghana Statistical Service, 2010).

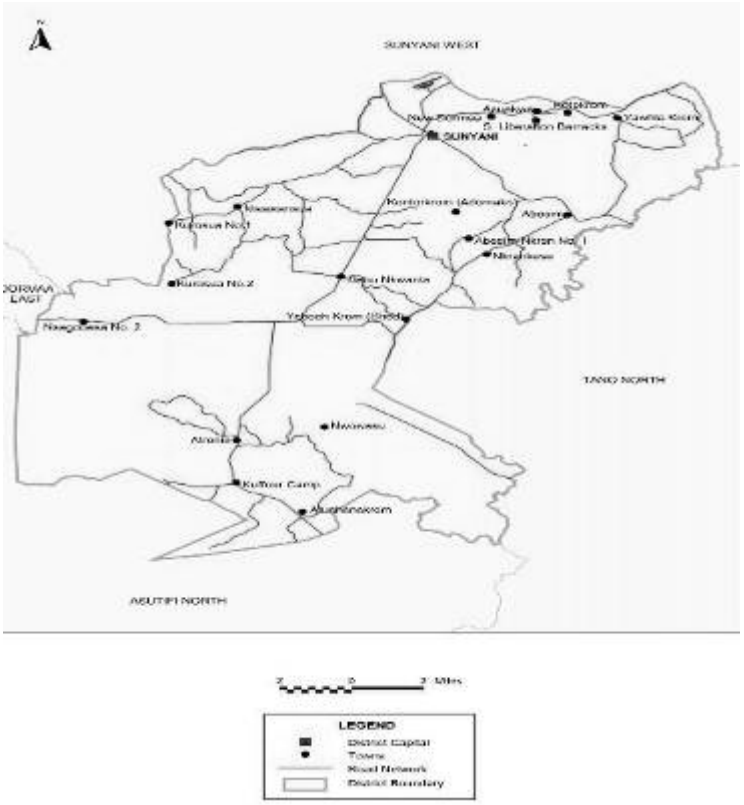

Fig. 1: District Map of Sunyani Municipal (Source: Ghana Statistical Service)

Materials and methods

Multi-annual temporal city maps as well as satellite scenes of spectral imagery were gathered for assessing the historical and spatial physiognomies of urban development from 1986 to 2017. The spatial imageries were retrieved from Landsat 4, 7, and 8 archives through the US Geological Survey (USGS). Listed in the Table 1 below are the datasets used in this study.

Tab. 1: Data sets used for Analysis

Satellite Sensor	WRS Path/Row	Year of Acquisition	Spatial Resolution	Spectral Resolution	Source
Landsat 4-5 TM	195/055	1986	30m	8 bands	Earth explorer
Landsat 7 TM	195/055	1999	30m	8 bands	Earth explorer
Landsat 8 TM	195/055	2017	30m	11 bands	Earth explorer

The retrieved Landsat imageries were analysed using ArcGIS 10.4.1, ENVI 4.7 and MS Excel

Results and Discussion

The Landsat images were georeferenced using a Universal Transverse Mercator projection, with radiometric correction done on the respective images to reduce the degree of spectral differences. Below in figure 2 is the false colour composite Landsat imagery of both the vegetation cover and the built-up areas. The built- up are seen as grey while the vegetation is also displayed as red.

This was also classified in NDVI ranges, where the green areas represent high vegetated areas and red represent built-up or bare land as shown in figure 3.

The classified NDVI images were further reclassified into vegetated and non-vegetated areas (built-up or bare areas) using a break point of 0.25 NDVI. This implied that areas with NDVI > 0.25 were considered to vegetated areas whiles areas with NDVI <0.25 were treated as built-up or urban development areas or bare land, as also shown in figure 4.

A change detection technique was used to establish changes from the classified images that had taken place over the years (1986 - 2017). The raster calculator in the ArcGIS was used to compute the vegetated and non-vegetated areas for the three temporal Landsat images (i.e. 1986, 1999 and 2017 images of Sunyani and the surrounding communities) as shown in figure 5 below.

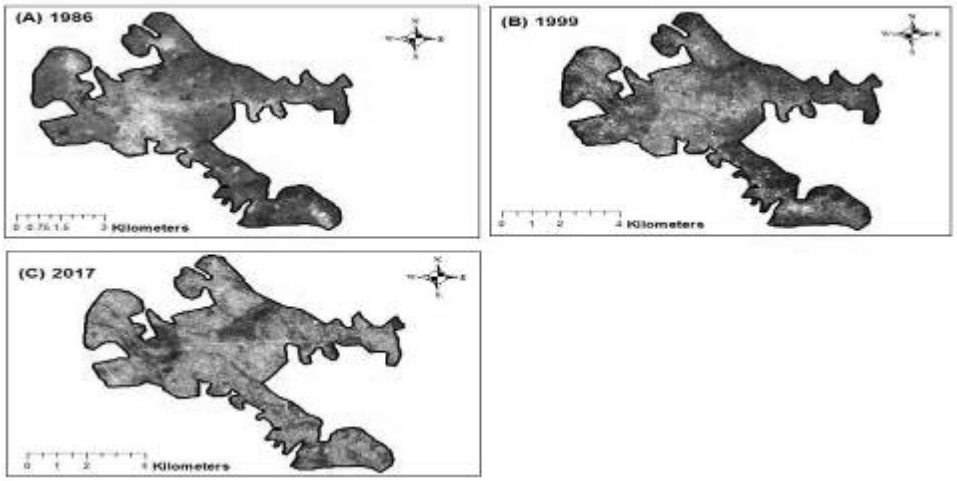

Fig. 2: Landsat false colour composite scene bands 4,3,2 (RGB) for 1986 and 1999 images and bands 5,4, 3 (RGB) for 2017 of Sunyani. The red pixels denote healthy vegetation and grey denotes urban development (bare or built areas)

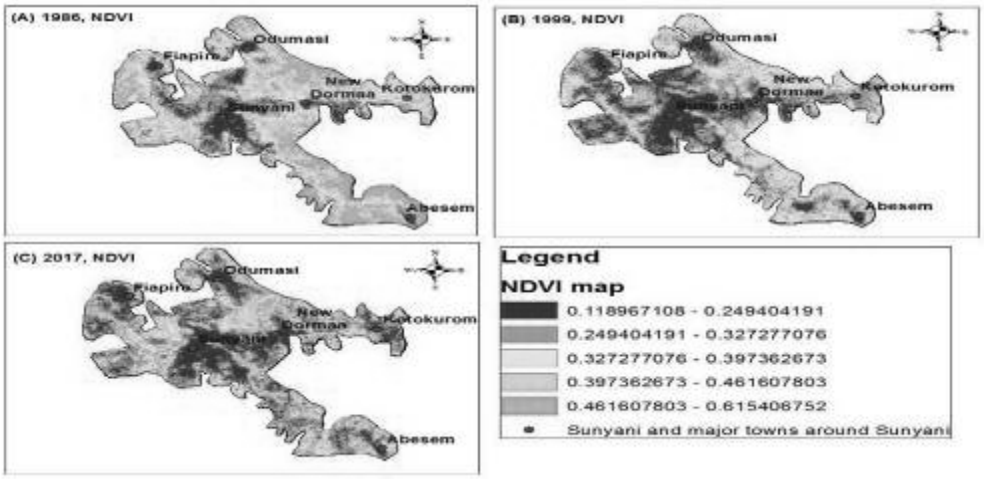

Fig. 3: Classified images in NDVI ranges

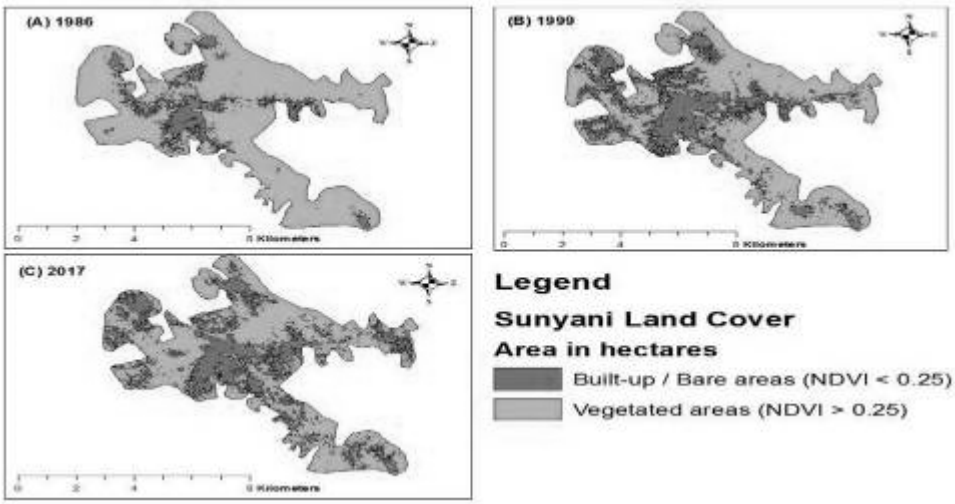

Fig. 4: Re-classified NDVI Images

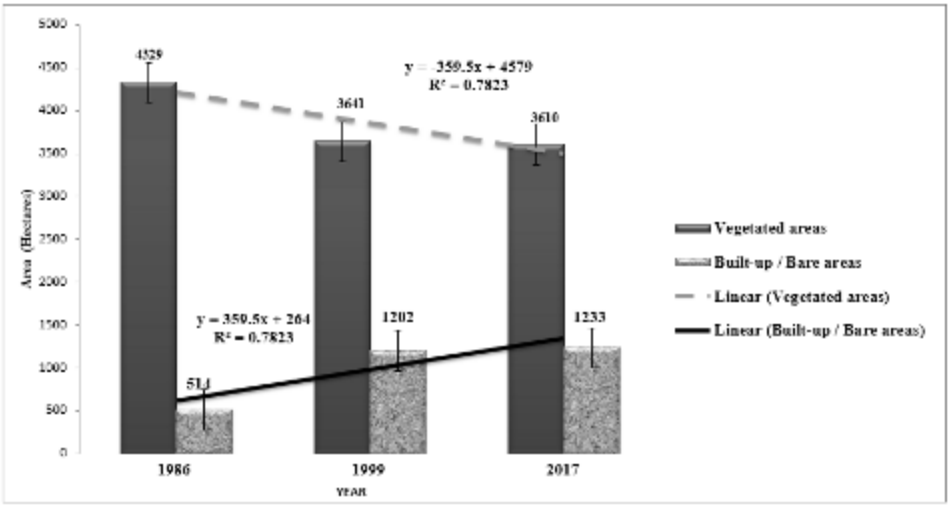

Fig. 5: Landsat false color composite scene bands 4,3,2 (RGB) for 1986 and 1999 images and bands 5,4, 3 (RGB) for 2017 of Sunyani. The red pixels denote healthy vegetation and grey denotes urban development (bare or built areas)

There was a significant difference in vegetation cover from 1986 to 1999 (as in figures 5). Although, there was a difference in vegetation cover between 1999 to 2017, it was not significant. Also, significant increase in the built -up areas from 1986 to 1999 accounted for the retreat in vegetated areas as observed in the figure above. There is no significant difference between the built- up areas from 1999 to 2017. These changes in land use cover could be attributed to an increase in population of the city over the years and the clearing of land to satisfy the housing demand of the city's inhabitants and other commercial activities. The merging of the surrounding cities around Sunyani could have also attributed to the retreat of the green vegetation areas as observed in figure 3b from figure 3a.

Consequently, this gradual shift or depletion of the green vegetation area will pose severe threats to the city's environment and its inhabitants. An earlier study by Anane (2013), revealed that pollution of water bodies, poor drainage system, and poor sanitation management are some of the existing environmental challenges already facing the city, as a result of urbanization and the clearing of green vegetation for built- up areas within the city. This will lead to scarcity in drinking water, loss of lives and properties during extreme weather conditions like flood. The increase in the mean surface temperature of mega cities like Accra and Kumasi is also as a result of urbanization (Manu et al., 2006). The research further explained how the destruction of the green vegetation to the impervious nature of the built- up environment within the city could reduce the evapotranspiration rate and lead to rise in temperature. Sunyani is likely to experience a similar scenario, which might pose health threats and affect agricultural productivity in the region.

Conclusion and Recommendations

The study mainly used remote sensing data to establish land use changes between 1986 and 2017. There has been a significant change in land cover causing the gradual reduction of the green vegetation to the built- up impervious surfaces, with significant effect on the environment. These land use changes have come about mainly as a result of growth in population from urbanization and commercial activities that destroy the forest cover (lumbering, bad agricultural practices and illegal surface mining). These actions have diverse effects on the climate, increasing the frequency in occurrence of extreme weather events such as drought, famine and flood conditions. Other environmental effects also include the occurrence of harmful diseases as a result of poor air and water quality from poor ventilation and sanitation practices in the city. This could lead to loss of lives and properties. Also, demand in energy for domestic and commercial cooling, is likely to increase with urbanization, due to increase in the mean surface temperatures.

It is recommended that city planners should consider proper climate change mitigation and adaptation policies that promote tree planting and restoration of green parks within the city, especially at commercial areas. Modern construction works that adhere to safe environmental measures need to be encouraged. Also, viability of renewable sources of energy need to be considered to complement the city's energy supply.

We further recommend future and well detailed studies to assess the climatic pattern within the city and make bold decisions on the effect of change in land use. Also, some statistics of available green parks as at 2018 from historic parks need to be provided in any future studies. This will better inform city planners of the extent of destruction to the green vegetation cover and serve as a wakeup call for them to introduce policies that will limit such destructive activities around Sunyani.

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Souhrn
Podle páté hodnotící zprávy Mezivládního panelu pro změnu klimatu jsou změny ve využívání půdy prostřednictvím urbanizace a zemědělství klíčovými antropogenními účinky změny klimatu. Zachování přírodního prostředí městských oblastí je proto nezbytné pro zachování vody a půdy a současně se upravují mikroklimatické proměnné (teplota, srážení, relativní vlhkost atd.) A stabilizace přirozeného ekologického systému před ničením. Bylo zjištěno, že většina částí městské zelené vegetace byla ztracena kvůli vývoji bytů a obchodním aktivitám. Tato studie byla provedena za účelem posouzení vlivu změny využívání půdy na moderní město, jako je Sunyani, při pozorování významných změn ve vegetačním obalu z obrazů LANDSATTM během 31letého období (1986-2017). Ze studie došlo k výraznému poklesu vegetačního pokrytí v letech 1986 až 1999 a k žádné významné změně v letech 1999 až 2017. V letech 1986 až 1999 došlo také k významným změnám v zastavěných oblastech a žádná významná změna od roku 1999 do roku 2017. Přijetí udržitelných a ekologických technologií, které udržují otevřenou zelenou vegetaci, se doporučuje pro budoucí plánování města.

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ENTENTE FLORALE EUROPE 2017 IN BRNO

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Abstract
Last year, the Statutory City of Brno took part in the international competition for flowering localities - ENTENTE FLORALE EUROPE 2017. Localities compete in ten criteria concerning the environment and all its aspects, town planning, quality of public spaces, environmental education, participation by inhabitants in public events and projects and the area of travel and tourism, in which the city of Brno has something to offer. On the basis of the points evaluation the city of Brno was awarded the gold medal making it the first city in the Czech Republic to win this prize.

Key words: city, greenery, public, environment

Introduction

The competition ENTENTE FLORALE EUROPE has taken place since 1975 and it is held by the NGO – the European Association for Flowers and Landscape in Brussels. The origins were in France and England, the number of members varies, and it is now active in nine countries. In the Czech Republic its guarantor is the Ministry of the Environment and the organiser of the competition is the Society for Landscape and Garden Creation. The primary impulse for the development of competition was to offer motivation to achieve better results and the pursuit of quality public spaces, the level of urban greenery and all this with regard to the involvement of the population in these activities.

The competition is judged in the category of towns and cities and the category of villages, with towns and cities divided by size. Nomination in the category of village is linked to the Village of the Year competition and the Green Ribbon, where the Green Ribbon holder is nominated for the competition. With nomination in the category of towns there is nomination in the City of Trees competition, which is a project of the Czech Environmental Partnership Foundation.

In 2016 the city of Brno hosted the awards ceremony for the year 2016. The gala awards evening took place in Besední Dům, with a European fair in the morning at the New Town Hall and ending at the Brno Observatory on Kraví Hora. On the basis of this successful event the city entered the competition.

Cities must compete in ten evaluated criteria, e.g. town planning, the natural environment, the quality of public spaces, the quality of urban greenery - permanent and seasonal, environmental education for all age categories, the participation of residents in events and projects of the city, the level of tourism and services and more.

Finally, there is the criterion of the promotion both of the city's projects and the competition itself. In this context it should be mentioned that within a village it would seem to be easier to cope with this criterion, because the competition usually involves almost the entire community. In a city with 29 districts it is more complex to get this spirit of togetherness started. To bring the contest to the attention of a wider spectrum of the population, the city launched the BRNO GREEN CITY campaign, which appeared in all the major parks, public spaces, on public transport and in the press. Especially for this occasion a summer newspaper supplement was released,

which functioned as a guide to events held in the summer in the city, especially in parks and squares and, of course, to draw attention to important city projects in this area.
The city has two options in the competition for demonstrating their quality. The first is the obligatory portfolio with a maximum of 24 pages, in which each criterion is addressed and which provides the international jury with introductory documentation before their visit. The second is the actual competition day. For a city of our size this is set in the range of seven hours, including an hour for lunch. The time limit cannot be exceeded, and if it is the point score is reduced. For this reason, the entire process involved the Brno Metropolitan Police to ensure smooth passage along the competition route.
Competition day began at the New Town Hall with an official presentation from its history to the present, as well as presentations of town planning criteria, prepared by Mr Leopold from the Planning and Development Department of Brno City Municipality. On 14 panels the city presented the system of urban and landscape greenery, territorial systems of ecological stability, the zoning plan for greenery, the green passport and the inventory of trees, GIS applications useful to the public concerning for example waste, accessibility of the city for the disabled as well as the method of water purification at Brno Reservoir. Within the presentation of urban projects we mentioned “IT’S UP TO YOU” – the participatory budget of Brno with a budget of 20 million crowns, which was piloted last year. Residents sent project proposals which were first evaluated for feasibility and then were voted on by citizens in a public poll, on the basis of which 16 projects were selected to be implemented in 2018. This year there will be another round of proposals.
The criterion of recreation and tourism was shown in the modern newly-built tourist information centre, where the guide presented the jury with the issues of tourism, the system of the functioning of the information centres, including the seasonal ones, the portfolio of information materials and other essential aspects.

On the way to the next scheduled stop we presented the results of the BANKS OF THE RIVER SVRATKA architectural competition – an example of the revitalisation of public spaces and the combining of recreational, natural and social features.

Fig. 1: Banks of the River Svratka – 1st prize (Author: Ivan Ruller; Cooperation: Václav Čermák, Miroslav Korbička, Miloš Trenz and Petr Valíček - Brno, Czech Republic)

Rainfall management was presented within the gravel gardens of the university campus in Brno-Bohunice, the designer of which was Zdenek Sendler, a landscape architect from Brno, who is also the author of the reconstruction of many other major parks in Brno. The foliage in the area is designed to need the minimum possible care and to be self-sustaining.
The third stop was the Kamínky low energy school near the Kamenný Vrch nature reserve, which owes its status to the occurrence of the **greater pasque flower** or ***Pulsatilla grandis***, with 55 000 plants, the largest population in Central Europe.

Fig. 2: Greater pasque flower (foto: (photo: L. Ondráčková)

Fig. 3: Park Pod Plachtami (photo: M. Schmerková)

Brno's youngest park, Park Pod Plachtami (which could be translated to English as the Park Under Sails), was built on a site originally planned for the construction of schools and residential buildings. After a workshop with residents who did not want this construction and after years of effort there was change in the zoning plan in favour of a park. The current appearance of the park was created gradually so that the park could be regularly used by residents of neighbouring houses. The plant material met the requirements for to being drought-resistant and thermophilic given the conditions of based on specific conditions of Kamenný Vrch. The species used are not colourful or showy in form. The mown lawns and extensive meadows complement the large groups of shrubs for the diverse fauna. In the central part of the park there is a pond crossed by a wooden footbridge. The pond is replenished by rainwater from the roofs of the neighbouring houses. It functions like a natural habitat where the water is cleaned by plants and there is a rich diversity of species of invertebrates, amphibians and fish.
From Kamenný Vrch (the Stone Hill) we moved on to Žebětín Pond, which was presented as a natural monument with a protected frog population. The Environmental Department of Brno City Municipality (abbreviated to OŽP MMB in

Czech) in cooperation with the Nature Conservation Agency of the Czech Republic (abbreviated to AOPK in Czech) and volunteers from among the ranks of conservationists has long contributed to ensuring the protection of amphibians in this area. Systemic measures for the safe migration of amphibians consist of two underpasses beneath roads in the area of the pond's dyke, gratings on tracks (to prevent amphibians making their way onto busy roads) and concrete barriers. Barriers to allow the safe movement of amphibians are assembled from precast concrete in the shape of wide "U" which is one third submerged.

