Geosite and geomorphosite assessment for geotourism purposes: a case study from the Vizovická vrchovina Highland, Eastern Moravia

Kirchner, Karel
2014

GEOSITE AND GEOMORPHOSITE ASSESSMENT FOR GEOTOURISM PURPOSE: A CASE STUDY FROM THE VIZOVICKÁ VRCHOVINA HIGHLAND, EASTERN MORAVIA

Karel Kirchner, Lucie Kubalíková
Institute of Geonics, Academy of Sciences of the Czech Republic, v.v.i.

Abstract
Geotourism can be understood at a broader sense as geographical tourism sustaining environment, culture, aesthetics, heritage and the well-being of residents of a place or in a more restricted sense as a form of nature tourism that specifically focuses on landscape and geology. Geological, geomorphological and pedological sites are the most important resource for the geotourism activities. It is evident that not every site can be used for geotourism purposes. To find out which site can be used, it is necessary to identify, describe and assess various sites using a suitable assessment methodology. Based on the definition and conceptsof geotourism and the assessment methods already used for geomorphosite assessment, authors propose five groups of assessment criteria. The method was used for assessing selected sites in the Vizovickávrchovina Highland (Eastern Moravia, Outer Western Carpathians). Thanks to the assessment of the sites in this region, some potential geotourism resources were identified. Although the proposed method is numerical which should reduce the subjectivity, there is always a degree of subjectivity due to the fact that the real value of some criteria cannot be measured and it depends on assessor's experience, knowledge and preferences.

Key words: geodiversity, geoheritage, numerical assessment, Outer Western Carpathians

Introduction

Geodiversitywhich is defined as the natural range (diversity) of geological (rocks, minerals, fossils), geomorphological (land form, processes) and soil features, including their assemblages, relationships, properties, interpretations and systems (Gray, 2004) is the most important resource for geotourism. It is evident that all the geodiversity cannot be used for geotourism; tourist use of geodiversity is generally made through the exploitation of geoheritage (represented by the geosites and geomorphosites). For the detection of such sites, it is necessary to do the inventory and evaluation of potential sites – this can be achieved by using the concept of "geomorphosites" (Panizza, 2001; Reynard, Coratza, Regolini-Bissig eds., 2009). This concept includes inventorying, identification and assessment of suitable sites. Plenty of assessment methods for the evaluation of the geosites and geomorphosites from different points of view were developed within this concept (e. g. Coratza and Giusti, 2005; Bruschi and Cendrero, 2005; Pralong, 2005; Serrano and Gonzalez-Trueba, 2005; Pereira et al., 2007; Reynard et al., 2007; Zouros, 2007). The analysis of these methods and their suitability for geotourism purposes was made by Kubalíková (2013).
The assessment of the geosites and geomorphosites in the Czech Republic using the geomorphosite concept was already done in several areas (e. g. Žďárskévrchy Protected Landscape Area, Podyjí National Park, Deblínskávrchovina highland), but this assessment was aimed mainly at the geoconservation purposes (e. g. Kubalíková, 2011;Kubalíková, Kirchner 2013). The assessment of the geosites and geomorphosites for geotourism purposes was not done yet; this paper presents both methodology and its application on the selected area (Vizovickávrchovina Highland, Eastern Moravia).

Methods

Geotourism can be understood at a broader sense as geographical tourism or tourism that sustains or enhances the geographical character of a place – its environment, culture, aesthetics, heritage and the well-being of its residents(Stueve et al., 2002; National Geographic Society, 2005). This concept is similar to the geomorphosite concept – it does not include only the abiotic features, but it takes into account so-called added values: ecological, cultural, historical and aesthetic (Panizza and Piacente, 2008; Reynard, 2008). In a more restricted sense, the geotourism is defined as a form of nature tourism that specifically focuses on landscape and geology (Dowling and Newsome eds., 2006; Dowling and Newsome eds., 2010) and that includes the provision of interpretative and service facilities for geosites and geomorphosites and their encompassing topography, together with their associated in-situ and ex-situ artefacts, to constituency-build for their conservation by generating appreciation, learning and research by and for current and future generations (Hose, 2012).