Fig. 4: Žebětín Pond (photo: J. Ferenc)

The route was planned so that the jury could perceive the beautiful landscape on the outskirts of the city with the forests to the west, north and east. These forests are largely managed by the joint-stock company Lesy města Brna (Brno City Forests). We visited Holedná where there is an enclosure with wild boars, freely moving deer and here there was a presentation of the activities of forestry education, one of the sectors that the company is also engaged in.
From the edge of town we moved to the very centre to Špilberk, one of the most important green areas in the city. Špilberk City Park, with an area of 17 ha, is the most significant Brno park set up by the city administration and as a unique monument to the gardener's art has been, along with Špilberk Castle, declared a national heritage sight.

Fig. 5:Špilberk Park (photo: P.Dvořák)

In medieval times the upper slopes of Špilberk hill were kept bare for defensive reasons, while the lower slopes were planted with vineyards and orchards. It is interesting that the trees planted were sourced mainly from neighbouring estates, as gifts from prominent personalities and from Brno citizens. Veřejná zeleň města Brna (Public Greenery of the City of Brno) has long promoted the use of natural management methods for the care of greenery and Špilberk Park has applied for "natural garden" certification. The registered area is about 20 hectares and together with the gardens of the Czech Environmental Partnership Foundation and the nursery school there are almost 23 ha of natural gardens.
The Hlídka Environmental Education Centre is of interest in terms of two of the criteria. The building of the former powder magazine, which had long been abandoned and inhabited by squatters, after lengthy negotiations was repaired and rebuilt as a facility for environmental education, especially that of preschool children. The building includes teaching classrooms, a multimedia room, a maternity centre and an outdoor playground. In the garden there is a gradually expanding range of activities such as a barefoot path, a garbage cemetery where individual crosses mark the decay times of various materials and flower beds with vegetables and herbs. Near the complex, in collaboration with beekeepers, bee hives have been placed. The activities of the centre build on the traditions and customs of different seasons, with urban camps and year-round clubs operating, and the maternity centre is open daily. For their outdoor activities they utilise the unique space of Špilberk Park.

Fig. 6: The jury during the visit to the Hlídka Environmental Education Centre (photo: L. Ondráčková)

For the criterion of involvement of residents and their own initiatives, we introduced the civic association of Vinice na Špilberku (Špilberk Vineyards) - a rare case of the renewal of historic vineyards on the slopes of Špilberk. This activity is of course only

possible with the cooperation of the city, the Environmental Department, the National Heritage Institute, Public Greenery as the manager of the park and the crucial enthusiasm of the people in the association.
From the vineyards on the south side of Špilberk we transferred to the north side, which houses the Open Garden at the Czech Environmental Partnership Foundation. The garden is a freely accessible educational space, it is home to the garden of the four elements, the former garden of the Sisters of Mercy of St Borromeo with its Grotto. Here they keep pets and people can hire a bed to grow their own vegetables, herbs or flowers. The area includes a passive building which applies the principles of the economic use of water and energy.
It would be impossible to not stop at the first public park in the Czech Republic to open – Lužánky. The park is a cultural monument and was originally a Jesuit garden. It has undergone many modifications, in the late 19th century Lužánky contained all the woody plants occurring in Moravia and more than 150 species of exotic vegetation. Since 1991, the park has been reconstructed to a design by Professor Ivar Otruba.

Fig. 7: Lužánky (photo: T. Pokorná)

Near Lužánky Park in Brno is another city park - Tyršův Sad. Park was created from a former cemetery, with an iron cross still there to remind us of this. It houses a garden for the blind with raised flower beds and a playground. Here, in addition to a tour of the park itself there was a presentation of the system of the maintenance of green areas, the existing green passport and the inventory of trees, the shrub care system, the transition from classical annual flower beds to sown beds and others. An essential part of this was the presence of journalists.

Fig. 8: Tyršův Sad (photo: L. Ondráčková)

From Tyršův Sad we moved onto the last part of our journey to the city district of Medlánky. Medlánky lies on the outskirts of Brno, with continuity and connectivity to open countryside and here the city offers beautiful features, being located near several natural attractions and Medlánky airfield, which is registered as a significant landscape element due to the population of the European ground squirrel, a critically endangered species. The location is one of the ten largest in the country. The natural background of the district creates ideal conditions for short-term recreation for the population of the surrounding area. In newer housing development there was a presentation of the disposal of bio-waste, individual composters are transported into the central composter and then the material is used further. In the centre of Medlánky a community garden has been created, a publicly accessible place for residents to meet and for support of community life in connection to the local nursery school.

Fig. 9: Composter (photo: L. Ondráčková)

In connection with the issue of waste should mention the project RE-USE – a second life. It concerns the recycling of well-preserved furniture, toys and other items that are still useful. They are sold for small sums and the money is then used for planting bulbs. The project partners are Public Greenery of the City of Brno, and SAKO a.s.

Fig. 10: RE - USE - collage (photo: L. Ondráčková)

Results
After successful completion of the competition day the same evening there was feedback with the first impressions of the jury. The outcome of the competition was ceremonially announced in September in the Slovenian town of Podčetrtek. The city of Brno won a gold plaque that was placed on the building of the Brno City Municipality.

Discussion
Part of the output from the competition was an assessment report with detailed comments on the various criteria. As a big city, of course, we face a number of challenges, one of which is universal - graffiti. The jury positively assessed the fact that we already mentioned this issue in the opening presentation, that we are aware of the problem and seeking new solutions to it. Each district has different approaches, CCTV, constant or daily inspections and immediate removal, the use of vines to cover exposed walls or painting of the walls by children from nursery and primary schools. For the city, it is a real challenge requiring a comprehensive approach focused on prevention and a long-term solution to the problem.

Souhrn
Statutární město Brno se v roce 2017 účastnilo soutěže ENTENTE FLORALE EUROPE a dokázalo v mnoha ohledech odbornou porotu zaujmout. Ať už se to týká prezentace územního plánování, projektů se zapojením veřejnosti, úrovně péče o veřejnou zeleň a postupný přechod k bližším postupům při její správě nebo kvality a šíře nabídky environmentálního vzdělání pro všechny věkové skupiny. Do organizace soutěže se zapojily všechny významné městské organizace, jednotlivé městské části i samotní obyvatelé města. Doufejme, že tento fakt přispěje k lepšímu povědomí a vnímání veřejného prostoru a ploch zeleně jako něčeho podstatného pro život ve městě a usnadní proces její ochrany a dalšího rozvoje.

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ENVIRONMENTAL IMPACT ASSESSMENT OF VECHEC FLOOD PROTECTION

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Abstract
The paper is focused on the environmental impact assessment (EIA) of flood protection in the municipality of Vechec, located in the district of Vranov nad Topľou (Slovakia). Flood protection consists of a design of a drainage system in order to ensure the receiving of water from the surface runoff in the area, the retention and then after the flow transformation, the regulated water drainage into the Lomnička creek. The design of the drainage system as a flood protection is assessed against its environmental impact before its construction using the "Methodology for Environmental Impact Assessment". The results of the EIA of floods have shown that the design of flood protection measures in Vechec is optimal.

Key words: floods, drainage system, drainage ditch, impacts, environment

Introduction

The emergence of EIA as a key component of environmental management since 1970 has coincided with the increasing recognition of the nature, scale and implications of environmental change brought about by human actions. During that time, EIA has developed and changed, influenced by the changing needs of decision-makers and the decision-making process, and by the experience of practice. (Morgan, 2012; Galas, 2014; Zeleňáková et al, 2017, Fialová, 2014) Nowadays it is more important than ever to scrutinize decisions that significantly affect people and communities, and the systems that underlie the natural environment, so it is useful to take stock of the progress made in the field, and to reflect on current and future challenges. While there are some studies in the literature considering risk analysis in construction projects (Zavadskas et al, 2010) studies of risk analysis regarding water management constructions, especially assessment of flood protection structures, are very limited. In classical project risk-analysis techniques, risk-rating values are calculated by multiplying probability and impact values, but direct analysis of the linguistic factors involved is often neglected. This paper introduces an application of a new approach to risk assessment of activities in water management using risk analysis.

Material and methods

The territory of the village Vechec is situated in a sloping terrain and therefore especially during spring and autumn months due to the storm rainfalls some parts of the built-up area of the village are flooded. Uncontrolled draining rainwater cause flooding of plots, cellars, watering the foundation of homes, and washing away the soil (Zeleňáková, 2017; Rusicova, Zeleňáková, 2010; Šlezingr et al, 2010). The proposed drainage system consists of: drainage ditch with retention function above the embankment, concrete dam on drainage ditch with retention function, drainage ditch with concrete cascade stages, drainage concrete channel, culverts, the outflow object to the Lomnička creek (Zeleňáková, 2017).
Flood protection objects (drainage system) are according to Annex no. 8 of the Act No. 24/2006 Coll. included in the list of proposed activities that are subjected to the EIA (Act No 24/2006). The potential environmental impacts/risks of the proposed

drainage system in Vechec (Variant I) compared to the current state (Variant 0, a condition that would have occurred if the proposed action was not realized) has been assessed by a modified template for Universal Matrix of Risk Analysis (UMRA) (Zvijáková, Zeleňáková, 2015). According to this approach, the risk analysis is an important step, consisting of three follow-up steps: identification of impacts, prediction of impacts and impact assessment. Approach to identify potential risks of floods (Tab. 1) in the environment uses a modified template for UMRA.

Tab. 1: UMRA for identification the environmental impacts of stressors

STRESSOR - SOURCE OF RISK	FIELD OF IMPACT													
	population	the mineral environment, mineral raw materials, geodynamic phenomena and geomorphologic conditions	climatic conditions	atmosphere	water conditions	soil	fauna and flora and their biotopes	landscape, structure and use of landscape, scenic aspects of the landscape	the protected areas and their protective zones	the territorial system of ecological stability	the urban environment and land use	cultural and historical monuments, cultural values of an intangible nature	archaeological and paleontological sites and important geological localities	other
WATER														
floods	●7				●8	●9	●10	●11	●12	●13	●14	●15	●16	

To predict effects is necessary to propose a set of criteria that reflect the impact of the proposed activity on the environment. For the determination of the probability "P_i" (0.25 to 1) and consequence "C_i" (0.25 to 1), which enters into the calculation of the individual risk "R_i" of each identified stressor effects on components of the environment, it is necessary to propose an indicator of probability and different levels of criteria. The probability is often use from the scale 0 – 1, so we also have used this scale and range it to 4 categories (0.25 to 1). Impact assessment is performed by calculating the individual risk R_i using the following equation (1):

$$R_i = P_i \cdot C_i \tag{1}$$

where R_i is individual risk of stressor (flood) impact on the compound of the environment, P_i is probability of occurrence, C_i is consequence.

Results and discussion

On the basis of the proposed methodology (Zvijáková, zeleňáková, 2015), probabilities of occurrence P_i and consequences D_i of the impacts of stressors on components of the environment for each considered variant (Variant 0 - current state, Variant I - drainage system) in the municipality of Vechec were determined (Tab. 2).

An example of probability and consequence of flooding on population for stressor 7 (related to water) is in the Table 2.

The local potential for flooding was state according the Figure 1.
Direct and indirect health effects of flooding are determined by point classification according to Table 3. Assessor assigns one point for each consequence. The sum of points is indicator of health consequences of flooding.

Tab. 2: Probability and consequence of flooding on population

Stressor: Flooding	Impact on population			
	P1	Local potential for flooding (-)	C1	Health consequences of flooding (point)
	0.25	very low, low	0.25	0
	0.5	medium	0.5	1 – 2
	0.75	high	0.75	3 – 4
	1	very high	1	≥ 5

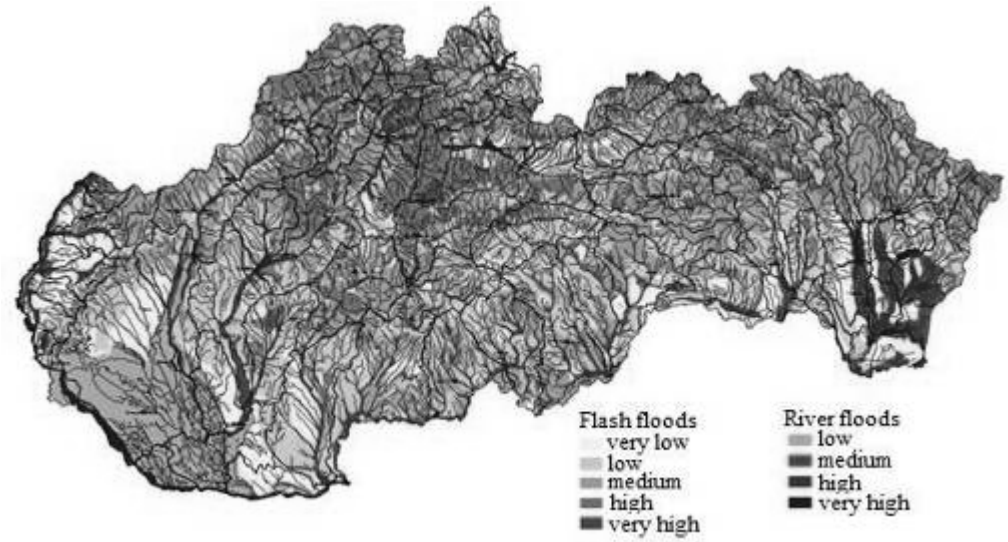

Fig. 1: Potential of flooding in the Slovak Republic

The other impacts of stressors on compounds of the environment (stressors from Table 1) are stated similarly, based on Zvijáková & Zeleňáková (2015).
Assessment of the probability and consequence were combined in order to set individual risk of stressor to environmental components. The individual risks R_i were calculated for each of 10 identified impact of stressor-flood (Tab. 4).
The level of risk was classified into four levels in semi-qualitative form using UMRA as follows: negligible risk – $R_i \in \langle 0.0625; 0.25)$, low risk – $R_i \in \langle 0.25; 0.50)$, middle risk – $R_i \in \langle 0.50; 0.75)$, high risk – $R_i \in \langle 0.75; 1.00)$. Resulting risk index is calculated as a sum of all individual risk of stressors.
The results showed that the impact of the stressor - floods on the environmental components reach different levels of environmental risk (Tab. 5). In the case of the Variant 0 (current state) 3 stressors' (floods) impacts represents a negligible risk to the environment; 2 low; 2 medium and 3 high risk to the environment. When assessing the option I (flood protection of the Vechec municipality) 6 impacts of floods represent a negligible risk to the environment; 3 low; 1 medium and 0 high risk to the environment.

Tab. 3: Probability and consequence of flooding on population

Health risks	Direct health effects	Point
Loss of lives	Death as a consequence of flood.	
Injury	Injury as a consequence of flood.	
Exposure to polluted water	Infections of the skin, nose, ear, eye.	
Exposure to cold water	Shock, cardiac arrest, hypothermia.	
Excessive stress	Physical and mental exhaustion of the body.	
Health risks	Indirect health effects	Point
Contamination of drinking water	Hepatitis A, dysentery, other diseases.	
Contamination of food and crops	Infectious diseases, intoxication by chemicals.	
Leakage of chemicals	Acute intoxication by chemicals.	
The dumping of waste	Infectious diseases, skin affections.	
Overgrowth of mosquitoes	Infectious diseases.	
Migration of animals, mainly rodents.	Infectious diseases (tularemia, toxoplasmosis).	
Humid residential areas exposed to mold	Acute, chronic respiratory diseases, allergies.	
Food shortages, disruption of rescue system.	Threat to health and life.	
Psychological stress and social exclusion	Increase in mental disorders.	
Lack of health services	Threat to health and life.	

Tab. 4: Assessment of environmental impacts of proposed activities

ID	Variant 0 „ current state “			Variant I „ flood protection“		
	P_i	D_i	R_i	P_i	D_i	R_i
7	0.5	1	0.5	0.5	0.25	0.125
8	1	1	1	1	0.5	0.5
9	1	0.75	0.75	0.25	0.75	0.1875
10	0.5	0.75	0.375	0.5	0.5	0.25
11	0.5	0.5	0.25	0.5	0.25	0.125
12	0.5	0.25	0.125	0.5	0.25	0.125
13	1	0.5	0.5	0.25	0.25	0.0625
14	0.5	0.5	0.25	0.5	0.25	0.125
15	1	0.25	0.25	1	0.25	0.25
16	1	0.25	0.25	1	0.25	0.25

Tab. 5: The number of stressors of each variant that reach different levels of risk

Level of risk	Classification	Variant	
		0	I
1	negligible risk	3	6
2	low risk	2	3
3	middle risk	2	1
4	high risk	3	0

EIA of flood protection in Vechec using the assessment of both variants showed that considered variants (Variant 0, Variant I) represents, on the basis of the calculated risk *R*i, the different risk of stressor - floods for environment. Based on this assessment it is possible to assume that Variant I is optimal in terms of predicted environmental impacts and that therefore the implementation of the flood protection of the municipality of Vechec is recommended.

Conclusion

It is supposed that climate change will cause more rainfall. This may result in more frequent and more intense floods of various types such as local, sudden floods (flash floods); extensive, longer-lasting pluvial and fluvial floods; coastal floods and snowmelt floods. In consequence, if no measures (polders, water reservoirs, water stream regulations (Šlezingr et al, 2010; Pelikán et al, 2017; Šlezingr, 2010; Harbuláková et al, 2017) are taken, river flooding can have huge economic and environmental impacts, damages and losses.

This paper summarizes the environmental impact assessment of Vechec (Slovakia) flood protection. The potential impact of flood control facility (drainage system) on environment before its construction assessed using the "Methodology for Environmental Impact Assessment" demonstrated that these flood protection measures ensure the safe drainage of rainwater from the surface runoff from the territory of the village and outside the village. Therefore the design of flood protection measures in Vechec is recommended.

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Souhrn
Příspěk je zaměřen na návrh protipovodňové ochrany obce Vechec, která se nachází v Prešovském kraji, v okrese Vranov nad Topľou. Příspěk sumarizuje návrh protipovodňové ochrany obce Vechec, úpravou odtokových pomerů v části obce a mimo obce. Návrh odvodňovacieho systému je vyhodnocen vzhledem k jeho předpokládanému vlivu na životní prostředí před jeho realizací využitím "Metodického postupu posuzování vlivů navrhované činnosti na životní prostředí". Z výsledkov hodnocení úrovně rizikových vlivů stresora - povodně pro součásti životního prostředí vyplývá, že návrh ochranných protipovodňových opatření je optimální a proto realizace protipovodňové ochrany obce Vechec je doporučena.

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ENVIRONMENTAL-LEGAL LIMITS OF THE RECREATIONAL POTENTIAL OF MUNICIPALITY

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Abstract
The recreational potential of the territory includes not only local conditions in terms of factual natural conditions, but also legal conditions and possibilities (i.e. set by legislation). The municipality is a body which both sets and carries out the exploitation of the recreational potential of its territory. The conceptual use of the recreational potential of the municipal territory should be reflected in the municipal planning. This should be then followed by the exploitation of the recreational potential, which - as well as the zone planning itself - is limited by the increasing demands for legal protection of the specially protected areas in the Czech Republic, if the municipality is located in there. On 1 June 2017, the amended Act No. 114/1992 Sb. on Nature and Landscape Protection, published in the Collection of Laws as No. 123/2017 Sb. (hereinafter "the Amendment"), came into force. The legal regulation of specially protected areas has undergone fundamental changes that affect municipalities, in particular. Our paper deals with the environmental-legal limits of municipalities located in specially protected areas, namely national parks, when exploiting the recreational potential of their territories.

Key words: municipality, territorial planning, national park, recreation, environmental-legal limits and limits

Introduction

Recreation is currently one of the major reasons why people seek opportunities to spend leisure time outdoors. At the same time, there is a tendency to transfer recreational activities to "small municipalities", all the more so in the case of municipalities situated in specially protected areas with significant natural values. Considering the principle of sustainable development, it is essential to address the recreational potential of the municipality territory in the context of the established environmental-legal regulation. The following text deals with the environmental-legal limits of the recreational potential of the municipal territory in specially protected areas, namely national parks.