Both broader and more restricted definitions include some key features of geotourism. According to the National Geographic Society (2005), they are represented by *integrity of place, international codes, market selectivity and diversity, tourist satisfaction, community involvement and benefit, protection and enhancement of destination appeal, land use and planning, conservation of resources, interactive interpretation and evaluation*; according toDowling and Newsome eds. (2010): *geologically based, environmentally educative, tourist satisfaction, sustainable, locally beneficial.*

Based on these definitions and principles, a suitable method for assessing the geotourism potential should consider these groups of criteria:

- Criteria which consider an assessment of the scientific and intrinsic values (e. g. diversity, integrity, scientific knowledge of the site) – based on the principles *"geologically based"* and *"integrity of place"* and geology/geomorphology-oriented definitions of geotourism.
- Criteria which consider an assessment of the exemplarity and pedagogical potential of the site (e. g. exemplarity, availability of the products that support education: leaflets, trails, information panels) – based on the principles *"environmentally educative", "protection and enhancement of destination appeal* ", "*interactive interpretation and evaluation".*
- Criteria which consider an assessment of the accessibility and the presence of tourist infrastructure– based on the principles *"tourist satisfaction", "locally beneficial", "market selectivity and diversity", "community involvement and benefit".* It is also a very important group of criteria as the new definitions and new approaches (Dowling and Newsomeeds., 2010; Hose, 2012) emphasize the involvement of local people.
- Criteria which consider an assessment of the existing threats and risks, assessing conservation activities or existing legislative protection of the site – according to the principle *"sustainable", "land use and planning"* and *"conservation of resources"*
- Criteria which consider an assessment of the added values (ecological, cultural, historic, archaeological, artistic, religious value of a site, aesthetic, landscape and scenic value) – according to the definition of the National Geographic Society (2005) the geotourism does not consider only the natural aspects, but also cultural and aesthetic aspects of the site.

Based on the analysis of the principles and definitions of geotourism (Stueve et al., 2002; National Geographic Society, 2005;Dowling and Newsome eds., 2006; Dowling and Newsome eds., 2010; Hose, 2012) and coming out from the already existing and used methods of geomorphosite assessment (Coratza and Giusti, 2005; Bruschi and Cendrero, 2005; Serrano and Gonzalez-Trueba, 2005; Pralong, 2005; Reynard et al., 2007; Pereira et al, 2007; Zouros, 2007), the method for assessing the geosites and geomorphosites for the geotourism purposes is proposed (see Table 1). To every criterion, a value from 0 to 1 is attributed. Some of the criteria are based on Kubalíková (2013).

Tab. 1: Proposed method for assessing the geosites and geomorphosites for the geotourism purposes(source: authors)

1. scientific and intrinsic values	1.a integrity, rarity and Earth-science importance of the site
	1.b scientific knowledge of the site
	1.c morphology, genesis, age, diversity ofthesite
2. educational values	2.a exemplarity and representativeness of the site, clarity and visibility of the features and processes
	2.b presence of educational facilities (leaflets, web pages, information panels, guidedtours)
3. economical values	3.a number, distance and quality of tourist services
	3.b accessibility
4. conservation values	4.a conservation activities (legal protection, other types of protection)
	4.b risks and threats to thesite
	4.c current status of thesite, the level of disturbance or degradation
5. added values	5.a cultural (historical/religious/archaeological) values
	5.b ecological value (relationships to livingnature)
	5.c aesthetic/landscape/scenicvalue

Study area

Vizovickávrchovina Highland is situated on the Eastern part of the Czech Republic on the border with Slovakia. Geologically it belongs to the Flysch complex of the Outer Western Carpathians. The area is a part of MaguraFlysch Belt (Rača tectonic unit) that is formed by alternating layers of claystones and sandstones of the Mesozoic and Tertiary age. The area is characterized by the largely dissected relief of highlands and mountain ranges with intervening deep valleys and basins (Czudek ed., 1972; Demek andMackovčin eds., 2006).