The conceptual exploitation of the municipal territory

Pursuant to § 43 of the Act No. 183/2006 Sb., on Zone Planning and Building Regulations (Building Act, hereinafter "BA")[1], the municipality makes the basic conception of its territory - the zone plan. It deals with all areas in the municipality[2]. The zone planning is to set the conditions for the development of recreation (see § 19 (1) (i) of the BA). Under law, objects can be placed in an undeveloped area to improve the conditions of its use for recreational purposes (e.g. cycling trails,

[1] Note: The Building Act was amended on 1 January 2018 by Act No. 225/2017 Sb. and introduced significant conceptual and factual changes.
[2] Frank Bold, Law Firm. Territorial plans of municipalities, updated on 1 January 2018 [online]. Citation from 27 March 2018. Available at: http://frankbold.org/poradna/kategorie/uzemni-planovani/rada/uzemni-plany-obci.

ecological or information centres)[3]. The municipality may establish the so-called recreation areas in the zone plan. These are usually created in order to ensure conditions for recreation in a good environment, and usually include plots for buildings used for family recreation (the law, however, no longer provides for any specific conditions or requirements relating to family recreation), plots for other buildings and facilities that are related to and compatible with recreation such as public areas, public camps, natural swimming pools, recreational meadows and others that do not reduce the quality of the environment and are compatible with recreational activities[4]. The municipality also defines the so-called natural areas to ensure conditions for nature and landscape conservation[5]. "*The natural areas usually include the territories of national parks,* ..."[6] The Amendment introduces an explicit regulation of the powers of the regional planning authorities (or of municipal authorities when creating zone plans, cf. § 6 BA) in order to preserve and create optimal ecological functions of specially protected areas and their protection zones (supported by opinions and binding opinions of the nature conservation authorities issued for the procedures according to BA[7]). Maintaining and creating the optimal ecological functions of specially protected territories and their protection zones represents the limit for the conceptual exploitation of the territory of the municipality located in the specially protected area. According to the judgment of the Supreme Administrative Court of April 29, 2015, No. 6 As 304 / 2014-50, "*if it is in the interests of nature protection then the zone plan cannot stand in the way of establishing a specially protected area as the nature protection authorities are not to implement zone plan objectives but only the objectives set by the Nature and Landscape Protection Act*".

How is the recreational potential of the territory of the municipality in a specially protected area limited and how can this limitation be affected by the municipality itself?

Specially Protected Areas (hereinafter "SPA") include, among others, national parks[8], in the Czech Republic. Their protection is regulated by Act No. 114/1992 Sb. on Nature and Landscape Protection (hereinafter "NLPA"), according to which it is a "special large-scale territorial protection" of nature and landscape (hereinafter "nature"). National parks may have the so-called protection zones. Conservation of nature is in public interest[9], which, however, clashes with the interest of the municipality in promoting recreational activities. This conflict is all the more evident if

[3] The additional function of the residential recreation is not acceptable for these buildings, § 18 (5) Act No. 183/2006 Sb. On Zone Planning and Building Rules (Building Act). In relation to recreation, the Building Ac uses the term of a building for family recreation. Decree No. 501/2006 Sb. On General Requirements for the Exploitation of the Territory, defines, in § 2 (b), the term of a building for family recreation which is further used in the Building Act. It is a building whose volume parameters and appearance correspond to the requirements for family recreation and which is intended for that purpose; the building for family recreation can have up to two above-ground and one underground floors and one attic. A more detailed definition of family recreation is not stipulated in the legislation.

[4] § 5 of Decree No. 501/2006 Sb. On General Requirements for Territory Exploitation. The definition of areas for recreation is closely related to the necessity of defining areas of public space, or mixed areas with dwellings (cf. § 7, 8 of Decree No. 501/2006 Sb.).

[5] § 16 of Decree No. 501/2006 Sb.

[6] § 16 (2) of Decree No. 501/2006 Sb.

[7] Vomáčka, V., Knotek, J., Konečná, M., Hanák, J., Dienstbier, F., Průchová, I. Zákon o ochraně přírody a krajiny, 1. vydání. Praha: 2018. K § 44a. In: ASPI [legal information system]. Wolters Kluwer ČR [cited on 2 April 2018].

[8] Then also protected areas, national nature reserves, nature reserves, national natural heritage sites and natural heritage sites.

[9] § 58 Act No. 114/1992 Sb., On Nature and Landscape Protection (hereinafter "NLPA").

prohibitions or restrictions of "recreation" activities apply in the SPA. The interest of the municipality in the recreational exploitation of its territory may not be (which is often the case) "pro-environmental". It is therefore necessary to seek a compromise between the interests of the municipality and the interests of nature conservation in SPAs, so that the provisions of § 2 Para. 2 (k) NLPA were not just a futile proclamation. In terms of this provision, nature conservation is ensured by protecting the landscape for environmentally friendly forms of tourism and recreation. **SPAs as such represent the primary limit of the recreational potential of the municipalities. The secondary limit is the protective conditions in these territories, consisting in prohibitions, restrictions or prerequisites of certain activities.** In our paper we only deal with the limits of national parks in terms of the municipalities' possibilities to influence this limitation, since the Amendment touched them the most.

§ 71 of the NLPA establishes the participation of municipalities in the protection of nature in its broadest sense. According to this provision, the municipality participates in the protection of nature in its territorial area, expresses its opinion on the proclamation and cancellation of the specially protected area and its protection zone[10]. **The proclamation of the national park or of the protection zone** of the national park takes place, in accordance with § 40 of the NLPA, in two phases, the municipality being expected to participate in the discussion of the proclamation project**. In the first phase** of the project, the Ministry of the Environment (hereinafter "the Ministry") will evaluate the condition of the preserved natural environment in the area and will propose the appropriate manner and scope of the protection of the area, including detailed protective requirements. This project will then be sent by the Ministry to the municipality in question. The municipality may file objections in writing within 90 days of the receipt of the project. Later objections are disregarded (limitation period). The municipality is obliged to cooperate on the publication of the project of proclaiming a SPA by displaying it on its official board at the request of the Ministry[11]. The Ministry shall decide on the objections raised within 60 days since the expiry of the opposition period. Subsequently, it will bring the project into line with the objections that have been upheld. A significant interference with the right to self-government as well as the right of ownership is represented by the provision of § 40 (5) of the NLPA.

Each municipality must abstain from all interventions that would negatively change or damage the preserved state of the area proposed for special protection from the time of publication of the intention to proclaim part of the area to be a SPA until its proclamation, but for a maximum period of two years. This is a significant limit for the municipality in terms of its conceptual approach to its territory. This is the so-called preliminary protection of the area in question[12]. This legal regime only involves the **consultative participation of municipalities** in the resulting legislation establishing the national park. Therefore, **we consider it essential to persuade the municipalities to see the proclamation of SPAs positively** (for example, by

[10] National parks and their protection zones were proclaimed by law pursuant to the legislation valid until 31 May 2017. However, only one national park, namely the České Švýcarsko National Park, was proclaimed by a separate law. The other three were proclaimed by the Government Decrees (Šumava National Park, Podyjí National Park, and Krkonoše National Park). From June 1, 2017, all four national parks, together with the protection zones, are proclaimed to be NLPA (cf. §15a to §15d together with Appendices 1-4).

[11] Cf. § 40 (3) NLPA.

[12] Vomáčka, V., Knotek, J., Konečná, M., Hanák, J., Dienstbier, F., Průchová, I. Op. cit. to § 40.

cooperating with the municipalities in the sense of § 71 (2) of the NLPA)[13]. **In the second phase**, the relevant legislation is issued, in the case of the National Park in the form of "Act". Municipalities can participate in the process with comments, in addition to the above-mentioned objections, according to the rules of the legislative process[14]. A change of the already proclaimed SPA or its protection zone is made in a similar manner as the proclamation. However, it is only discussed with the municipalities concerned (§ 41 NLPA). The same applies to the process of cancellation (§ 45 NLPA).

The protection of the national park also involves the exploitation of its territory for the purpose of nature-friendly tourism (§ 15 (4) NLPA). The protection of the national park consists in the **basic and more detailed protective conditions**. Originally, the **basic protective conditions** were based on the zoning of the national park, but since 1 June 2017 they have been based on the criterion of "the entire territory of the national park" and "the territory of the national park outside the built-up area of the municipality and the municipality areas that can be built up (the so-called municipal area).[15]" In the entire territory of the national park there are prohibitions pursuant to § 16 (1) NLPA, for example the prohibition of fireworks. In the territory of the national park outside the municipal territory, there are prohibitions pursuant to § 16 (2) NLPA[16].

The prohibited activities included in (b), (m) to (r) of the above mentioned legislation may be classified under the concept of recreation[17]. There is also a current prohibition included in § 16 Para. 2 (s) NLPA which prohibits the operation of drones which are often used for recreational purposes[18]. We consider it quite important that due to the Amendment some bans concerning the territories of municipalities have disappeared. This means that the activities pursuant to Section 16 (2) NLPA are no longer prohibited in the built-up areas and in the areas of the municipalities that can be built in the territory of the national park[19]. **More detailed protective conditions** are set for individual national parks (§16a to 16d NLPA), reflecting the specifics of

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[13] In the case of national parks, the statutory duty of cooperation between nature and landscape protection authorities with municipalities is manifested, among others, in a "qualified form", which is the cooperation with national park councils (municipalities are represented by delegated representatives). On the National Park Councils in the sense of § 20 NLPA, see the chapter titled Municipalities located in national parks, published by Ilona Jančářová, Jana Dudová et al., Sustainable development and conflict of interest in nature protection. Brno: MU, Faculty of Law Brno, 2017. pp. 67-83, 17 p. Acta Universitatis Brunensis, IURIDICA, Vol. 600. ISBN 978-80-210-8817-7. Available at: https://science.law.muni.cz/knihy/monografie/Jancarova_Sustainable_development.pdf.

[14] Vomáčka, V., Knotek, J., Konečná, M., Hanák, J., Dienstbier, F., Průchová, I. Op. cit. to § 16.

[15] See § 16 (1) and (2) NLPA.

[16] According to (b) it is a prohibition of authorizing or realizing constructions, except for those which do not require a territorial decision or a territorial consent and are intended for the purposes of nature conservation, tourism or heritage site protection. Such constructions may also be buildings for family recreation (towards that, see § 79 (2) (o) Building Act).

[17] It is a ban on cycling or riding horses off roads, local roads and places determined by the nature conservation authority, then a ban on climbing, watering or performing other water sports off places determined by the nature conservation authority, a ban on camping and making fires off places determined by the nature conservation authority, and a ban on organizing sports, tourist or other public events off places determined by the nature conservation authority.

[18] Vomáčka, V., Knotek, J., Konečná, M., Hanák, J., Dienstbier, F., Průchová, I. Op. cit. to § 16.

[19] This includes, for example, a possibility, in the built-up areas and the municipal areas that can be built-up, to place, permit or carry out constructions, remove the topsoil or make landscaping, permit or carry out geological work, collect minerals, plants or catch animals, to use, outside the gardens, artificial fertilizers, slurry, silage juices or to lime land, to sow or plant plants outside the gardens, to use biocides outside the buildings, to remove wastes originating in the territory of national parks, to modify the natural stream of watercourses or to remove natural obstacles from the natural channels of the watercourses, to organize sports, tourist or other public events off the areas determined by the nature conservation authority, to operate trade, to operate non-pilot airplanes or aircraft models, or to apply chemical substances on roads.

the natural conditions of individual national parks. These are also reflected in the criterion established the Amendment. For example, in the territory of the České Švýcarsko National Park the more detailed protective conditions include the prohibition of overnight camping off the areas determined for that by the nature conservation authority in the form of a general measure. The basic and more detailed protective conditions are further complemented by the so-called **rest areas of national parks**[20] (§ 17 NLPA). They define areas with a limited movement of persons, i.e. the routes reserved for the movement of persons are newly defined (the movement of persons elsewhere is prohibited). The rest areas are established by the Ministry adopting a general measure, subsequently being marked in the territory. **The zoning of the national park** (§ 18 NLPA) is another means of the protection of the territory of the national park and an exclusive instrument of differentiated care for its territory. In the past, the territory of the national park was divided into three zones. The Amendment divides it into four ones (the natural zone, the nature similar zone, the nature zone of intensive care and the cultural landscape zone). The so-called cultural landscape zones can be established in the municipal built-up areas and areas that can be built-up, determined for the permanently sustainable development, and in the areas where man-changed ecosystems determined for the permanent human use prevail. The zones of national parks can then include territories that do not conform with the legal characteristics of the zones, but their inclusion is necessary for maintaining a uniform way of maintaining the zone and achieving the goals of protection and maintaining the integrity of the area. Thus, the municipal territory can get into a regime other than that of the cultural landscape zones. The law also presupposes a part of the territory of the national park not being included into any of the zones. The zones are subject to the prohibitions defined in § 18a NLPA. According to the transitional provisions of the Amendments, the built-up areas of the municipalities and the areas that can be built-up in the territories of the national parks are considered to be the cultural landscape zone. Pursuant to Article II (5) of the Amendment, a discussion about determining the national park zones must be commenced no later than two years after the date of the Amendment entering into force, i.e. until 1 June 2019. The plan of the zones must be agreed with the National Park Council[21] and by that the municipality participates in the zoning process through its delegated representatives. The zone regime complements the legal protection of the national park, while a higher standard of the protection for the basic and more detailed protective conditions must always be maintained.

As for the participation of municipalities in proceedings pursuant to NLPA, it is also necessary to mention § 71 Para. 3, NLPA, according to which "*Municipalities are, in their territorial districts, involved in proceedings under this Act, unless they are deciding the same case as nature protection authorities*." In this context, it is necessary to point out that in the territories of the national parks and the protected landscape areas, the municipalities are not nature conservation authorities.

The Amendment changed the nature of many environmental institutes according to the NLPA when these are newly issued as "the only, or also" **measures of a general nature**. Pursuant to § 71 (4) NLPA, as of 1 June 2017, "*When dealing with*

[20] In detail, Dudová, J. Quiet territories in national parks as an effective tool for protecting wildlife? In: Jančarová, I., Dudová, J. et al. SUSTAINABLE DEVELOPMENT AND CONFLICTS OF INTEREST IN NATURE PROTECTION IN CZECHIA, POLAND AND SLOVAKIA. Brno: MU, Faculty of Law Brno, 2017. pp. 53-66. Acta Universitatis Brunensis, IURIDICA, Vol. 600. ISBN 978-80-210-8817-7. Available at: https://science.law.muni.cz/knihy/monografie/Jancarova_Sustainable_development.pdf.

[21] Towards this, cf. § 20 NLPA.

the proposal of a measure of general nature pursuant to Part Three of this Act[22]*, the municipalities have, in their territorial districts, the status of the concerned authority according to the Rules of Administrative Procedure".* The municipality is, for example, the authority concerned when issuing measures of a general nature pursuant to § 21 (3) NLPA laying down the conditions for the exercise of hunting and fishing rights (as recreational activities) in the national park. Thus, the municipality is placed in the same position as the other authorities concerned when considering measures of a general nature in the sense of § 136, § 171 to 174, Act No 500/2004 Sb., Rules of Administrative Procedure. **Has the Amendment brought about major changes in this respect**? In our opinion, no substantial changes have been made in terms of the procedure. The municipal self-government was able to take part in discussing measures of a general nature even before, in accordance with § 136 (1), (2) and § 172, Administrative Procedure Rules. In our opinion, the regime of measures of general nature in the protection of the environment in SPAs is the most important instrument of the municipality to ensure its participation as a concerned authority.

It should be remembered that as for the statutory prohibitions in SPAs it is possible to grant an **exception** in the public interest in accordance with § 43, NLPA. Until May 31, 2017, exceptions could only be granted on an individual basis. Now, the special nature conservation allows to grant an exception for an indefinite group of people by a measure of a general nature.

It can be noted that the Amendment brought about a number of other changes with a possible impact on the recreational potential of the municipalities. Some overlaps and contexts of the new legislation can only be outlined for the purposes of this paper. One of them is, for example, a general change in the concept of the Visitor Rules of National Parks which has only become an informative document. We may also mention the change based on the principles of care for national parks. Within the framework of the above-mentioned legal instruments, the municipality is given an opportunity to make comments, i.e. to **re-participate in the limitation of its territory.**

Conclusion

In the light of the above mentioned, it can be concluded that the limitation of the municipality when determining and exploiting its recreational potential depends on whether the municipality is located in a specially protected area or not. If so, the municipality is limited by legislation designed to protect such territory. In the case of national parks, this is in particular the basic and more detailed protective conditions defining a number of prohibited or conditional activities. The Amendment introduces a new criterion of these protective conditions, namely the municipal territory (the built-up area of the municipality and the municipal area that can be built-up), or defines directly the activities that are permitted in the territory of the municipality located in the national park. The Amendment defines rest areas and changes of the zoning of national parks. The municipality can participate, as a consultant, in the process of the creation, modification or eventual abolition of this special protection of nature (in the form of objections and comments). The protection of national parks can be seen as a limitation of the recreational potential of the territories of the municipalities, but since 1 June 2017 the municipalities have been allowed to participate to a greater extent in the decision-making process on such limitations through the measures of a general nature. This is a major step forward, as the

[22] See § 14-45 NLPA.

municipality becomes the authority concerned if a measure of a general nature is issued, changed or abolished. The Amendment seeks to alleviate the friction of the interests in the protection of nature and the interests of the municipality. However, these are such sensitive competitive interests that the quality of this legislation will only be possible to be assessed in the future practice.

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Legislation, judgments mentioned in the paper.

Souhrn

Limity rekreačního potenciálu území obce představují mimo jiné podmínky a možnosti, nastavené právními předpisy. Obec je subjektem stanovujícím a realizujícím využití rekreačního potenciálu jejího území. Příspěvek vymezuje koncepční přístup obce k jejímu území z pohledu územního plánování a rekreačních lokalit, podrobně se zabývá limity obce ve zvláště chráněném území – národním parku. Vše se zřetelem novely zákona č. 114/1992 Sb., o ochraně přírody a krajiny, ve znění pozdějších předpisů, publikované ve sbírce zákonů pod č. 123/2017 Sb., účinné od 1. 6. 2017. Příspěvek podává, jakými způsoby obec participuje na ochraně přírody v národních parcích. Od vyhlášení národních parků či jeho ochranných pásem, změny a zrušení této zvláštní ochrany, přes jednotlivé způsoby ochrany – základní a bližší ochranné podmínky, klidová území, zonace, možnost výjimek atd. Dle textu právní úpravy došlo k preferenci obecní samosprávy, oproti ochraně přírody, nastolením kritéria „obecního území“ při stanovení ochranných podmínek národních parků. Zásadní je umocnění využití opatření obecné povahy v rámci této zvláštní ochrany přírody, kdy obec je dotčeným orgánem v případě jeho vydání, změny nebo zrušení. Novela se snaží zmírnit třecí tendence zájmu na ochraně přírody a zájmu obcí.

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EVALUATION OF THE RELATIONSHIPS BETWEEN VISITATION RATE OF SELECTED AREA AND ITS NATURE PROTECTION & CULTURAL-HISTORICAL VALUE (NITRA TOWN AND ADJACENT AREA)

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Abstract
The main aim of this paper is to assess the relationships between visitation rate of selected area and its nature protection and cultural-historical value; based on an example of the town Nitra and its adjacent municipalities. The significance of the area in both aspects is expressed in a relative scale on the basis of interpretation of existing landscape-ecological, nature protection and cultural- historical documentation, as well as on the map of the current landscape structure of the area. When assessing a visitation rate, Google Panoramio database was used, where users have been adding photos of the visited places within case study area during 2006-2014. Subsequent analyses in QGis and GRASS Gis were used for assessment of recorded photos placement and their density in the landscape; and then for the comparison of the visitation rate with the determined significance of the area. The results point to the relationship of the assessed landscape features and allocate "focal points" of the area that are located in various landscape elements with different degree of nature protection and cultural-historical value. The research results could be used for the management of valuable areas with higher visitation rate, which are nowadays exposed to dynamic changes and increasing environmental pressures.

Key words: nature protection, cultural and historical values, visitation rate, tourism, Google Panoramio

Introduction

Aesthetic value or visual attractiveness has gained great importance for human well-being, not only in public perception but also in socio-economic research (Frank, 2013). The aesthetic value of the landscape is based mainly on the biological, cultural and personal preferences of individuals. Biological or instinctive preferences are given genetically, and cultural and personal preferences are derived from various stages of personal development (Tempesta, 2010). Quantification of the aesthetic value, that people place on different parts of the landscape, represents an innovative approach to the mapping of cultural ecosystem services. One of the potential metrics of landscape aesthetic value can be found in the spatial distribution of photographs of the natural environment that people send online so they are creating visitation rate "hot spots" of aesthetically interesting landscapes (Casalegno, 2013). This approach was used e.g. in the European cultural landscape assessment (Tiesken, 2017) or in the study assessing the landscape aesthetic values of Slovakia (Lieskovský, 2017). Wood et. al. (2013) points to a correlation between empirical data about visitation rate and data from social media, particularly from the Flickr database. Also, define areas of interest is possible by studying the density of tourist photographs using geographical information systems GIS (García-Palomares, 2015).

This paper presents an assessment of the relationships between nature protection and cultural-historical value of the selected area, its aesthetical value and the related potential visitation rate. The model area is the Nitra town and adjacent

municipalities. This area is currently under significant dynamic changes due to industrialization and urbanization pressure (Haladová, Petrovič, 2017), that mainly relates to the arrival of the Jaguar Land Rover investor into this region.

Materials and methods

Research area of our research is the town Nitra and 8 adjacent municipalities (Lužianky, Zbehy, Čakajovce, Jelšovce, Podhorany, Žirany, Štitáre, Nitrianske Hrnčiarovce). They are situated in the south-western part of Slovakia, in the Nitra district. The size of area is 187.6 km^2, 88 834 inhabitants lived here in 2016, 77 374 of which are living within the town Nitra. The central part of research area is an urbanized and industrialized landscape of Nitra town, the surrounding area belongs to the intensively used agricultural landscape; the northern part of the area (so called Zoborské vrchy) belongs to the Tríbeč mountains, which are particularly important in terms of nature conservation as well as recreational background of the adjacent area.

As a first step, the relevant spatial data were created in order to assess nature protection and cultural-historical values of the landscape. The map of nature protection significance of the area was expressed on the basis of the existing spatial layers of the State Nature Conservancy of the Slovak Republic (layer of Protected Landscape Area Ponitrie, Natura 2000, small-scale protected areas). The layer of the current landscape structure (with the legend by Petrovič et al., 2009), was created on the basis of the aerial photos from 2016. A reclassified map with 5 categories of nature protection significance of the area was created from these data (table 1).

A map of cultural-historical value of the area was proceeded in a similar way. The layer of the Protected historical reserve Nitra and the historical zone was used (www.pamiatky.sk). Outside this area, a map of the current landscape structure was used for the selection of the significant cultural-historical elements in the adjacent municipalities. Final 3 categories of the cultural-historical significance of the area are then determined as a reclassified map (see table 2).

As a next step, the maps of the nature protection and cultural-historical significance of the area were compared with geolocalised photos from Google Panoramio that were uploaded to this application between 2006 and 2014 (the locations were taken from a photo database by Lieskovský et al., 2017). Google Panoramio has presented photos of "places in the world" with particular emphasis on the landscape aesthetics, nature elements (e.g. forests) and animals in their natural environment (Casalegno, 2013), till its cancelation in 2016. Based on the overlay of mentioned layers, we determined potential visitation rate, or more precisely attractiveness of individual categories of the area significance, in the form of the density of images per 1 km^2 for each category of area significance. For this, we used Quantum GIS 3 and Grass GIS 7.4. The obtained data were then interpreted by common statistical MS Excel tools.

Results and discussion

Photo density in Google Panoramio

There were 3270 photos of the town Nitra and surrounding research area uploaded into Google Panoramio between 2006 and 2014, which represents the average of 17.4 photos/km^2. The highest photo concentration is in the Nitra town centre, its wider surrounding and in the protected area of Zoborské vrchy, where the photo density is more than 100 photos per km^2. The highest photos density is mainly near Nitra castle and its neighbourhood, also along the Nitra river, in localities Kalvária,

Borina forest park and Skateboard park Klokočina. Outside the city, in the protected areas there are photos concentrated mainly near the Dražovce chapel, nature protection areas Zoborská lesostep, Žibrica, Hunták and localities Nitra-Zobor specialized hospital, Svorad cave or deforested tourist trail to the Meško hill. The localization of the photos can be seen in figures 1 and 3, together with categories of area significance.

Relationship between area attractiveness and its nature protection significance

The nature protection significance of the area is documented in figure 1, the categories of significance and brief description of these areas are in table 1. As seen from the data, the 1st (the lowest) category of significance dominates the area (it occupies 79.0% of the area). It is followed by the 3rd category (13.9%) and the 2nd category (6.5%). The extent of the two most significant classes is represented at least – it covers only 0.6% of the study area.

Subsequent recalculation of density of photographs per 1 km^2 in given categories revealed that with increasing nature protection value of the landscape, also the density of photographs is directly increasing (figure 2). For category 1 with insignificant nature protection value is the density 15.4/km^2 and is gradually reaching up to 209.1 photos per 1 km^2 in category 5 with very high nature protection significance. Significantly higher than overall average (17.4/km^2) is the density of photos also in category 4 with high significance (126.9/km^2). The results show that the most valuable landscape in terms of nature protection in the area of Zoborské vrchy is also the most visited one and the most interesting, therefore we should continue to pay higher attention to this area.

Relationship between area attractiveness and its cultural-historical significance

The cultural-historical significance of the area is documented in figure 3, the description of the individual categories localization is presented in table 2. It is obvious that the lowest category of significance dominates the area and occupies up to 96.5% of the study area. The second category of significance occupies 3.4% and the most significant localities occupies only 0.1% of the area.

Tab. 1: Classification of the nature protection significance of the study area

Category	Characteristic	Area (ha)
5 – extremely high importance	The area with the highest degree of nature conservation (V.) within the Protected Landscape Area Ponitrie and the Natura 2000 network (Zobor forest-steppe area).	22.0
4 – high importance	The area with overlay of three categories of protected areas – national network of protected areas, Protected Landscape Area Ponitrie, Natura 2000 (e.g. Nature Reserve Žibrica).	100.9
3 – average importance	The area with overlay of two categories of protected areas (most frequently Protected Landscape Area Ponitrie and Natura 2000). Also, the most significant elements of the landscape outside of protected areas (broad-leaved forests, semi-natural meadows, open bedrock areas, natural and semi-natural water courses and wetlands.	2607.4
2 – low importance	The rest of the protected areas; also other significant landscape elements (mixed forests, small woods and linear woody vegetation, scrubland, pastures, artificial water bodies).	1211.6
1 – no importance	Other landscape; without nature protection values.	14814.7

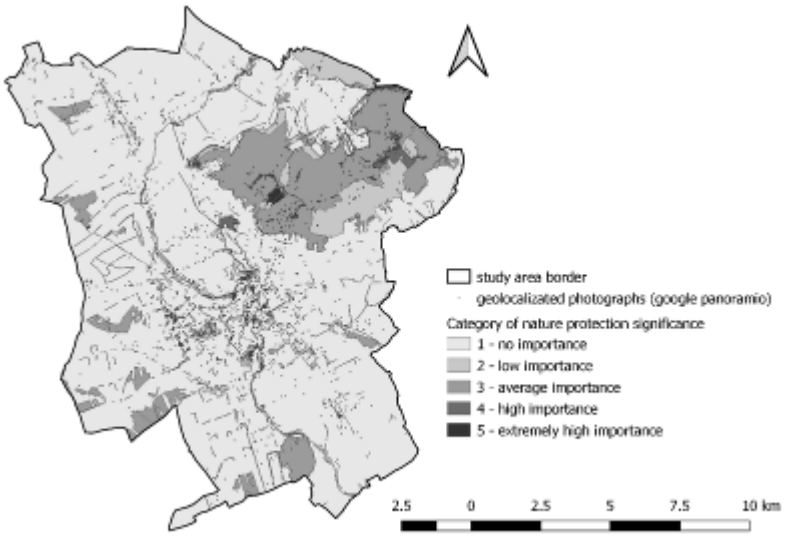

Fig. 1: Nature protection significance of the landscape in the Nitra town and adjacent municipalities

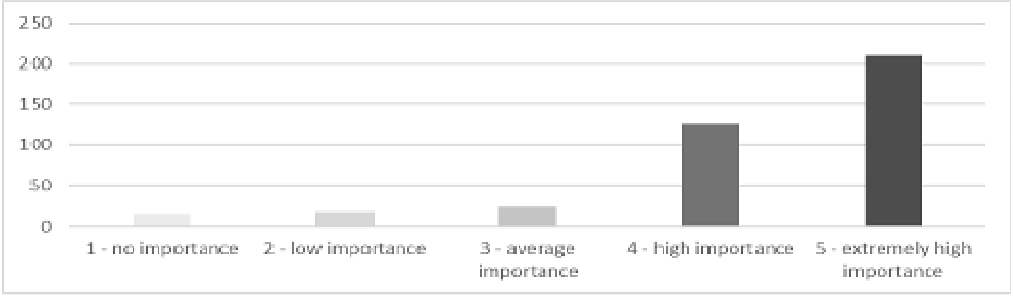

Fig. 2: The density of geolocalized pictures from Google Panoramio per 1 km^2 in different categories of nature protection significance of the landscape

Tab. 2: Classification of the cultural-historical significance of the study area

Category	Characteristic	Area (ha)
3 – high importance	Protected historical reserve Nitra Important historical sites outside reserve: Kalvária, Dražovce church, Zobor historical hillfort	25.5
2 – average importance	The historical zone of the Nitra town and other adjacent areas to the Protected historical reserve, cultural-historical objects within the municipalities (mansions, churches, historical cemeteries) park areas, traditional small-scale vineyards and gardens in the neighbourhood of Nitra town	626.3
1 – no importance	Other landscape without cultural-historical values	18104.8

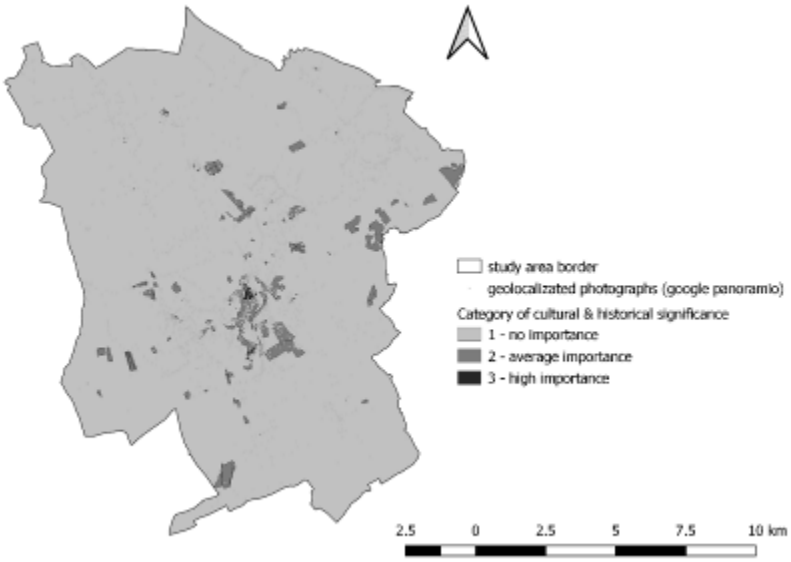

Fig. 3: Cultural-historical significance of the landscape in the Nitra town and selected adjacent municipalities

By comparing cultural-historical significance of the area and its visitation rate (figure 4), we found similar relationship as in the case of nature protection significance – the density of photographs is significantly rising with increasing value of the importance. In category 1 with very low cultural-historical value, the density of photographs is 15.5/km^2, in the category 2 the value is 59.7/km^2, in category 3 with high cultural-historical value it reaches 325.5 photographs/ km^2.

Most of the photographs are located in historical centre of the Nitra town, as well as in other significant localities (Dražovce chapel, Kalvária hill, Zobor monastery and its surroundings, Zobor historical hillfort). So, the cultural-historical areas with highest significance are probably the most visited places – therefore it is important to pay higher attention at their protection, as in the case of areas with high nature protection significance.

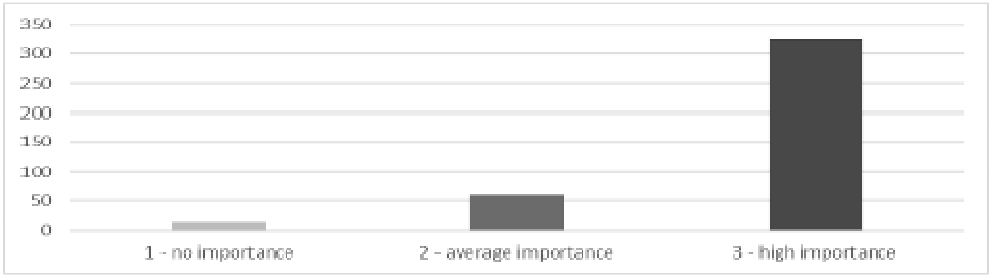

Fig. 4: Density of geolocalized images from Google Panoramio per 1 km^2 in different categories of cultural-historical significance of the landscape

Based on the results, there could be seen the direct relationships between visitation rate of the area and their nature protection and cultural-historical value. In both cases, the intensity of the visitation rate increased directly with the natural and cultural-historical value of the landscape. The most valuable area in terms of nature conservation and also the most photographed area is the National nature reserve Zoborská lesostep, also it certainly belongs to the most visited natural elements in the landscape. The most valuable area in terms of cultural-historical importance and also the most visited cultural-historical element is the Nitra castle. Our results confirm the fact that people predominantly document and probably also visit the areas representing significant natural, cultural and historical values. These findings are important for further nature and landscape management – mainly nowadays, when these landscape values are not sufficiently taken into consideration within the regional and local spatial development and decision making.

Conclusion

The value of the nature, living organisms including humans, is related to the fact that they evolved naturally over million years and if we significantly destroy them, we will never be able to restore them again. Nature is the source of inspiration in all human history, it is connected with culture, language, art and religion. In many cultures, nature is closely related to spirituality and traditions that contribute to the sense of place, social cohesion and belonging (Elmquist, 2015). Besides natural processes, the landscape is influenced by varying intensity of human activities, which determine the degree of the landscape urbanisation and industrialization (Hanušin, Oťaheľ, 2013). In this paper, we pointed out the relationships between natural and cultural-historical values and visitation rate of the area. It has been proved that the areas with highest nature protection or cultural-historical significance could be valued as aesthetically the most attractive and potentially the most visited ones. Therefore, it is clear that conservation of nature and cultural-historical landscapes brings a high added value for the society.

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Souhrn
V práci jsme se snažili poukázat na vztah mezi návštěvností vybraného území a jeho prírodoochranní a kulturně-historickou hodnotou na příkladu města Nitra a přilehlých obcí. Významnost území z obou hledisek vyjadřujeme v relativní škále, na základě interpretace podkladů ochrany přírody a krajiny, ochrany památkového fondu a mapy současné krajinné struktury území. Při hodnocení návštěvnosti území vycházíme ze služby Google Panoramio, ve které uživatelé v letech 2006 - 2014 umisťovali do mapy fotografie z navštívených lokalit zkoumaného území. Výsledky výzkumu jsou vyjádřeny v mapových výstupech a grafech, poukazují na vztah hodnocených ukazatelů, a vymezují "ohniska návštěvnosti" ve zkoumaném území, které se nacházejí v různých krajinných lokalitách s různým stupněm významnosti. Z dosažených výsledků vyplývá, že se stoupající přírodoochranní nebo kulturně-historickou významností stoupá návštěvnost a tedy i atraktivita území. Výsledky výzkumu mohou být využity při manažmentu významných území se zvýšenou návštěvností, které jsou v současnosti vystaveny dynamickým změnám a stupňujícímu tlaku na životní prostředí.

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FLOOD CONTROL MEASURES - DRY BASINS - CASE STUDY

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Abstract
Flooding has several aspects, such as climatic, social, economic, institutional, and technical, that are differently addressed for rural and urban conditions. The effectiveness of the best practices flood mitigation measures depends on among other hydrological and environmental circumstances. Based on the types of interventions to control or minimize damage, flood control measures can be categorized as structural measures, a combination of structural and bioengineering (vegetative) measures and watershed protection. Some of these selected measures are described in the paper. Polders Oreske, Dobra Niva and Sverzovka which belong among structural measures are characterized via them elementary characteristics, operation mode and parameters in details. These dry basins are built at different watersheds in different parts of Slovakia.

Key words: polder, structural flood measures, watershed

Introduction

The extreme hydrological events could have environmental, social and economic impacts (Kovar et al, 2014). The basic cause of rural or riverbasin flooding is heavy rainfall of rainfall combined with snowmelt, followed by slow development of flood flows, which exceed the capacity of natural waterways (Andjelkovic I, 2001). Designing of appropriate measure or flood protection and prevention is a combination of interdisciplinary approaches (Markova and Hubacikova; 2015) regarding each hydrological and morphological parameters of the river/stream/basin as well as to the consideration of complex conditions of catchments area. Water management in urban areas should seek to prevent negative hydrological changes (Price, 2014; Šlezingr 2016). There are many methods used for prevention, protection and mitigation of floods where the most of them are based on hydraulic conditions (Pelikán et al 2018; Slezingr and Fialova, 2012). Based on types of intervention to control or minimize flood´s control measures are classified as structural measures, environmental (vegetative) measures and the combination of structural and vegetative measures (Jha H et al, 2000). Technical measures supported by vegetative seems to be the best solution for the flood protection. A dry basin provides one of the engineering structures to detain the stormwater runoff and provides the infiltration and particle settings. (TRPA BMP Handbook, 2014; Pavlik, 2008). Structures are able to provide control of stormwater runoff for both water quality and peak flow attenuation for flood control and also provides benefits besides water quality, such as wildlife habitat and open space (Slezingr and Uhmannova, 2014).

The term "dry basin" is an area that is flooded with the purpose of floods. The surrounding area must be separated by dykes so that floods do not flood other areas. Additionally, no area or important infrastructure can be found in the area of the dry basin. A prerequisite for establishing a dry basin is to have an existing dyke near the watercourse. A new dyke will be connected to the existing one, in order to form jointly a dry basin. An inlet will be built in the dyke along the river, through

which the dry basin will be tanking and regulating. After the flood retreat, the basin will be emptied over several days through the bottom outlets. In order to achieve the optimal use of retention volume, accurate data of precipitation and expected flood wave development should be available (www.cs-povodne.eu, 2017). The word “dry” stands for a fact, that there is no permanent water level of the lake in the basin between flood events. (TRPA BMP Handbook, 2014).
In the paper are presented dry basins build on rivers across Slovakia situated in different regions as well as the different rivers. These dry basins are the only one flood protection or stand for one the flood protection system in the selected areas.

Case study dry basins
Three selected dry basins in three different regions built in Slovakia are described in the next chapter. Dry basins are situated in Trnavsky (Oreske dry basin), Banskobystricky (Dobra Niva) and Presovsky Region (Sverzovka) across the Slovak Republic.

Dry basin Oreske
Dry basin Oreske is situated in the cadastral area of Oreske village in the district of Skalica town in Trnava region (Fig. 1). The dry basin is built on Chvojnica River and its purpose is the flood protection for villages Oreske, Radosovce, Dubovce a Popudinske Mocidlany as well as for the protection of the area under the dry basic (www.geocaching.com, 2017).

Fig. 1: Dry basin Oreske

The purpose of the dry basin is to capture and mitigate the flood wave in the selected area. The construction was built in 2005. Its basic function was to create the consistent and mainly the retention space. The dry basin practically does not

affect the flow in the river because during the period without floods there is no increasing in water level and water can freely flow through the bottom outlet.
The first successful implementation took place during the floods in 2006 (vodotika.sk, 2017).Retention volume is more than 1 mil. m^3, the length of the dyke is more 430 meters and the width of the crest is 5 meters.

Dry basin Dobra Niva
The dry basin is located in the cadastral area of Dobra Niva in the district of Zvolen town in the region of Banska Bystrica (Fig. 2). The purpose of the construction was to adjust the drainage conditions in the catchment area of Dobronivsky Creek and thus increase the flood protection of Dobra Niva village. Only three dry basins only are currently being built and put into operation in this region of Slovakia including this one. The design of the technical solution consists of the protection of the municipality of the Dobra Niva village against flood flow (Q_{100} = 17 $m^3.s^{-1}$) of Dobronivsky Creek. It was necessary to increase the protection of the municipality of the village against the floods by constructing the Dobra Niva dry basin because the floods had caused a huge material and moral damages in the area. The water structure consists of a dyke, a safety spillway, a bottom outlet, creek regulation under and in the reservoir as well as access path (www.enviroportal.sk/sk).

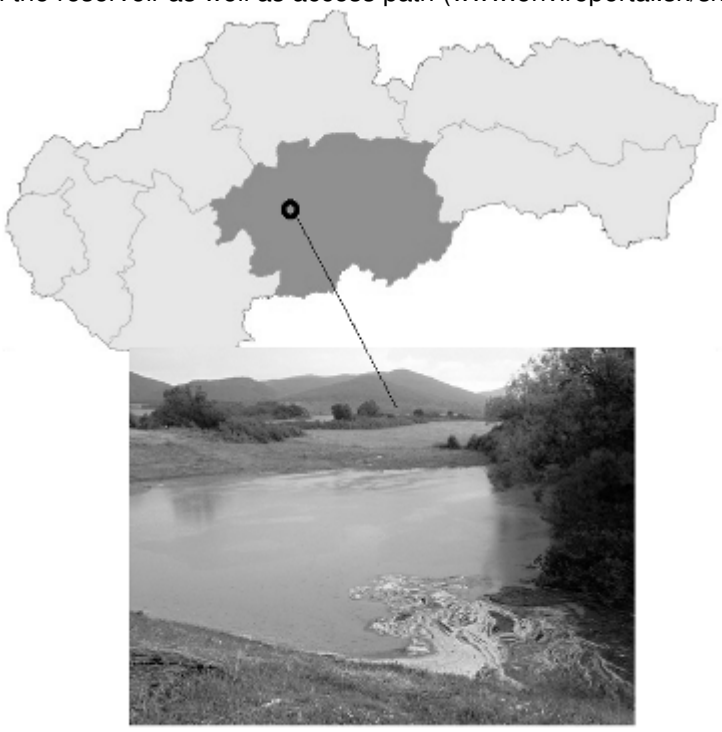

Fig. 2: Dry basin Dobra Niva

Retention volume is 60, 829 m^3, the length of the dyke is more 93.5 meters and the width of the crest is 3.5 meters.