The studied area (see Figure 1) forms the north-eastern part of the Vizovickávrchovina Highland and it is called Komoneckáhornatina Mountains. The area is built by FlyschPaleogene rocks of Zlín Formation and Soláň Formation of the Rača tectonic unit of the MaguraFlysch Belt. The central part of the area is formed of the geomorphological district Klášťovskýhřbet Ridge which reaches the altitude around 700 m a.s.l. (Vrátnice 683 m, Krajčice 730 m, Kopce 699 m) and it is drained by the Senice River (left tributary of the VsetínskáBečva River). Bedrock consists mainly of coarse grained sandstones of Luhačovice member of Zlín Formation of the Maguranappe. The tectonic setting of these sediments forms a part of the Čertovykameny–anticlinal zone with the anticlinal position of Flysch strata. The different rock resistance and the conditions of the strata position influence the structural-denudational relief of the Klášťovskýhřbet Ridge which is represented mainly by the steep hillslopes, isolated boulder accumulations, landslides and sandstone outcrops where the large amount of the mezoforms and microforms can be seen (pseudokarst caves, honeycomb weathering etc.). At the alluvial plain of the Senice River, the typical fluvial features can be found (Kirchner, 2004).

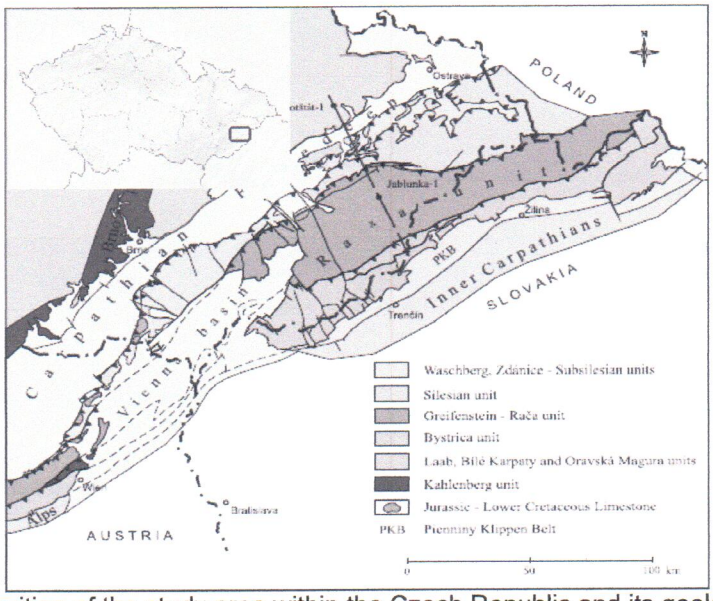

Fig. 1: The position of the study area within the Czech Republic and its geological context (adapted from the Czech Geological Survey).

Six sites were selected for the assessment and they represent the typical landform features of the area, localization of studied sites see at the Figure 2. Some of them are displayed at the Figure 3.

Site 1: Kopce -pseudokarst caves

The site is located in a landslide area and it includes both pseudokarst fissure caves and a rocky landslide (with dimensions of 200 x 250 m which is quite unique within the area) that are both of gravitational origin. There is 11 large pseudokarst caves created thanks to the deep seated landslide, the biggest of them reaches the depth of 14 m, another are around 7 – 10 m deep. The walls of the caves are covered by calcareous sinter. In the proximity of the caves there are some pseudo-sinkholes (maximal depth of 2 m) with an entry into the small debris cavern. The site has also a high added value due to the presence of the cultural-historic component (remnants of the Bronze Age settlement nearby, a quartz wall) and geomythological aspect (existence of various legends connected to the caves – especially about the treasures

hidden here by the bandits). As the caves are home to some species of the bats, the site has also a high ecologic value.

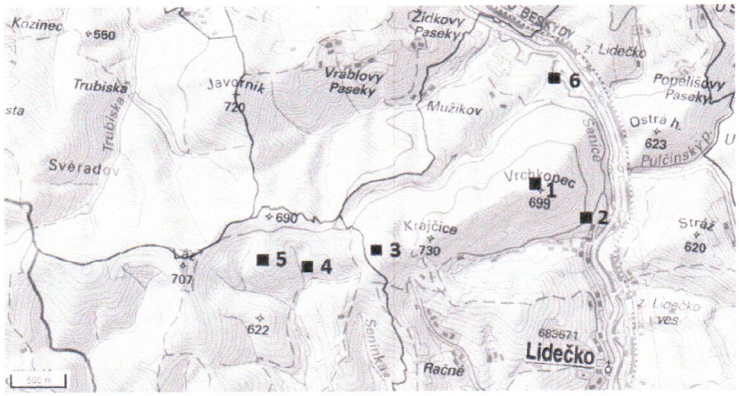

Fig. 2: Localization of the studied sites. 1 - Kopce- pseudokarst caves, 2 - Čertovyskály/Devil's rocks, 3 - Láz Hill, 4 - Horníškály Rocks, 5 - Dolníškály Rocks, 6 - Meanders of Senice River (*map source -www1.cenia.cz*)

Site 2: Čertovyskály (Devil's rocks)

The unique structural-denudation rocky wall is formed of the perpendicularly declined sandstone layers (Lower LuhačoviceMember of the Čertovykameny- anticlinal zone). The crag is divided into several regular thick-bedded sandstone blocks by the perpendicular fissures; along the system of the fissures some small pseudokarst caverns were formed. The total length of the wall is around 250 m, the height reaches 25 m. Its width in its upper part is around 3 m. The surface of this rocky rampart is covered by various microforms typical for sandstone weathering (honeycombs, tafoni, weathering pits). The site is protected by the law in the category of natural monument (the year of the declaration already in 1966). The cultural and historical aspect of the site is also very important – there are plenty of myths (mostly connected to the devil's activities) and aesthetical aspect of the site is also very significant (the wall dominates the surrounding landscape). The site is very often presented as typical site of the area and it is often presented in various tourist guides. It is also used by the climbers which brings some problems (the rope traces, surface abrasion).

Site 3: LázHill

An upper part of the southern structural – denudation slope of the elevation called Láz Hill has a character of the frost cliff (3 m high and 50 m long) and it is built by the rocks of the Lower LuhačoviceMember of the Čertovykameny – anticlinal zone (mostly quartzose sandstones). This natural outcrop was formed by cryogenic and gravitational processes and it exhibits many interesting weathering phenomena such honeycombs, weather pits and tunnels. The typical features for this site are the spherical cavities (maximal dimensions are 0,6 m in diameter, 0,35 m in depth). The cliff is divided by fissures in the north – south direction. Along these fissures, some deep clints were developed (maximal depth is 0,4 m, maximal width 0,6 m, length around 10 m). On the western part on the top of the frost cliff there are several weathering pits; the biggest is filled with water and it has a diameter of 0,6 m. On the eastern part of the cliff there is a tunnel leading into the rock (length of 3 m, diameter of 0,75 m). The nearly entire surface of the cliff is covered by the microforms of the honeycomb weathering. Thus, this site is very rich in the mezo- and microforms which represent its most valuable features (e. g. tunnel leading inside the cliff is a unique mezoform within the study area). From the geologic and educational point of view, the slope shows and documents the steep position of the LuhačoviceMember of the Čertovykameny – anticlinal zone.

Site 4: Horníškály Rocks

A morphologically significant frost cliff on the top of the VrátniceHill is developed on the forehead of the Paleogenequartzose sandstones and conglomerates of the Luhačovice Member of the Čertovykameny – anticlinal zone. The cliff is stretched in the north-eastern – south-western direction and it has a south-eastern exposition. Its length is around 90 m and the height up to 10,5 m. The cliff is divided into several blocks by fissures and the rock walls (which are partly pendent) are covered of the large number of the typical weathering microforms (especially honeycomb weathering), some of them have a character of tafoni with the depth of up to 0,5 m.