Dry basin Sverzovka
The dry basin is located above the village Vysny Tvarozec in the valley of the Sverzovka Creek in the Bardejov district in Presov Region as presented in Figure 3.

The purpose of this structure is to ensure flood protection of the municipality and its surroundings against the flood. The maximum flow that Sverzovka Creek is able to transfer via the existing natural channel without consequences is Q_{max} = 11.0 $m^3.s^{-1}$. The bottom outlet is calculated on this flow. The safety spillway of the dry basin is calculated to transfer up to Q_{100} = 32.0 $m^3.s^{-1}$.

Fig. 3: Dry basin Sverzovka

The dry basin came into operation in 2006. The operation of the dry basin is designed to handle water without the intervention of a human agent. When the flow rates are increasing the dry basin is spontaneously filled and a transformation which is dependent on the shape and volume of the flood wave is made. In the event of a flood wave with a flow and volume that cause filling up the total volume capacity and the bottom, outlet function will not be sufficient for the flood wave transformation at the same time, the water level in the reservoir will be rising. Under such circumstances, the transformation is ensuring via safety spillway (Kolesarova, 2017). Retention volume is 10,900 m^3, the length of the dyke is more 117.3 meters and the width of the crest is 3.5 meters. The total volume of the dry basin is 58 000 m^3.

Conclusion

Large water structures, designed over the last decades, to retain the floods and provide the infiltration and transformation of the flood wave, are dry basins. Water is detained in the reservoir and slowly drained through one or more outlets and spillways of the structures. There have been 48 dry basins built on the territory of the Slovak Republic. The construction of the dry basins started in the 1960s and only four of them were built by 2000. The largest construction of dry basins has started since 2010 when 32 dry basins were built. The paper presents examples of dry basins across the Slovak Republic, focusing on their construction parameters in the

Trnava Region (dry basin Oreske), Banskobystricky Region (dry basin Dobra Niva) and in the Presov Region (dry basin Sverzovka).

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Souhrn
V rámci navrhování suchých nádrží je třeba vždy dodržovat předpisy, kterými jsou především platné zákony, vyhlášky a nařízení vlády. Účelné je také dodržovat ustanovení a doporučení technických platných norem, typizačních předpisů a metodických pokynů a příruček, které zohledňují v mnoha případech současný stav znalostí řešené oblasti. Na území České republiky bylo dosud vybudováno 48 suchých nádrží. Výstavba poldrů začala v 60-tých letech minulého století a do roku 2000 se vybudovali pouze čtyři. Největší výstavba suchých nádrží se rozběhla až po roce 2010, kdy bylo vybudováno 32 suchých nádrží. V příspěvku jsou prezentovány ukázky suchých nádrží napříč Slovensku se zaměřením na jejich konstrukční parametry v Trnavském kraji (suchá nádrž Oreské), Banskobystrickém kraji (suchá nádrž Dobrá Niva) a v Jihomoravském kraji (suchá nádrž Sverzovka).

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FLOODS THROUGH THE EYES OF THE INHABITANTS

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Abstract
Floods through the eyes of the inhabitants deal with floods over time in two selected localities and the research is focused on the view of local population. It describes the specific situation in the village Moravičany and the town of Olomouc. The monitored municipalities were affected by floods repeatedly, the worst in 1997. Since this critical year, various flood control measures have been implemented to protect the municipalities from overflowing water and it is interesting to see the awareness of the local population today, in the context of the changes that have already been made. Many of these flood control measures are used recreationally and they increase the attractiveness of the areas.

Key words: people, sociological research, awareness, recreation

Introduction

Water is a very important element that can unleash the hell and destroy not only human property but also lives. It is therefore important to approach it with respect. Floods are, however, a part of the water cycle in nature and it would be mistaken to assume that they are only a negative consequence of civilization activities. In many civilizations, floods were considered positive phenomena as they helped secure the livelihood of the population. (Bačík and Ryšavá, 2011)
Moravičany and the town of Olomouc differ in size, equipment, but one combines them. People have experienced critical moments during the 1997 floods. There was the biggest flood and people were not ready for it. Its peak flow in the municipality of Moravičany was 625 m3 / s, which corresponds to N = 700 years (Dostál et al., 2007). One third of the area of Olomouc was flooded and the peak flow here reached 780 m3 / s. and it is stated that the probability of repeating this flow is 500 years. Only water in Olomouc caused water damage for more than 2 billion crowns.
This flood has shown many failures of state and private institutions. There were no flood plans, safety regulations were violated, and companies were using the technique in poor condition. (Povodí Moravy s., © 2010-2017) The situation has moved the responsible authorities to make more fundamental adjustments to the flood control measures, which are still ongoing.

Materials and methods

Most of the technical documents for the study were provided by Mr. Josef Holásek, Chief Operating Office Olomouc Povodí Moravy s. p. and during the consultations (technical reports of the individual measures, building permits and documents of original situation, proposals and implemented measures).
Municipalities were also contacted. Unfortunately, the result was not very satisfactory, so the remaining materials were get by self-help. Citizens were approached directly in the village and some of them through social networks. These talks were then recorded on a dictaphone and rewritten into text. They mainly showed human insights into the floods and the difficult fates of people and families.
The choice of sociological survey was consulted with Ing. Ulčákem Ph.D. and also carried out with regard to the knowledge gained form the book „Jak se vyrábí

sociologická znalost“. (Disman, 2000) The qualitative survey method deals with the motives behind people's actions. There is much information about a small number of individuals. Conclusions can not be applied to the entire population. Implementation ways can be by participatory observation, document analysis, and non-standardized interview. (Metody sociologického výzkumu, ©2011) With the citizens was conduced non-standardized interview reflecting on their personal experiences with this issue.

Results

In Moravičany, as a flood protection measure, a dividing building, a mobile barrier, a ramp, a protective wall, a limiting object and a mobile pumping station with a paved area were constructed. From the point of view of recreational use, they are interesting four protective wing dams and adapt their surroundings, which allows for great tourist use.

In Olomouc, due to the difficulty of the project, all construction measures were divided into several stages and sub-stages. In the first stage, a new bypass's riverbed, weir and crossing for fishes were constructed. In the next stage a right-banked dam, extended berm, branching of the riverbed, construction of the left-bank dam and the coastal walls, damming of the building and movable closure were constructed. There were also improvements under the Velkomoravská bridge and greening of the areas. Bicycle paths, sidewalks and roads have also been built. These became a joint investment of the city of Olomouc and the Povodí Moravy s.p. (cycling paths in the green areas were the investment only of the city of Olomouc). They serve as recreational and sporting surfaces for people and simultaneously they relieve to the traffic load of Olomouc. Broken roads and walkways were repaired.

The major difference between the situation in Moravičany and Olomouc is, of course, the size of the village, the population and the area affected by the flood. Social relationships are much closer to Moravičany, as a smaller village. Current building in the village also brings Moravičany economically active population and decreases the average age.

In Moravičany, mainly senior citizens were interested in this issue, and earlier the inhabitants themselves tried to build primitive measures to save their lives and property. The impact of the floods on the health status of the population, especially on the psyche, was very significant. Although there were several injuries or health was damaged by the consequences of floods (e.g. mosquitoes), the psyche of the population was the most shaken. The social role of the family and other inhabitants played a major role in the consequences.

Damage to property was considerable. Unless a citizen was insured for this risk, he did not receive much compensation. In Olomouc, the amount was about CZK 10,000, the Moravičany provided a shelter for the inhabitants, and the municipality received a post-flood cleaning allowance. Many people lost all the property that they had stored at home or they lost entire houses. After the water had fallen, in both villages there was a time when the inhabitants tried to save the maximum things and to remove a lot of mud and dirt. Unfortunately, there were a large number of people who went to these areas only for sensation, and sometimes monitored the vain effort of the inhabitants.

In both municipalities, respondents praise the recreational use of flood control measures. Dykes are used for walking and cycling and are also visited and used by residents from surrounding municipalities.

The management of the municipalities was praised, in essence, for informations and

solution the issue of flood control measures. In Olomouc, some of the respondents were dissatisfied with the approach of the city during and after the floods due to the low awareness of the Citizen and the replacement of the damage.
The asked citizens in both municipalities agreed that possible financial cooperation of citizens would not be possible. Only citizens in flood areas would be willing to contribute.

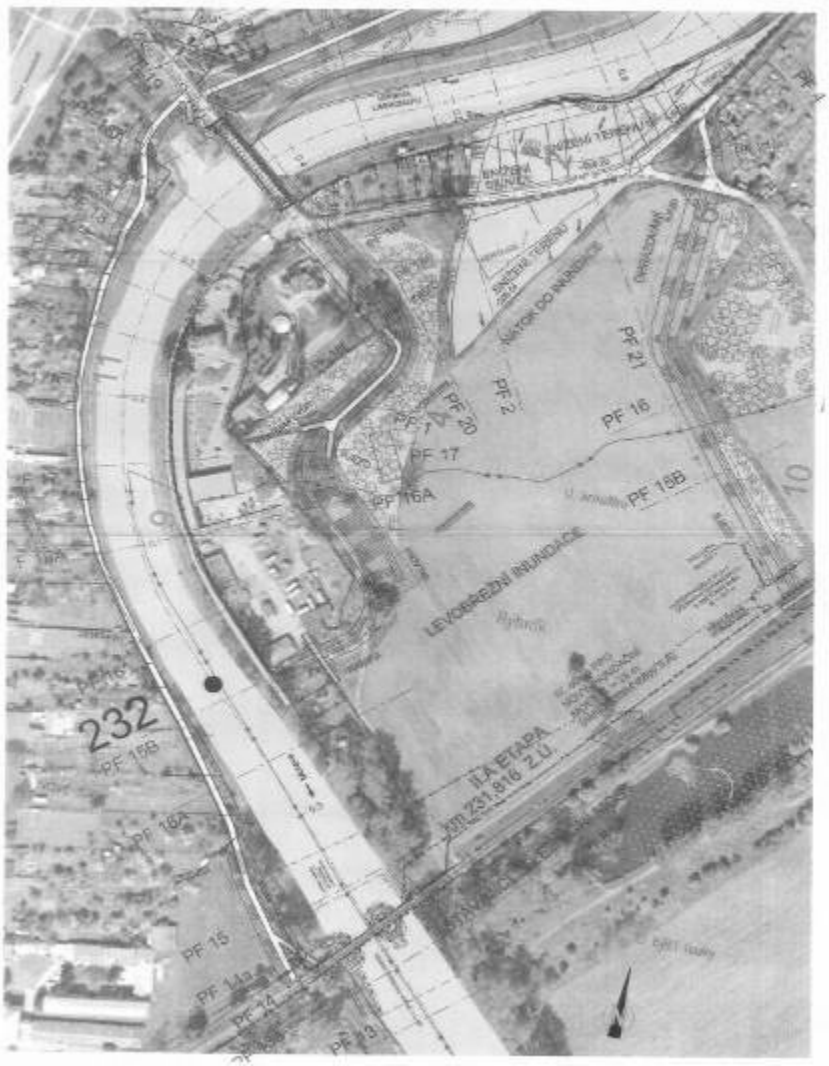

Fig. 1: Situation II. A Stage (archive of Povodí Moravy s.p.)

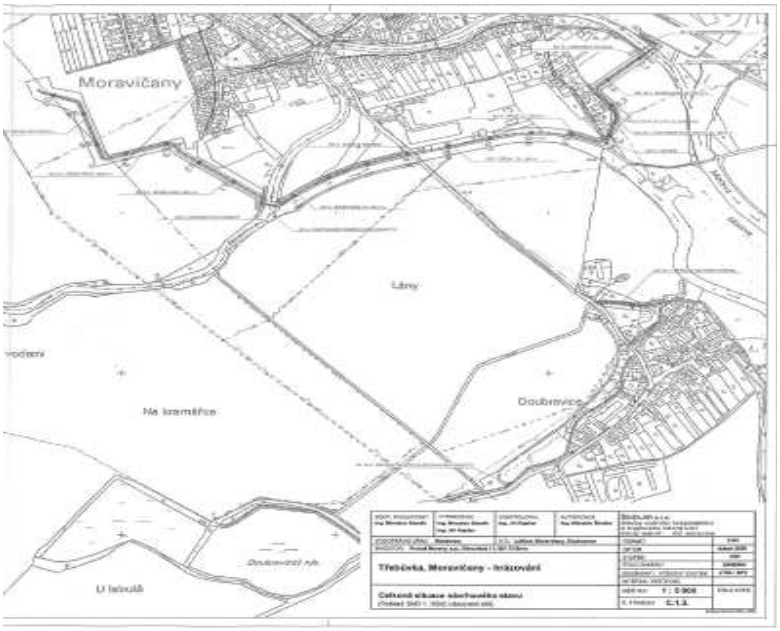

Fig. 2: Situation in Moravičany (Archive of the Povodí Moravy s.p.)

Fig. 3: Protective dam with wall in Moravičany (photo: Zuzana Prchlá, 2017)

Fig. 4: Bicycle path in Olomouc (photo: Zuzana Prchlá, 2017)

Conclusion

Our research dealt with the sociological aspect of the flood problem, which was researched through a sociological survey done with some inhabitants of Moravičany and Olomouc. We also focused on the use of implemented flood control measures as recreational objects.

Asked residents commented on the issue of flooding, especially to that of 1997, which hurt many people. They testified their personal experiences of this tragic event. They also spoke about flood control measures. Most of them were aware of what was happening in their village, what measures were built, and whether they were effective. From provided materials, social differences follow. It is, in particular, the behaviour of citizens in each other during critical situations, municipal assistance and also awareness. However, this conclusion can not be applied across the board, due to use the qualitative survey.

Current flood protection measures in Moravičany currently protect the built-up area of the cadastre. In Olomouc, the complex protection is expected after the completion of the following two stages. In the future, further revitalization is likely to be necessary in order to effectively protect citizens, but in the near future people will not be afraid, hopefully.

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Souhrn

Příspěvek se věnoval problematice povodní a protipovodňových opatření ve dvou odlišných lokalitách. Cílem bylo zaměřit se především na pohled obyvatelstva obou obcí. Byla zvolena metoda kvalitativního průzkumu formou nestandardizovaných rozhovorů, z kterých vyplynulo, že starší generace má větší respekt k potenciálnímu riziku a to hlavně z důvodu zkušeností z minulosti. Rozdíl je rovněž v menší sounáležitosti mezi obyvateli ve větším městě v porovnáním s malou obcí. Lidé v rozhovorech popisovali svoje zážitky a skutečnosti, které se tehdy odehrály. Škody na majetku byly tehdy značné a velkou měrou se tyto povodně negativně podepsaly

i na zdravotním stavu obyvatel, především těch staršího věku. Velký prostor byl věnován stávajícím protipovodňovým opatřením a důvěře, kterou do nich lidé vkládají.
Aktuální situace je v obou obcích považována za stabilní a relativně bezpečnou, a to z pohledu obyvatelstva i vedení obcí. Stávající protipovodňová opatření v současné době v Moravičanech zcela chrání zastavěné území katastru. V obci Olomouci se stále buduje komplexní ochrana, která bude kompletní po dostavbě zařízení z následujících dvou etap. V budoucnu bude vlivem změn zřejmě nutná další revitalizace, aby byly obce účinně dále chráněny, nicméně v blízké budoucnosti se obyvatelé strachovat, doufejme, nemusí.
V kapitole Conclusion je brán zřetel i na informovanost obyvatelstva, která je velice důležitá. V Moravičanech byli obyvatelé informováni lépe, což potvrdilo předpoklad, že v menší obci má vedení k občanům blíže a ti se také více zajímají o veřejné dění.
Současná ochrana slouží v obou obcích i možnost rekreačního vyžití, což významně zvýšilo atraktivitu daných oblastí. V Olomouci se jedná nejen o hráze, ale i o nově vzniklé cyklostezky, chodníky a komunikace, které jsem občanům k dispozici. V obci Moravičany jsou takto využívány nové hráze i lidmi z okolních obcí.

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FLOWERING OF SPRING HERBS IN ONE OF THE MOST FAMOUS SLOVAKIAN SKI RESORT – DONOVALY

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Abstract

Effect of Machine Made (MM) snow on the vegetation was examined by the various works but only a few of them were focused on the relation towards the vegetation development of the early flowering spring herbs. To assess this impact, the snowpack characteristics (depth, density, duration), soil temperature and phenology of five herbs (beginning of flowering) were identified on the plot treated by MM snow and on the control plot with untreated natural snow. Research took place in the ski resort Donovaly – Záhradište (Western Carpathians) during winter season 2015–2016 and continued during vegetation period of 2016. Results showed higher average density and depth of the treated snowpack, while at the end of the winter, there were 26 more days with snow on the treated plot. Changed snowpack properties influenced topsoil temperature and consequently postponed beginning of flowering of all observed herbs. *Crocus discolor* starts to bloom first in the season with a delay of six days on the treated plot. These results showed that snowpack characteristics changed by human activity can significantly influence soil temperature and vegetation development on the ski slope what could be useful for management and protection of the meadow ecosystems used for recreation.

Key words: ski slope, phenology, snowpack, artificial snow, soil temperature

Introduction

Winter tourism is important economic sector in the European mountainous regions. However, ski tourism as the most important part of it is dependent on the solid winter precipitation. Climate change scenarios predict changes in the precipitation patterns. Recent studies, focused on the precipitation variability, identified decreasing trends of precipitation totals in some regions of the Central and Southern Europe (Vido et al. 2015; Zeleňáková 2017). Another studies from Slovakia pointed out the general tendency of decreasing or large inter-annual fluctuation in duration of snow cover (Vojtek et al. 2003; Škvarenina et al. 2009; Mikloš et al. 2017b). To stay snow reliable, the most of the ski resorts produce Machine Made (MM) snow. Although, the natural snow cover plays following important roles: i.) water management (Hríbik et al. 2012; Bartík et al. 2014), ii.) transport nutrients and also pollutants, iii.) protect soil and vegetation during dormancy (Mikloš et al. 2017a), iv.) influence seasonal micro- and mesoclimate (Hrvoľ et al. 2009; Střelcová et al., 2013, Vido et al. 2016); the mixture of MM and natural snow on the ski slopes has different properties compared to natural snowpack. That is why it is possible that the snowpack on the snowed ski slopes has different impact on the environment of the recreational resorts.

Aim of this work was to identify differences between: i.) the snowpack properties (depth, density, duration) on the plot treated by MM snow and on the control plot with natural snow; ii.) the top soil temperature on the research plots; iii.) the timing of early spring herbs flowering.

Materials and methods

The study was conducted in the Slovakian ski resort Donovaly (48.881 N, 19.226 E; Fig. 1a,b), ski slope Záhradky (945 m a.s.l.), Inner Western Carpathians (Starohorské Vrchy Mts.). On the ski slope were defined two plots: i.) plot where Machine Made (MM) snow is producing in the high volume (treated plot), ii.) plot with natural snowpack (untreated plot). Both plots are under the similar winter and summer management activities and have a similar site conditions (elevation, aspect, slope, soil properties, etc.; Fig. 1c).

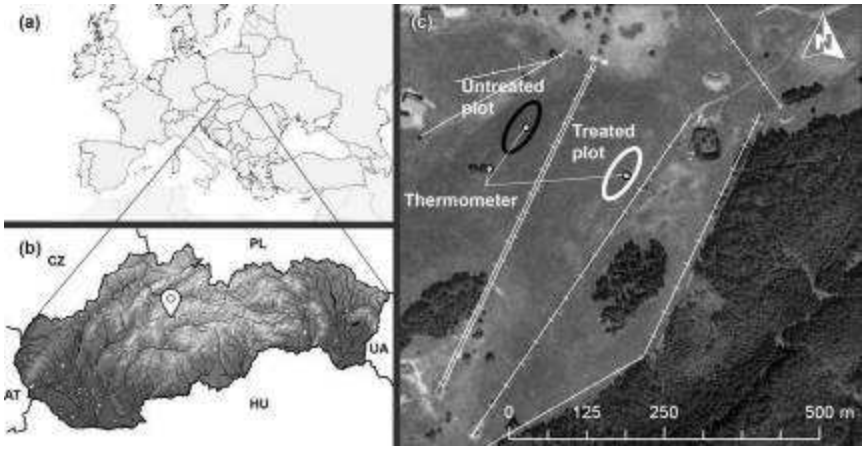

Fig. 1: Situation of the ski resort Donovaly in the Europe (a) and in the Slovakia (b). Location of the research plots on the ski slope Záhradky (c).