Other typical features are represented by the weathering pits with maximal diameter of 0,3 m and maximal depth of 0,25 m. On the base of the cliff, there are several niches (abri). Other important mezoforms of the site are represented by the pseudokarst cavern (depth 3,2 m, width 1,6 m, height 1,5 m) and cryoplanation terrace with blocks of sandstones. The site is used by the climbers, so it presents a source for recreational activities; on the other hand, the sandstones suffer from these activities.

Site 5: Dolnískály Rocks

A frost cliff on the lower part of the slope of VrátniceHill has a length of 70 m and its height oscillates between 6 and 14 m. The cliff was created by the cryogenic and gravitational processes; on the south-western part, there is an evidence of the influence of fluvial processes. The cliff is developed on the forehead of the Paleogenequartzose sandstones and conglomerates of the Luhačovice Member of the Čertovykameny – anticlinal zone and as the HornískályRocks site represents the typical steep position of the rocks. The cliff is exposed to the south-west and it is divided into several blocks by fissures and the rock walls (which are partly pendent) are covered of the large number of the typical weathering microforms (especially honeycomb weathering), some of them have a character of spherical cavities (or tafoni) with the depth of up to 0,7 m. The cavities are arranged along the main fissures and its large number makes this site unique within the area of interest. Other unique mezoform is represented by the small gorge (also unique in this area) developed on the south-western part of the site where the frost cliff meets the channel of the mountain creek.

Site 6: Meanders of Senice River

This site represents the fluvial phenomena within the study area and it documents an interaction between the vertical and lateral channel erosion and river channel migration. In the past, the alluvial plains were exposed to the human impacts, so they are relatively rare today. Especially valuable are the sections where the mountain river enters into the alluvial plain, it creates the initial turns and then starts to meander, but there still predominates side erosion and lateral shift of the river channel. The bedrock is constituted of the PaleogeneÚjezdMember where the sandstones and claystones predominate. The studied section is approximately 500 m long and here it creates the turns which pass to the meanders. An important and unique geomorphological feature of this site is the dynamic lateral erosion which undercuts the shores and then exposes the sediments. Regular natural flooding is also typical in this area; this processes influenced the water regime, soils and ecosystems in the alluvial plain. Thus, the site has also a relatively high ecological value. Within the site, the results of natural processes and different stages of the development of turns and meanders can be observed. Some morphologically remarkable mezoforms in the alluvial plain (e. g. remnants of the oxbow lakes or abandoned meanders) then prove the natural migration and shifting of the river channel in the past. This has a very high educational and scientific value (especially because of the possibility of palaeogeographic reconstructions).

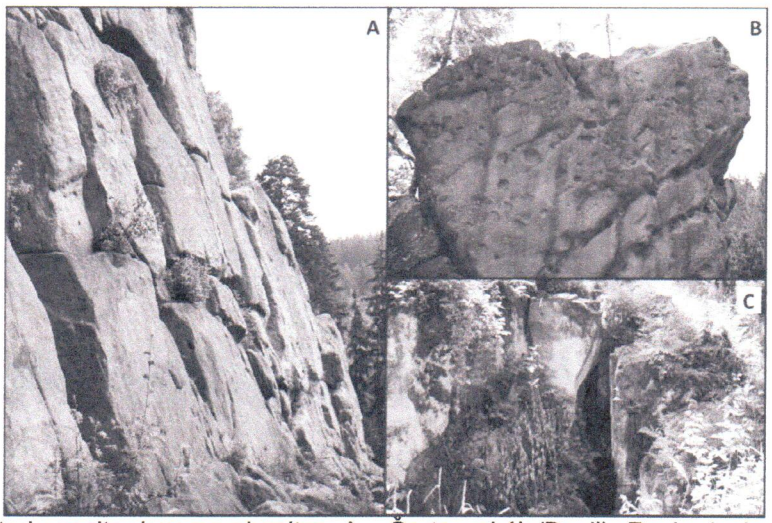

Fig. 3: Selected geosites/geomorphosites: A – Čertovyskály/Devil's Rocks (unique structural-denudation sandstone outcrop with the perpendicular fissures), B – DolnískályRocks (typical weathering features as honeycombs and pits), C – Kopcepseudokarst caves (an entry to the one of the caves) (author: K. Kirchner, 2009).