During whole winter season 2015–2016, the snow depth and density measurements were done (75 values on the treated plot and 30 values on the untreated plot were recorded). Measurements start at the beginning of December and finished at the beginning of April. The snow density was determined with the mass method.

When there was a snow on the plots it could be recorded as “snowpack” (depth of the snow was higher than 0.5 cm and snow covered more than 50 % of the observed plot) or “trace” (under the conditions of snowpack). Occurrence of the snow was identified continuously during whole season, directly in the field or through webcam.

The data loggers recorded hourly topsoil temperature (3 cm below the ground) and air temperature (2 m above the ground). Time frame used for analyzes shows Figure 3. At the end of winter 2015–2016, the phenology (flowering – developed normal flowers) of first five herbs was observed according “Návod pre fenologické pozorovanie lesných rastlín” (Šamaj 1984). Herbs were selected chronologically, in order in which they start to bloom. Recorded was date when at least three individuals start to bloom.

The relation between the soil and air temperature was tested using a simple linear regression (95 % significance level). Pearson correlation coefficient (r) of this analysis express strength of the linear relationship. Comparison of two samples was

done by the Mann-Whitney (Wilcoxon) W-test to compare medians, because most of the samples not come from normal distribution.

Results

The depth and density of snow on the treated and untreated plot showed significant differences (Fig. 2). In the whole season average, the depth of snow on the treated plot was about 38 cm higher and density about 0,319 g/cm^3 higher, compared to natural snow on the untreated plot. The highest identified density of snow was 0.858 g/cm^3 on the treated plot and 0.421 g/cm^3 on the untreated plot. The higher variability of data was recorded on the plot treated by Machine Made (MM) snow (Fig. 2).

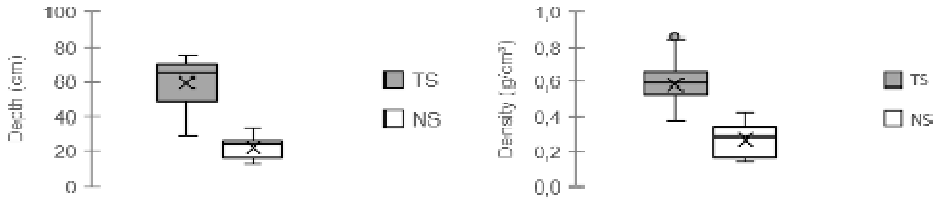

Fig. 2: Whole season comparison of depth and density of treated snow (TS) vs. untreated natural snow (NS). Mann-Whitney (Wilcoxon) W-test showed statistically significant difference in the both cases ($p < 0.05$). Cross in the box plot indicate mean and horizontal line indicates median.

The occurrence of snowpack over the winter seasons was significantly different on the treated plot and on the untreated plot of the ski slope (Fig. 3a). Snowpack treated by MM snow was identified for 97 days without any interruption during this period. Untreated natural snowpack was identified for 66 days during winter season with four interruptions which lasted for one to three days. The snowpack was melted on 11 March on the untreated plot and 6 April on the treated plot. The trace (snow depth lower than 0.5 cm and coverage less than 50 % of the observed plot) was recorded for 34 days before and 19 days after the snowpack occurrence on the treated plot (Fig. 3b). On the untreated plot was not observed similar long-term occurrence of the trace.

If there was no snow on the ground, the topsoil temperature fluctuated in relation to air temperature on the threated plot ($r = 0.751$) and also on the untreated plot ($r = 0.857$). If there was a snow, the topsoil temperature was constantly close to 0 °C and weakly correlated with air temperature ($r = 0,446$ on the treated plot; $r = 0,543$ on the untreated plot). At the end of the winter, the natural snowpack was melted away 26 days earlier compared to plot treated by MM snow (Fig. 3a). Thus, topsoil temperature on the untreated plot starts to rise above the zero much more earlier.
All observed herbs start to bloom earlier on the untreated plot and in the same order on the treated and untreated plot (Fig. 3b). The first herb, *Crocus discolor* starts to bloom at the end of March, six days earlier on the untreated plot compared to treated plot. Fifteen days later starts to bloom *Anemone ranunculoides* (eight days delay), followed by *Anemone nemorosa* (nine days delay), *Primula veris* (nine days delay) and *Cardamine pratensis* (five days delay).

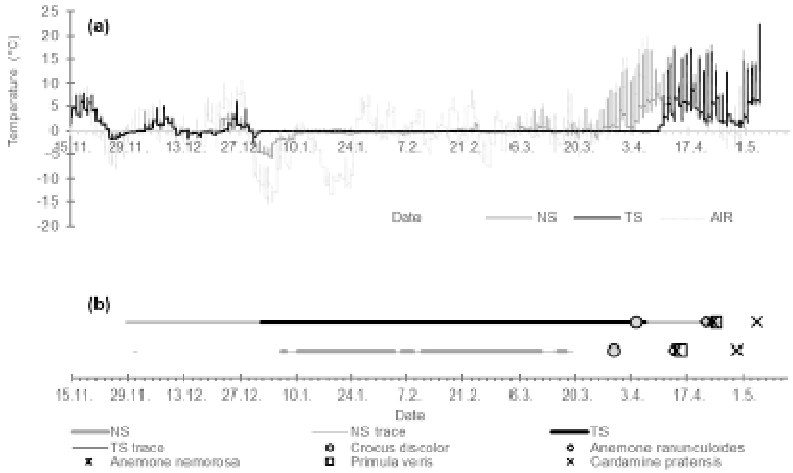

Fig. 3: (a) The course of topsoil temperature on the untreated plot with natural snow (NS) and on the plot with treated snow (TS); air temperature (AIR). (b) Occurrence of the snowpack (NS, TS) and trace on the ski slope with date when herb species start to bloom

Discussion

Results of this study confirm our previous findings (Mikloš et al. 2017a,b) and the findings of the other authors (Rixen et al. 2001; Zeidler et al. 2016), that concluded following statements: i.) depth and density of snowpack with added Machine Made (MM) snow is higher compared to natural snowpack; ii.) duration of the snowpack with MM snow is longer and the snowmelt date is therefore postponed. Snowpack quality and duration on the ski slopes has significant impact on the operability of the ski lifts and finally on the whole ski resort. According to Abegg (1996) is minimum depth of snow 30 cm on the grassy ski slopes. Steiger et Mayer (2008) reduce this high to 20 cm on the ski slopes where the MM snow is produced because of the higher density of the mixed snow (MM plus natural snow). We find out, that on the plot treated with MM snow was average seasonal snow depth 60 cm with minimum 29 cm while on the untreated plot it was only 22 cm (average) and 12 cm (minimum). We can conclude that, without production of MM snow, the depth of snow would by insufficient during most of the season 2015–2016. Moreover, because of the snow production, the snowpack occurred on the ski slope 97 days instead of 66 days and the snowmelt day postpone for the 26 days. Without MM snow, the examined ski season would be at least one month shorter.

This study confirms that if there is a snow on the ground the topsoil temperature is still around 0 °C (Rixen et al. 2001; Zeidler et al. 2016). Therefore, longer occurrence of the snowpack on the snowed ski slope result in the later start of the vegetation development (Rixen et al. 2001). In our case the flowering of first herb species was delayed by the five to nine days. Whether the changed snowpack characteristics affect also later flowering species and consequently the productivity of the ski slope meadows are proper questions for further research.

Conclusion

On the ski slope Záhradky (Ski resort Donovaly), where the machine made snow is produced, the snowpack has higher density, depth and longer duration. These changes in the snowpack properties results in the prolonged period with frozen

topsoil layer at the end of winter and consequently cause delay of the early spring herbs flowering. By the production of snow, the snowpack properties for skiing are improved (higher depth and density) and operability of the ski slope is longer by about a month, what is beneficial for the recreational potential. On the other hand, it postponed ski slope vegetation development what can finally result in the lower productivity or can change species composition of the local meadow ecosystems.

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Souhrn
Vliv umělého sněhu na vegetaci byl zkoumán několika pracemi ale jen pár se jich zaměřilo na vztah k vývinu časných jarních druhů bylin. Za účelem zhodnocení tohoto vlivu byly zjišťovány vlastnosti sněhové pokrývky (výška, hustota, doba trvání), měřená teplota půdy a dělány fenologické pozorování (kvetení) pěti druhů bylin na plochách pod vlivem umělého sněhu a na kontrolních plochách s přírodním sněhem. Výzkum probíhal v lyžařském středisku Donovaly - Záhradky (Západní Karpaty) během zimní sezóny 2015-2016 a pokračoval během nadcházející vegetační sezóny. Výsledky ukázaly vyšší průměrnou hustotu a výšku sněhu na zasněžovaných plochách. Na těchto plochách se sněhová pokrývka roztála o 26 dní později. Změny vlastností sněhové pokrývky ovlivnily teplotu ve vrchní vrstvě půdy což mělo za následek zpoždění kvetení sledovaných druhů bylin. Šefran různobarvý (Reuss 1853) začal v sezóně kvést jako první se šestidenním zpožděním na zasněžovaných plochách. Výsledky ukázaly, že vlastnosti sněhové pokrývky změněny lidskou činností mohou významně ovlivnit teplotu půdy a vývin vegetace na lyžařském svahu. Tato zjištění může být užitečné pro management a ochranu lučních ekosystémů využívaných k rekreaci.

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FORECAST OF ENVIRONMENTAL IMPACT OF TOURISM DEVELOPMENT IN THE GEOPARK COLCA AND ANDAGUA VOLCANOES IN THE SOUTHERN PERU

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Abstract
Geopark Colca and Volcanoes Andagua is located in the region of Arequipa, in the Central Andes of southern Peru. Currently, the project of including the Geopark area to a global network of Geoparks of UNESCO is being carried out. The inclusion of Geopark to this network could create new opportunities for sustainable tourism development. Geopark enjoys a great interest of tourists, their number in the last 10 years has doubled. Also increases the offer of tourist services, accommodation, catering, new roads are being built, parking lots. These activities have a significant impact especially on the landscape, the aquatic environment and the local population. On the basis of the spatial analyses, the impact of the tourism development on the environment was assessed and the possibility of minimizing its negative consequences were proposed. The article will present the results of research carried out by the Polish Scientific Expedition to Peru, which since 2003 has been conducting extensive geological and environmental surveys in order to document the values of this area.

Key words: geopark, tourism, protection, environment

Introduction

Geopark Colca and Volcanoes Andagua (GCaVA) is located in West Cordelier, in the Central Andes of southern Peru. A natural cross-section through the Earth's crust which creates a Colca Canyon has outstanding and unique values in the world scale for the development of geotourism. Currently, the assessment of GCaVA is being carried out, which is a candidate for a UNESCO Global Network of Geoparks. One of the conditions for including a geopark in the UNESCO network is the sustainable development of tourism. During the period of 2005-2016, the number of Geopark visitors significantly doubled (Fig. 1) (Autocolca, 2017). The Geopark area is willingly visited throughout the year, the largest number of tourists is recorded in July-November (Fig. 2).

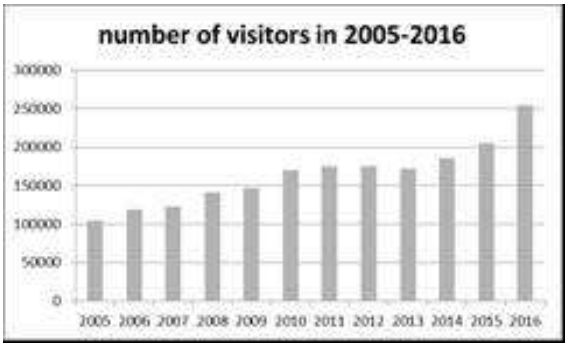

Fig. 1: The number of visitors in 2005-2016 (Autocolca, 2017).

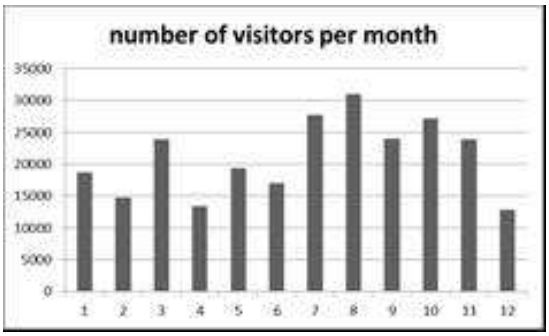

Fig. 2: Monthly number of visitors in 2016 (Autocolca, 2017).

Discussed area is located in the Department of Arequipa, which has few protected areas, the most important of them: the Cotahuasi Valley landscape reserve, the national reserve of Salinas and Aquada Blanca are located at the opposite ends of the Geopark (Fig. 3). As a part of inventory and valorisation of geosites in the discussed area, 129 sites were selected, divided into 9 thematic groups (Galas & Galas, 2017, Zavala et al., 2016) (Fig. 3). At the present time there is no network routes that could be used in hiking around the presented area. A major obstacle is the difficult access to water, and the lack of a camping places. Local authorities promote the so-called road loops (*cirquito*): 1) Ampato, 2) Canyon and Valley of Colca, 3) the Valley of the Volcanoes and 4) Canyon of Cotahuasi (Fig. 3). In principle, only the first route has the nature of a loop (around the volcano Ampato) which is a shortcoming of the whole idea. However, the three of them (1, 3, and 4) intersect in Huambo which can be an interesting prospect of development for this settlement. In principle, the idea of this plan is to promote all the attractions available for tourists using public transport.

The constant growth in the number of tourists visiting every year Colca Canyon translates into an increase in the number of services in the tourism industry, for example accommodation and catering, and the organization of leisure time and sightseeing. Tourist centers, thermal pools and museums are available for visitors. Currently, the undisputed tourist capital of the region is Chivay, as the only tourist resort with the full tourist service facilities. The remaining locations within the Geopark were created based on the possibilities of mining operation, agricultural crop or pastoralism. When tourists began to reach them, depending on local conditions, they started to offer them accommodation and other services. Since 2015, many farms have prepared an offer that corresponds to the standards of agritourism. The technical and communication infrastructure is being expanded. The most important investment is the road connection from Ayo in the Valley of the Volcanoes through the Colca Canyon to Canco and further to Huambo. Currently, there is realized the project key section between Ayo and Canco, in the bottom of the Colca Canyon, where on less than 2 km there is a need to put up 3 bridges. The construction of bridgeheads on steep scree and brittle walls results in a significant transformation of the unique rock formations (Gałaś et al., 2016).

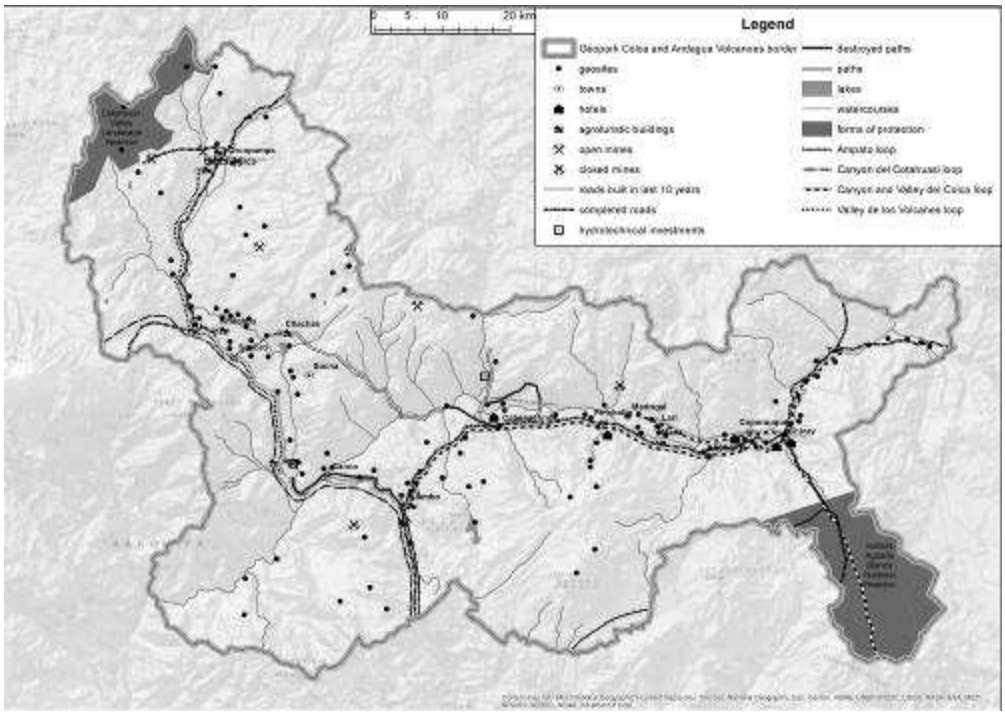

Fig. 3: Tourism development in the Geopark area

Methodology

The forecast the impact of tourism on the environment was performed with the use of GIS systems. On the basis of the topographic map, showing the main tourist attractions spots and areas most vulnerable to the negative impact of tourism were designated (Fig. 3). The Leopold matrix was applied for the impact assessment, in which the intensity of activity was determined for particular environmental aspects (small, medium, large), and it was estimated whether the occurrence of the aspect is existing or potential and whether it has a reversible or irreversible negative impact on the environment (by UNWTO, 2004, Agyeiwaah et al., 2017, Lazzarotto, 2009). As a result of the assessment was specified which aspects have the most negative impact on the environment and the inhabitants of the Geopark and the possibilities of their elimination was proposed. The data on which the impact forecast was based come from the research of the Polish Scientific Expedition to Peru on this area since 2003.

Results

The constantly growing offer of services and the tourist infrastructure in the Geopark area, as well as the increasing number of tourists has a significant impact on the environment and on the quality of life of the local population. From the conducted spatial analysis, observations and assessments of the impact of tourism development on the environment (Table 1) it follows that the most negative impact can be considered:

- Changes in the way of land use and landscape changes resulting from the construction of hotels, resorts and road infrastructure.

- Changes in the traditional way of building and an adverse impact on the ethnographic value of the region.
- Degradation of the area as a result of the use of land for the construction of accommodation and other facilities as well as activation of landslides during the construction works.
- Lack of a rational water-wastewater management and waste management.

Tab. 1: The assessment of the impact of the tourism development in the Geopark area (Legend: intensity of activity (A-small, B-medium, C-large), existing (E) or potential (P) aspect, reversible (R) or irreversible (I) negative impact on the environment) (by UNWTO, 2004, Agyeiwaah et al., 2017, Lazzarotto, 2009).

Receptor	**Impact of turism**	**Intensity of activity**	**existing or potential**	**reversible or irreversible**
Air and Climate	Air pollution from vehicle emissions and traffic	B	E	R
	Air pollution from combustion of fuels for heating and lighting	A	P	R
Water resources and water bodies	Water pollution through discharge sewage	B	E	R
	Damage to river banks	B	E	I
	Uncontrolled use of water	B	P	R
Soil and geology	Change in risk occurrence of land spill/slides	B	E	I
	Damage to geological features	B	P	I
	Depletion of mineral resources for building materials	A	P	I
	Damage to built assets from feet and vehicular traffic (including vibration effects)	A	E	R
	Waste and litter causing contamination	B	E	R
	Depletion of fossil fuels to generate energy for tourism activities	A	P	I
Flora and Fauna	Disruption of breeding habitats, alimentation and protection of wild animals by the tourism presence	B	P	R
	Change and dependence in the alimentation habit caused by the feed of tourists	A	E	R
	Inward or outward migration of animals	A	E	R
	Clearance of vegetation for camping, footpath	B	P	R
	Loss of habitat and change in species composition	A	P	R
	Over exploitation of biological resources (e.g. overfishing)	A	P	R
Human beings	Noise pollution from tourism transportation and activity, over-dependence on tourism, increase population due to migration	B	E	R
	Substitution of economic activities for tourism activities: change in lifestyle and quality of life, social problems	B	E	R

	Changes in (urban) functions, increase in prices of houses, food and commodities	B	E	R
	Traffic	B	E	R
Landscape	Change in land use for primary production	B	E	I
	Detrimental visual impact on natural and non-natural landscapes trough tourism development	B	E	I
	Introduction of new architectural styles	B	E	I
	Built facilities (e.g. buildings, new roads, car park)	B	E	I
	Vandalism	A	P	R
	Litter and sewage	B	E	R
	Physical expansion of built-up areas- increase in prices of land	B	E	R
	Change in character of built areas trough urban expansion or redevelopment	B	E	I
Cultural Heritage	Destruction and vandalism of historical buildings	A	E	I

Conclusions and reccomendations

The idea of sustainable tourism development is to bring benefits to tourists and local communities living in the visited areas, as well as entitles providing tourist services without causing loss or irreversible changes in the natural environment (Królikowska, 2017). Following this thought, it is necessary to develop the directions of sustainable development of the area, protection strategies, plans, protective tasks and organizational activities aimed at the protection and rational sharing of the values of the Geopark Colca and Volcanoes Andagua. The anthropogenic pressures of the tourism industry can be reduced if its investments will be preceded by studies on the assessment of their impact on the environment with the active participation of the inhabitants of the Geopark.