Results

The above mentioned sites were evaluated using the method proposed above. It was supposed that the sites more suitable for geotourism purposes have to be both geologically/geomorphologically important and attractive from different point of view (historical, cultural, ecological etc.). The results are presented in the Table 2.

Tab. 2: The results of numerical assessment of the selected sites

Name of the site/ group of the values	Kopce pseudo karst caves	Čertovy Skály/Devil's rocks	Láz Hill	Horní Skály Rocks	Dolní Skály Rocks	Senice meanders
1. scientific values	2,75	2,25	2,25	2	2	2,5
2. educational values	1,75	2	1	1,5	1,5	1,75
3. ecomonical values	1	1	1	1	1	1
4. conservation values	2	1,5	1,25	1,75	1,75	1,25
5. added values	2	2,5	1	1,5	1	1,75
Total score	**9,5**	**9,25**	**6,5**	**7,75**	**7,25**	**8,25**

The highest scientific values were reached by the Kopcepseudokarst caves and the Senice meanders. It is especially thanks to the presence of the features that are rare within the area of interest (Kopce) and thanks to the presence of the actual processes (fluvial erosion at Senice meanders). Although the Čertovyskály/ Devil's rockshad a quite big score thank to the genesis and diversity of the landform, the integrity of the site was lower.

The highest educational value was reached by the Čertovyskály/Devil's rocksthanks to the both existence of the educational material and good visibility and clarity of the geosciences features. Other two sites were also evaluated quite well especially thanks to the exemplarity of the landform (Senice meanders – a possibility of the observing the natural fluvial erosion and typical fluvial landforms both in the channel and in the alluvial plain; Kopce – typical and well visible pseudokarst caves).

Economical value was the same for all the sites, because they are accessible by the tourist paths and the tourist infrastructure in the area is the same for all the sites as the study area is quite small.

The conservation value included both legal protection and possible threats to the site. Although the site Čertovyskály/ Devil's rocksis protected under the law, its score is not so high because of the climbing activities that disturb the site and also because of the larger number of the visitors that damage the outcrop. The site of Kopce is both protected by the law and there are not so intensive threats, so it reached the highest score. Relatively high score of the Hornískály Rocks and DolnískályRocks is given especially thank to the lower number of the visitors. Senice meanders reached relatively low score because of the presence of natural threats that can damage the site (on the other hand, these natural processes are the good educational source).

The highest added value was obtained by the Čertovyskály/Devil's rocks especially thanks to its geomythological aspect and a high aesthetical value. In the case of the Kopce site, the most important added values were represented by the ecological and historical values.

The highest total score was reached by the sites of Kopce, Čertovyskály/Devil's rocks and Senice meanders. These sites are not important only from the scientific point of view, but also they have the significant educational potential (Kopcesite and Senice meanders) and important added values (Kopce and Čertovyskály/Devil's rocks). On these examples can be seen that the sites suitable for the geotourism should be not only geologically and geomorphologically valuable, but they should include also some added values to be chosen as the possible sites for development of the geotourism.

Based on this assessment, some geotourism activities can be proposed (especially educational activities as the installation of the information panels, guided tours etc.)

Conclusions

Based on the analysis of the geotourism concepts and definitions and on the already existing geomorphosite assessment methods, the modified method for the geosite and geomorphosite assessment for the geotourism purposes was proposed. The assessment criteria were divided into five groups to cover all the key features of geotourism. The first group (scientific and intrinsic values) is based on the principles *"geologically based"* and *"integrity of place"* and geology and geomorphology – oriented definitions of geotourism. The second group of criteria

(educational values) comes out from the fact that most of the definitions of geotourism emphasize the educational issues; this group is based on the principles "*"environmentally educative", "protection and enhancement of destination appeal* ", "*interactive interpretation and evaluation"*. The third group of criteria (economic values) considers the principles*"tourist satisfaction", "tourist satisfaction", "locally beneficial", "market selectivity and diversity", "community involvement and benefit"*. The fourth group (conservation value) is based on the principles *"sustainable", "land use and planning"* and *"conservation of resources"* and partly on the geoconservation principles. The last group of the criteria (added values) comes out of the fact that geotourism does not consider only the natural aspects, but also cultural and aesthetic aspects of the site.

The method was firstly tested in the Vizovickávrchovina Highland to get the information about the geotourism potential of the selected sites. It was supposed that the sites that are geologically and geomorphologically important and that have also high added values (historical, cultural, ecological etc.) and educational potential are more suitable for the geotourism purposes and they are good for the future development for the educational activities.

Although the proposed method is numerical which should reduce the subjectivity, there is always a degree of subjectivity due to the fact that the real value of some criteria cannot be measured and it depends, for example, on assessor's experience, knowledge and preferences. So, the future improving and testing of the method is inevitable as well as the list of assessment criteria is not complete and it is a subject to further discussions.

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Acknowledgements
This article was supported by long-term conceptual development support of research organisations RVO: 68145535.

Souhrn
Geoturismus je chápán jako udržitelná forma cestovního ruchu založená zejména na využívání geodiverzity, respektive geologických a geomorfologických lokalit. V širším smyslu lze do geoturismu zahrnout i aktivity, které se vážou ke kulturní, historické nebo ekologické stránce lokality. Ne všechny lokality však lze pro geoturistické účely využít. K ohodnocení potenciálu lokalit pro geoturistické účely byla na základě analýzy definic geoturismu a na základě analýzy metod používaných v rámci konceptu geomorphosites navržena upravená metoda, která umožňuje numerické hodnocení lokalit a jejich potenciálu. Hodnotící kritéria jsou rozdělena do pěti skupin v souladu se základními principy geoturismu: vědecké hodnoty, vzdělávací hodnoty, ekonomické hodnoty, ochranářské hodnoty, přidané hodnoty.
Metoda byla testována v atraktivním prostředí Vizovické vrchoviny, kde bylo vybráno šest lokalit reprezentujících typické geologické a geomorfologické prvky oblasti. Zahrnuty byly zejména tvary vzniklé gravitačními, kryogenními a fluviálními procesy (např. sesuvy, pseudokrasové jeskyně, skalní výchozy, mrazové sruby, meandry), významnou roli však hrály i mezoformy a mikroformy (voštiny, skalní mísy, drobné fluviální tvary v nivě). Bylo zjištěno, že vhodnější pro geoturismus jsou lokality, které vedle vysoké hodnoty geovědní mají i přidanou hodnotu, ať už se jedná o kulturní aspekty (např. existence pověstí), historické souvislosti (zbytky hradiště) nebo ekologickou hodnotu (výskyt chráněných druhů živočichů). Důležitou roli v hodnocení hrála i názornost tvarů a procesů a jejich viditelnost a zřetelnost. Na základě hodnocení může být navržen vhodný management lokalit a jejich racionální využití zejména pro vzdělávání.
Metoda jako taková je sice založena na kvantitativním hodnocení, což by mělo snížit subjektivitu, nicméně některá kritéria jsou stále těžko objektivně hodnotitelná, protože závisí jednak na zkušenostech a znalostech hodnotitele. Kritéria by tedy měla být dále diskutována a testována v dalších oblastech.

Contact
Doc. RNDr. Karel Kirchner, CSc.
Institute of Geonics, Academy of Sciences of the Czech Republic, v.v.i., Branch Brno
Drobného 28, 602 00 Brno
kirchner@geonika.cz
+420 545 422 730

Name: **Public recreation and landscape protection – with man hand in hand?**
Editors of the proceeding: Ing. Jitka Fialová, MSc., Ph.D.; Dana Pernicová
Mendel University in Brno, Zemědělská 1, 613 00 Brno
First Edition
Year: 2014
ISBN 978-80-7375-952-0