The residents of Geopark are mainly people living from agricultural crops, often carried out in difficult climatic conditions. Their mobilization, learning English language, courses for guides or tour operators, and learning how to rational management and also environmental management would have given better opportunities to use values and resources to improve their quality of life.

The plans should include the creation of educational and thematic paths, along with the necessary supporting and accompanying infrastructure (sanitary facilities), whose task is to not only to show the unique values of the environment, but also to raise the awareness of the local community and tourists about the need to protect these extremely valuable elements of the environment. Properly carried out the expansion of tourist infrastructure and services should be implemented taking into account the absorptivity of the Geopark. Only such activities will enable the practical implementation of the idea of sustainable tourism development.

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Souhrn
Geopark kaňonu Colca a údolí sopek se nachází v oblasti Arequipa v centrálních Andách jižního Peru. Tato oblast je charakteristická jedinečnou geodiversity. V současné době probíhá pousouzení začlenění Geoparku do globální sítě Geoparků UNESCO. Zahrnutí geoparku do této sítě by mohlo vytvořit nové příležitosti pro udržitelný rozvoj cestovního ruchu. Stále více turistů se zajímá o geopark, počet turistů se za posledních 10 let zdvojnásobil. Z tohoto důvodu zvyšuje sa take nabídka služeb cestovního ruchu, ubytování, stravování, staví se nové silnice, parkoviště. Tyto činnosti mají významný dopad zejména na krajinu, vodní prostředí a místní obyvatelstvo. Na základě prostorových analýz byl posouzen dopad rozvoje cestovního ruchu na životní prostředí a byla navržena možnost minimalizace jeho negativních důsledků. Článek prezentuje výsledky výzkumu polské vědecké expedice v Peru, která od roku 2003 provádí rozsáhlé geologické a environmentální průzkumy s cílem dokumentovat hodnoty této oblasti.

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GEOTOURISM AND A POTENTIAL OF THE TOURIST INDUSTRY IN CHŘIBY

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Abstract
The study deals with the relationship of small-area specially protected areas, geomorphologically and geologically important sites to the network of hiking trails used for recreation and the availability of collective accommodation facilities. In the model area of the geomorphological complex of Chřiby, there were conducted analysis of geologically important sites (geomorphosites), the density of communications used for recreational use in the countryside (marked hiking trails, nature trails, marked cycling trails, cycle paths and local hiking trails), and analysis of the attractiveness of specific sites in terms of tourism and recreation, including sports activities. Approximately one third of the naturally protected areas in Chřiby are attractive from the point of view of geotourism, namely rock outcrops, isolated rocks, remains after stone quarries or travertine hot springs. Knowledge of the intensity of use of individual types of trails, their placement and network of tourist accommodation may significantly contribute to the sustainable tourism and nature conservation in the Chřiby region.

Key words: Chřiby upland, geotourism, sustainable tourism, geomorphosites

Introduction

The geomorphological complex Chřiby with its 328,79 km^{2}is a significant part of the Outher Western Carpathian (Demek, Mackovčin, 2006). It is a large island of well preserved natural forests in highland relief surrounded by a long-time intensively managešd landscape in the floodplains and vales of the Morava, Haná and Litava rives. Brdo, the highest peak, has an altitude of 587 m. Comparing to surrounding area, the settlement in Chřiby is very sparse. In terms of the settlement system in the Czech Republic, it is so called internal periphery. The prevailing forest stands, rugged relief, the occurrence of rock outcrops, abandoned quarries and geomorphologically attractive locations provide ideal conditions for tourism development (Kubalíková et al., 2016), especially outdoor activities such as hiking, biking, mountaineering or geocaching.

Materials and methods

Identification of geologically important sites (geomorphosites)
The primary source for identification was the polygonal representation defined by borders of protected areas established due to protection of geology-related features. In second step this selection was extended by set of point features defined as a combination of sites from geology.cz website and localities marked as a rock or group of boulders in ZABAGED with the addition of known mineral springs (Bajer et al., 2014).

Accessibility from trails for recreational usage
Trail network designed for recreation and free movement in nature are various types of marked trails and routes. All types of marked trails set up in model area for

recreational use were mapped in the GIS. These trails can be classified into basic categories according to the type of movement:

- hiking - tourist marked trails managed by KČT (Czech Tourist Club), local and special tourist routes, nature trails, paths for handicapped people
- cycling - cycling trails and marked cycling routes including MTB trails but without the city's trails designed only for everyday mobility
- skiing - marked routes for cross-country skiing
- equestrian - marked routes designed for horseback riding

The analytic indicator „density of marked recreational trails in the area" (Sáňka et al., 2013) was calculated for the whole area to evaluate accessibility of each part of model area. The mapping output was elaborated using spatial
analysis „line density" in ArcGIS with following rules: raster cell size - 25 m, circle search of surrounding lines for calculation - 1780 m (corresponds to area of 10 km^2), the output value is trail density in km per km^2.
The common accessibility of geological POIs thru recreational trails network was evaluated within buffer in distance 100 m from identified features.

Accommodation establishments

The survey was focused on the settlements within 6 km of the border of studied area, that is common range of hikers and bikers.
Data of collective accommodation establishments (CAE) were obtained from Accommodation Establishment Register (CZSO, 2018) that is continually updated based on available information sources and investigation of capacity and attendance of collective accomodation establishments. Spatial database of was created in GIS by investigation based on addresses and names of individual CAEs.

Results

Geologically important sites *(geomorphosites)* here understood in a broader sence as significant geological and geomorphological landscape features with high natural, tourist and aesthetic value. (Reynard et al., 2009, Bajer et al., 2015). The data provided by Nature Conservation Agency revealed there are 13 protected areas in model area (Fig. 1), which are set up to protect various geological phenomena. Additional 102 geological points-of-interest (POI) were mapped including 6 mineral hot springs (travertine springs).

Trails for recreational usage

Three out of four trail categories used for classification were identified in model area of Chřiby mountains. While hiking and cycling are activities widespread the whole area, the only cross-country skiing route was found. And the importance of equestrian is probably quite low as there is no specific trail defined. The overall length of marked trails of all categories is 441.1 km (Tab. 1). Certain sections are shared by hiking and cycling marked routes jointly. The only skiing trail follows marked hiking trails at 96.5 % of its length.

Tab. 1: The length of marked trails designed for recreational activities

	activity			
indicator	**hiking**	**cycling**	**skiing**	**equestrian**
length [km^2]	298.2	232.2	53.1	0
density [km per km^2]	0.91	0.71	0.16	0

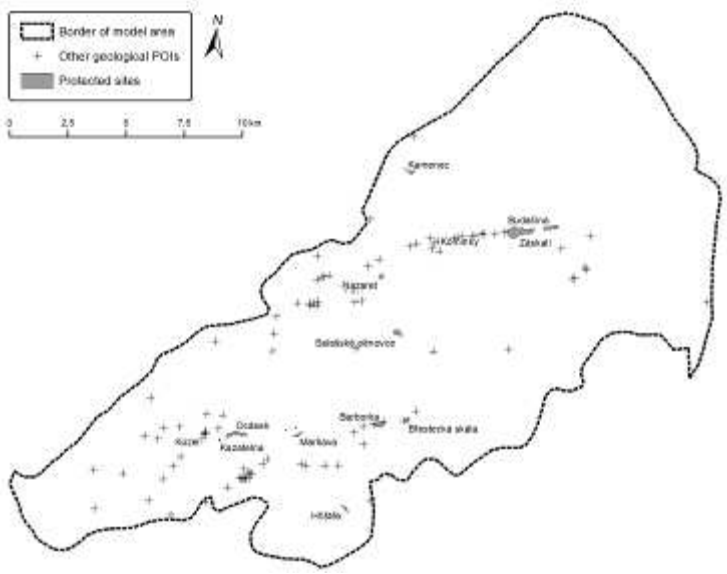

Fig. 1: Geologically important sites in model

Tab. 2: Accessibility of geological POIs by recreational trails

	activity							
indicator	**hiking**		**cycling**		**skiing**		**total**	
Protected areas	9	69 %	7	54 %	4	31 %	11	85 %
Other geoPOIs	45	44 %	16	16 %	9	9 %	47	46 %

The highest achieved density of recreational routes in the model territory was 2.78 km per sq.km (Fig. 2). The hotspots with highest densities are located mostly in places where ridge hiking routes are intersected by road network (Bunč, U křížku). These points are the ideal starting points for trips, because of parking space availability as the most of the model area is not accessible by public transport. Outside the model area, there were other hot spots representing tourist-attractive sites of a historical-cultural character (e.g. Velehrad and Modrá). Remarkably lowest density is clearly visible in north-east part, where the agricultural-cultural landscape prevails (Fig. 2).

Nature trails and their relation to geological processes

Several nature trails with info-boards are designed in the area to educate visitors. The route of six trails intersects model area but not all the whole. The overall length of nature trails routes within model area is 34.5 km. Three of these trails are maintained by municipalities (or their subsidiaries), one is managed by regional administration, one by State Forests Administration and the last one was set up by nonprofit association with a focus on local history and tradition.

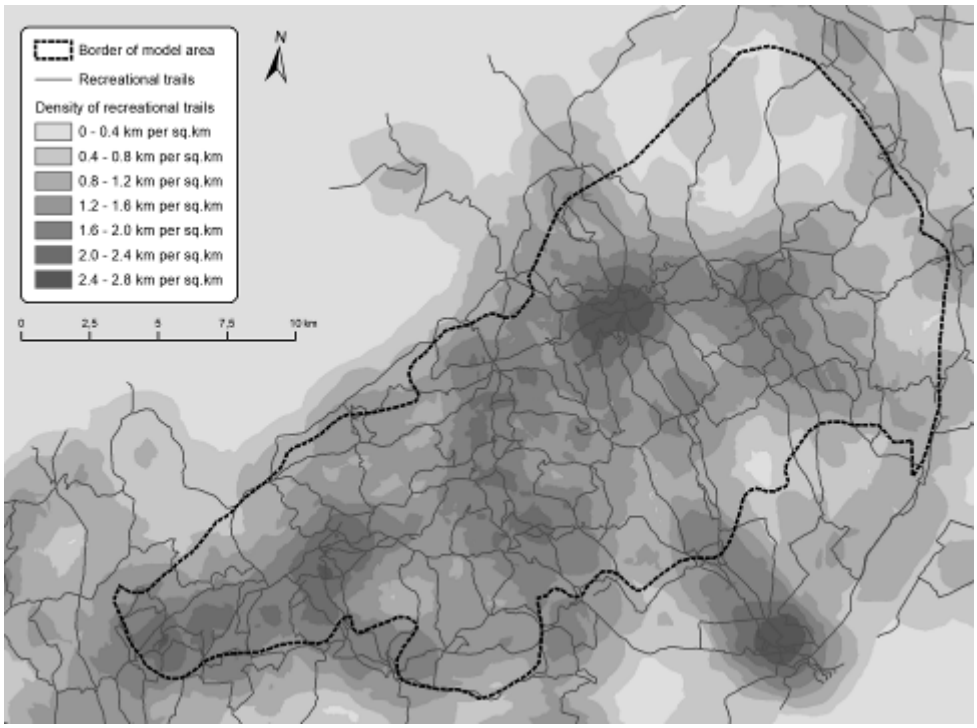

Fig. 2: Density of marked recreational trails in the area

Evaluation of accommodation capacity

In 2018, 51 of the total 106 municipalities in Chřiby provide accommodation. There are 183 accommodation facilities with the total capacity of 6096 beds (Table 3). The largest capacity is provided by municipalities in the wider neighbourhood of Chřiby– Otrokovice 845), Uherské Hradiště (723) Kroměříž (646), Kyjov (336), Koryčany (261) and also in some recreationally attractive municipalities – Buchlovice (584), Osvětimany (261), Roštín (229), Velehrad (214). The structure of accommodation capacity is varied. There are hotels of higher quality, guest houses, ranches, holiday resorts with cottages, spa resorts, camps, tent camps, private houses and cottages (Table 3). Accommodation capacity has been increasing and renovating mainly guest houses.

Tab. 3: Categories of accommodation and number of beds in study area

Categories of accommodation	**Number**	**Number of beds**
hotel	34	1549
pension	80	1667
tourist hostel	27	1228
cottage	21	190
camp	5	329
other	16	1133
Total	183	6096

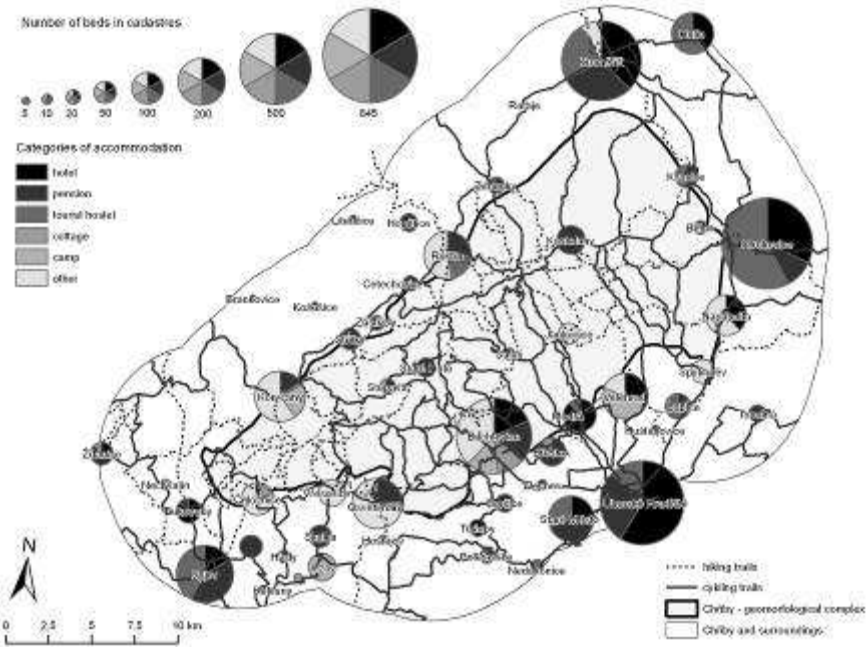

Fig. 3: Accommodation in study area

Hotels

Larger hotels are recorded in the largest towns in the vicinity of Chřiby, in Uherské Hradiště and Kroměříž (Fig. 3). Some hotels have been specifically built directly in Chřiby, recently (Modrá, Buchlovice, Bukovany, Velehrad). Newly built guesthouses are often situated in smaller municipalities in the heart of Chřiby or on the boundary slopes of this highland. Unlike hotels, guesthouses enable significantly better accessibility to geomorphologically attractive localities. Its total number and accommodation capacity is the biggest comparing all types of accommodation facilities in the region (Table 3). Even closer to the geomorphologically attractive localities are private houses and cottages, which are as the objects of individual recreation represented most in rugged relief of Chřiby in the vicinity of forestry and water areas. Camps and other recreational facilities are typical for the region, they are used predominantly during the summer season.

Conclusion

The geomorphologically acttractive localities of Chřiby are accessible especially from guesthouses, camps, recreational facilities, private houses and cottages in the area of the geomorphological complex, but also in the closest background. In recent years, the offer of higher quality accommodation has been increasing including wellness services and support of cycling.

Practically the entire Chřiby territory is interwoven with a dense network of tourist trails and paths that appear to be sufficient for hiking and cyling. Also cross-country skiing trails are appropriately designed but being just minimally used due to the lack of snow in last years. Development of basic network of hipotrails seems to be a good idea. Also development of 2-3 maintained single trails, in a suitable are without any conflicts of interests, might be a potential tourist attraction. The current state of tourist exploitation of Chřiby area with exceptions (tourist trails crossing, the

surrounding of Bunče and Buchlov castles) appears as a long-term sustainable and with no significant impact on studied geomorphosites.

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Souhrn

Studie se zabývá vztahem maloplošných zvláště chráněných území, geomorfologicky a geologicky významných lokalit, sítě turistických tras a dostupností hromadných ubytovacích zařízení. V modelové oblasti geomorfologického celku Chřiby byla provedena analýza geologicky významných lokalit, hustota komunikací využívaných pro rekreační využití v přírodě (značené turistické stezky, naučné stezky, značené cyklostezky, cyklostezky a místní turistické stezky) a analýza přitažlivosti konkrétních lokalit z hlediska cestovního ruchu a rekreace, včetně sportovních aktivit.. Přibližně jedna třetina přírodně chráněných území v Chřibech je atraktivní z pohledu geoturistiky, jmenovitě skalní výchozy, izolované skály, zbytky po kamenolomu nebo travertinových horkých pramenů. Znalost intenzity využívání jednotlivých typů tras, jejich umístění a síť turistického ubytování mohou významně přispět k udržitelnému cestovnímu ruchu a ochraně přírody v Chřibech

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GREENERY FOR DECORATING PURPOSES

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Abstract
Decorating materials are very popular non-wood forests products 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 spruce greenery in Christmas time. There are differences in origin of wreath which were observed in survey in 2018 year. 13 % of respondents are buying wreaths, 52 % are making their wreath at home, 4 % obtain wreath as a present, 2 % gained wreath otherwise and 29 % of respondents have no wreath as decoration.

Key words: wreath, Christmas, survey, decoration

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 January and February 2018. 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 from survey were compared with previous survey (Kadlec, Hejduková 2017).

Results and Discussion

The questionnaire within a month of 84 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 (52 %) manufacture their wreaths at home, 13 % are buying wreaths, 4 % obtain wreath as present, 29 % of respondents have no wreath as decoration and 2 % gained wreath otherwise.

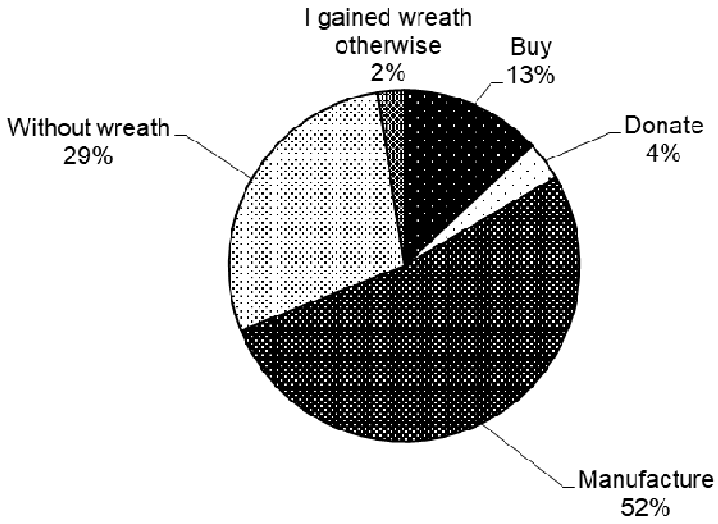

Fig. 1: How did you gained in this year a wreath?

Interesting results are connected with materials which are used in making of wreaths (see Figure 2). 86 % of respondents use greenery, 4 % other materials, 3 % wickery, 2 % mosses and 5 % of respondents used cones as decorating material.
There were just small differences between years 2017 (Kadlec, Hejduková 2017) and 2018 where the portion of buyers was the same and there was slightly higher portion of manufactured wreaths and higher portion of families without wreaths. When we are looking for increasing portion of homemade wreath we can assume that material for making of wreath is collected during touristic visits in forest.

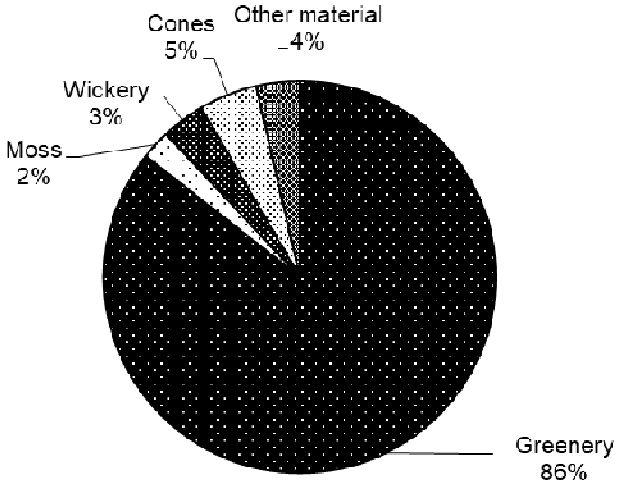

Fig. 2: From what material was a wreath?

Greenery was growing in portion in comparison with year 2017 (Kadlec, Hejduková 2017) and cones became second most popular material for making of wreaths. We will be looking for sources of decorating materials for making of wreaths at home next year.

Conclusion

Wreaths are typical Christmas decoration in many families in the Czech Republic. It became very popular and it is interesting that 29 % of families have no wreath as decoration. On the other hand, higher portion of homemade 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 and legality of sources of decorating materials.

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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 rozdíly v popularitě věnců v předvánočním čase a preference materiálu pro jejich tvorbu mezi lety 2017 a 2018. Z výsledků dotazníkového šetření je zřejmé, že vzrostla dominance vlastní výroby 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 potřeba se zaměřit na zjištění, jakým způsobem byl materiál pro výrobu věnců získán.

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HERBAL VEGETATION AS A STABILIZING ELEMENT

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Abstract
Herbal vegetation as a stabilizing element - part of the stabilization of banks in the area of the Hulín sand pit is also herbal vegetation. It is not the basic, the main stabilization, but it supports other stabilization. (Harbuláková et al, 2016; Pelikán et al, 2018) These are mainly plantings of Acorus calamus, Typha latifolia L., Gliceria maxima (HARTM) and others.

Key words: reservoir, water, bank

Introduction

An important part of stabilization are also reeds. This is primarily about:
Araceae – Acorus calamus - non autochtonous species
Butomaceae - Butomus umbellatus L. – autochtonous species
Poaceae – Glyceria maxima (HARTM) HOLMB. – autochtonous species
Iridaceae – Iris pseudacorus L. – autochtonous species
Cyperaceae – Schoenoplectus lacustris (L) PALLA – autochtonous species
Cyperaceae – Schoenoplectus tabernaemontanii (GMEL.) PALLA " Zebrinus" – autochtonous species
Typhaceae - Typha latifolia L. – autochtonous species
etc. (Vaněk, Stodola, 1987, Zeleňáková et al, 2015)

Materials and methods

To design suitable riparian and accompanying stands, it is important to understand the division of riparian zones according to the best prospering types of vegetation (Jedlička, Šlezingr, 2010; Šmak et al, 2016) – fig. 1 :

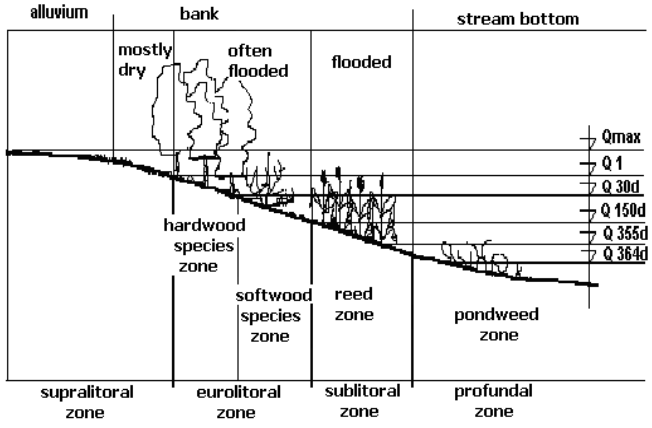

Fig. 1: Riparian vegetation arrangement

 profundal zone: a continuously flooded part of banks, colonised by freely floating, immersed, rooted or not - duckweed, pondweed etc.
 sublitoral zone: it is often called the reed zone – reed, calamus, flowering rush and others.
 eulitoral zone: a wide range, in lower parts knotweed, reed, cattail flag, near the surface soft tree species - willow, alder, poplar
 supralitoral zone: above the level of the design surface, rare flooding, area of accompanying stands of English oak, ash, maple, lime tree…

Fig. 2: Targeted planting of reeds – experimental area Bystré
(Photo: M.Šlezingr, 2017)

Fig. 3: Targeted planting of reeds - experimental area Hulín
(Photo: M.Šlezingr 2017)

Results

Experimental areas were established at Bystré u Poličky Czech-Moravian Highlands (Českomoravská vysočina) fig. 2 and on the reservoir (gravel pit) Hulín fig. 3 (Šlezingr et al, 2010; Zeleňáková, 2015) Used (in the first phase) - Typha latifolia L., we also assume use Glyceria maxima (HARTM) HOLMB, Iris pseudacorus L., Schoenoplectus lacustris (L) PALLA.

Conclusion

In this case, we focused on stabilization methods of biological engineering – reinforcement by vegetation – mainly riparian stands of willow shrubs in the eulitoral zone, reed stands in the sublitoral zone. (Šlezingr, Fialová, 2012; Vaněk, Stodola, 1987)

We are tracking experimental areas for the third year. Plants grow very well. It has shown to naturally propagate. The stabilization effect has not yet been demonstrated - low water level.

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Souhrn

Součástí návrhu stabilizace břehů – především u velkých nádrží, či splavných vodních toků – je také návrh stabilizace v oblasti přechodu profundálního a soblitorálního pásma.

Tato oblast – zóna rákosin – není většinou součástí základního opevnění ohroženého břehu, ale může v rámci stabilizace velmi dobře spolupůsobit.

Se základního výběru vhodných rostlin můžeme navrhnout například:

- Acorus calamus – puškvorec obecný, u nás neautochtonní, avšak široce rozšířený druh rákosiny, pochází z Indie, k nám byl zavlečen v 16. Století jako léčivá rostlina
- Butomus umbellatus L. – šmel okolíkatý, u nás domácí rostlina
- Glyceria maxima (HARTM) HOLMB. – zblochan vodní, také autochtonní rostlina
- A další viz výše

Výsadby a úpravy rákosin probíhaly v letech 2016 a 2017, velmi dobře se rozrůstají, ale bohužel stále zaklesnutá hladina vody v nádrži Hulín nedovoluje posoudit stabilizační účinek. V roce 2018 budou plochy rákosin významně rozšířeny a budeme dále sledovat jejich růst.

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IMPORTANCE OF WEATHER LORE FOR RECREATION IN REGIONS OF SLOVAKIA

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Abstract
The paper evaluates the validity of the weather lore "Medard's drop forty days dripping" and its impact on recreational utilization in individual regions of Slovakia. In the period from 8 June (Medard) to 17 July the total rainfall and the number of days with precipitation was monitored between 1961 – 2014 at three meteorological stations in Slovakia (Hurbanovo, Sliač, Poprad) at an altitude range of 115 – 670 m asl. The results were compared with the climatic norm. The validity of the weather lore in the locations of Hurbanovo and Sliač was confirmed by total precipitation over 23 years, which is 46% and by the number of days over 24 years (48%). In the location Poprad the weather lore was confirmed by the total rainfall in 23 years (46%) and by the number of days with rainfall over 29 years (58%). A 40-day rainfall occurred in the site Hurbanovo twice and in Poprad eight times.

Key words: weather lore, rainfall, Hurbanovo, Sliač, Poprad

Introduction

Weather lores had a significant role in the life of humans in the past, especially in terms of their practical function. Meteorologists have defined them either as a popular wisdom stemming from long-term observation of nature, or they were often viewed as primitive attempts to predict the weather. Recently, climate scientists have shown interest in the weather lores and they express their real value using statistical methods (Sepešiová, 2013). Therefore, using modern meteorology and statistical measurements, we have attempted to express the real value of one of them. Thus the validity of the weather lores will be either refuted, or their timelessness will be confirmed. As Malberg (2013) states, most of the weather lores were created in the past, a period of relatively stable climate. In a way we can consider validated weather lores as a kind of a climate change indicator. We decided to verify the validity of the weather lore "Medard's drop drips for forty days". Precipitation and water balance represent a main bioclimatic factor in the country (Zeleňáková et al., 2017, Bartík et al., 2016). The annual rainfall pattern in the Central and Northern Europe is typical and more or less less frequent each year. Approximately 40% of the annual rainfall is during the summer period (June – August). As a result, our territory has plenty of moisture for high tree vegetation (Škvarenina et al., 2004, Sitko et al., 2016). In the mediterranean countries, dry and hot summers have conditioned the formation of shrublands without significant tree vegetation (Plesník 2004). The most rainfall is in June or July, and the least rainfall is in January to March (Szolgay et al., 2009, Zeleňáková et al., 2017). The great variability of precipitation causes a frequent and sometimes prolonged drought in the lowlands (Škvarenina et al., 2009, Vido et al., 2015, 2016).
The selection of the weather lore was chosen based on the impact of the total precipitation on tourism and recreation. Both climatic conditions, as well as weather, are important factors in the development of tourism (Pichler et al., 2010, Mindáš and Škvarenina 2016). The aim of the work was to process the meteorological data to

verify selected weather lore in Sliač, Hurbanovo and Poprad and to use it for the recreational potential of these sites.

Materials and methods

We used meteorological data from the Slovak Hydrometeorological Institute stations - Hurbanovo, Sliac and Poprad when evaluating this weather lore. We processed the period 1961 – 2014 in a time span from 8 June to 17 July. The Automatic meteorological station in Hurbanovo with an altitude of 115 m asl. Is the oldest station with the longest continuous time series of measurements in Slovakia. The Sliač meteorological station was founded in 1944. The station is situated in the western part of the Zvolen basin and at the western ridge of the Slovenské Rudohorie Mts. at an altitude of 373 m asl. The meteorological station in Poprad with an altitude of 700 m asl. is found in the high Poprad basin. We've evaluated the total precipitation for a given time interval for each year, the number of precipitation days, the number of days with continuous precipitation, the total precipitation for each day, and the highest daily precipitation sums. We compared the total precipitation and precipitation with climatic norm. For long-term average parameter values, such as temperature and precipitation, 30-50 yearly averages are considered appropriate from a climatic point of view. To evaluate weather extremes, we have worked with 50-year climatic norms agreed by the World Meteorological Organization (WMO).
From 8 June (Medard) by 17 July from 1961 to 2014, we observed the total precipitation over the reference period (40 days) of individual years, and we compared the data with the long-term average (normal).

Results

Evaluation of the total precipitation and the days with precipitation

Hurbanovo: The normal of the total rainfall in the given period reached 76 mm. Excessive values were found in 23 years (fig. 1), which is 46%. The highest sum of precipitations was recorded in 1999 (220.5 mm), a significantly subnormal sum (11.1 mm) was in 1976. We also observed the number of precipitation days in the same period (8 June – 17 July) of the years 1961 – 2014 and we compared these values with the long-term average. Long-term rainfall averaged at 18 days. Excessive values of the numbers of days were recorded in 24 years, representing 48%. The highest number of days with rainfall was in 1974 (28 days) and 1979 (27 days), we recorded the lowest (9 days) in 2013.
Sliač: The normal daily precipitation for the observed period is 100 mm. We found abnormal values on the site in 23 years representing 46%. The highest values were measured in 1999 (241.6 mm). The lowest total was 2003 with a total of 13.5 mm (Fig. 2). The long-term average of the days with precipitation is 20 days. Abnormal incidence was observed in 24 years (48%) as in the Hurbanovo site. The highest number of days (29) in which the total precipitation was measured was in 1979, the lowest number of days with rainfall was 1961 (11 days).
Poprad: Normal rainfall is 108.8 mm. The number of years with abnormal precipitation was the same as in Hurbanovo and Sliac (46%). The highest cumulative we observed in 1999 (242.7 mm), the lowest total was in 1994 (18.3 mm). (Fig. 3). The long-term average of the number of days for this site is 24 days. Abnormal days with precipitation were 29 years (58%). The highest number of days with precipitation was between 1979 and 1998 – 33 days. The lowest 16-day values were recorded in 1968, 1976, and 2006.

Evaluation of the extreme highest daily rainfall sums over the reference period 1961-2014:

Hurbanovo: In 1992, we recorded a highly abnormal daily rainfall (12 July = 81.8 mm), which is the highest daily total precipitation period during weather lore (40 days). In this year there was the second highest total precipitation over the reference period (171.5 mm). A total of 42.0 mm was measured on Medard day and the continuous rain lasted from 28 June to 13 July (16 days).

Sliač: In 2002, the highest daily rainfall was measured (13 July = 81.5 mm) and the total precipitation of the observed period reached 125.6 mm. We recorded 14 days with precipitation and only 4 days with continuous precipitation, which represents the shortest rainfall in this locality during the 54-year period under review.

Poprad: In the years under review, at the time of "Medard's drops" we recorded the highest daily precipitation of 56.9 mm (16 July). In this year (2002) there was a second highest total precipitation of 227.7 mm over the period under review. Days of precipitation (29) were above normal. Severe precipitation occurred during 32 days (16 June – 17 July). (Fig. 4).

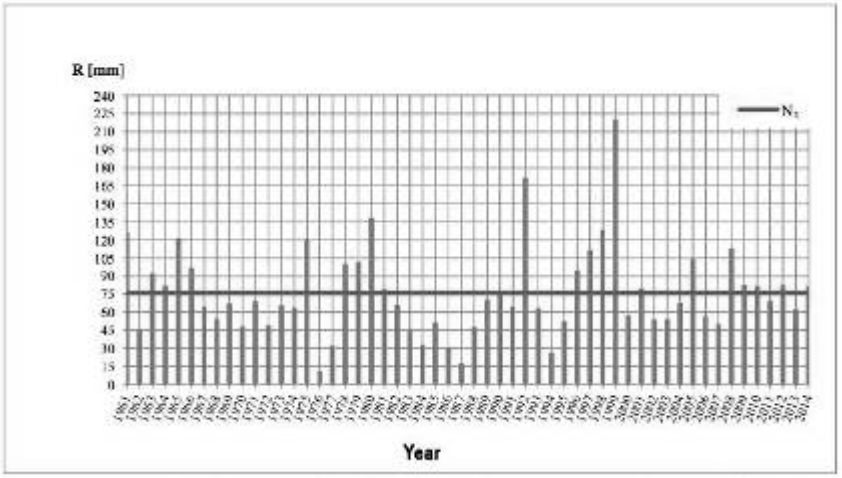

Fig. 1: Comparison of Hurbanovo long-term precipitation total, where R – is the sum of precipitations and N1 – is the long-term average in the period 8 June – 17 July years 1961-2014

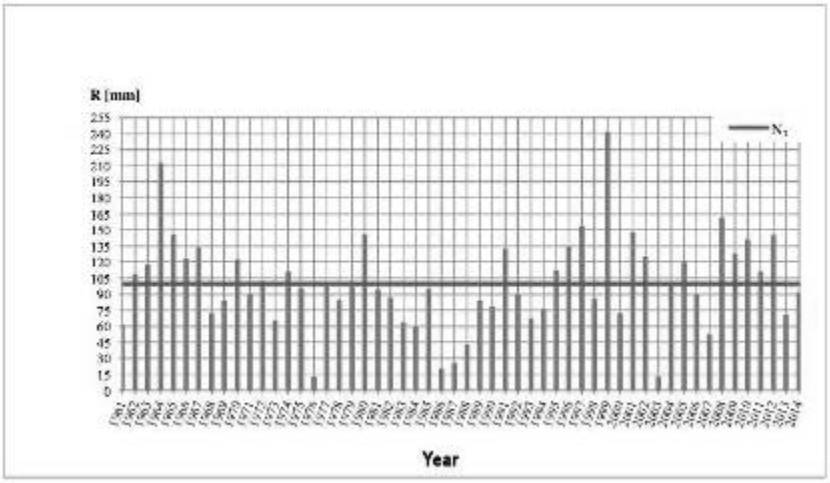

Fig. 2: Comparison of the long-term precipitation total in Sliač, where R – is the sum of precipitation and N1 – is the long-term average in the period from 8 June – 17 July years 1961 – 2014

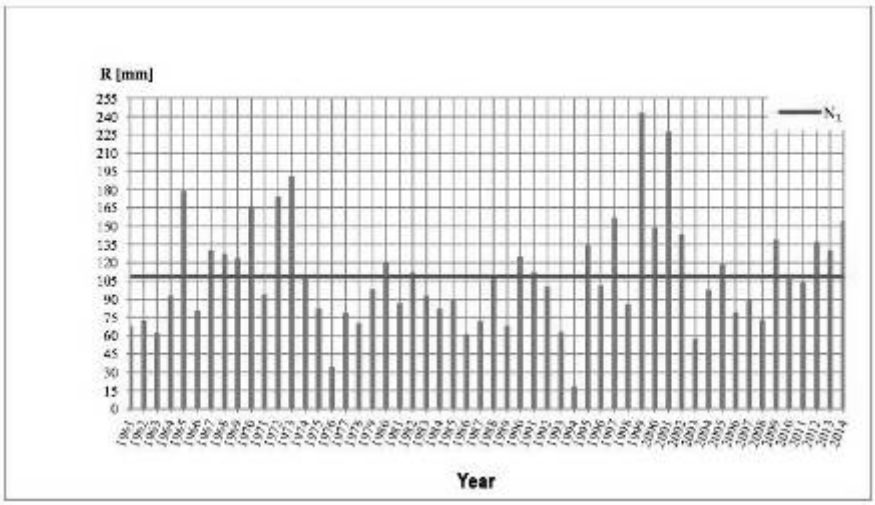

Fig. 3: Comparison of the long-term precipitation total in Poprad, where R – is the sum of precipitations and N1 – is the long-term average in the period from 8 June – 17 July years 1961-2014

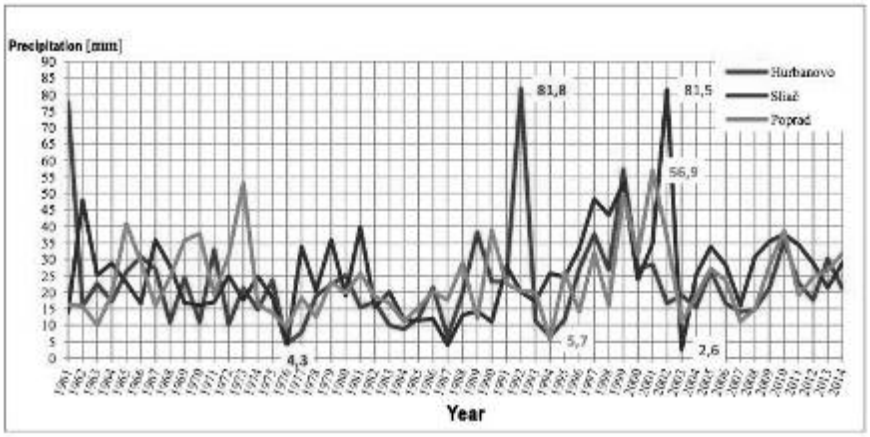

Fig. 4: Overview of highest daily precipitation sums, where R is the sum of precipitation in the period 8 June – 17 July years 1961 – 2014

Discussion

The issue of the weather lores is rather rare and few authors are devoted to it. In the discussion, we used the work by Munzar (1986), which deals with "Medard's drops", to compare our data. The author claims that the pressure and temperature conditions over the Atlantic Ocean and the European continent are crucial for June's Medard precipitation. The conditions are not the same every year, so the intensity and length of the weather on Medard day is different. Furthermore, according to Munzar, the 40-day duration of precipitation in the weather lore demonstratively suggests that rainy weather can sometimes last longer. In the case of high temperature contrasts between the ocean and the European inland until July. Otherwise, the European summer "monsoon" will be less pronounced and shorter, or even absent. After comparing our results with this claim, we can say that our results are more or less the same for all observed locations.

Conclusion

When evaluating the "Medard's drop – 40 days dripping", we worked with meteorological data from climatic stations Slovak Hydrometeorological Institute Hurbanovo, Sliac and Poprad between 1961 and 2014. We processed the period from 8 June to 17 July for each station. From the results, we found that the total rainfall was confirmed at all three locations in 23 years, representing 46%. Hrabanovo and Sliač stations in 24 years (48%), Poprad in 29 years (58%) reached the number of days with more than normal precipitation. From our results we can say that the weather lore was confirmed with a repetition time every 2 years. The absolute extreme of the daily rainfall (81.8 mm) was 1992 in Hurbanovo.

On the basis of the weather lore verification, it is possible to assess the potential of tourism in the localities, which is affected by the total precipitation. The location Sliač is an important spa and recreation center. Hurbanovo is characterized by the oldest and the highest quality meteorological station with scientific eductional character. The locality of Poprad is considered to be a tourist center. Thus, during the time of weather lore, there is a prerequisite for lowering the visibility of sites due to adverse meteorological conditions.

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Souhrn
Z výsledků jsme zjistili, že pranostika úhrnu srážek se potvrdila na všech třech lokalitách v 23 letech, což představuje 46%. Počet dní se srážkami nad normálem byly na lokalitách Hurbanovo a Sliač v 24 letech (48%), v Popradu v 29 letech (58%). Z našich výsledků můžeme konstatovat, že pranostika se potvrdila s dobou opakování každé 2 roky. Na základě verifikace pranostiky je možné hodnotit potenciál turistického ruchu v lokalitách, který je ovlivněn úhrnem srážek.

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