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Mining Landforms: An Integrated Approach for Assessing the Geotourism and Geoeducational Potential

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Abstract

Anthropogenic landforms (especially the mining landforms – quarries, pits, mines) have undoubtedly a great potential for the geotourism development. In addition, they are important from the geoconservation and geoeducation point of view as they allow to see the Earth-science features that would normally remain hidden (e.g., stratigraphic boundaries or soil profiles). However, the potential of these landforms in some case is not fully recognized and the sites themselves can even be endangered. The article presents guidelines for inventorying and assessment method for geotourism and geoeducational purposes of these specific landforms (respectively, the mining geosites and geomorphosites which are going to be used for geotourism and geoeducation) and gives an example from the area in which geotourism has not been fully developed yet (Červený kopec/Red Hill in Brno, Czech Republic).

Keywords

mining landforms, mining geoheritage (geosites and geomorphosites), assessment method, geotourism potential, geoeducation

JEL classification: Q26, L83

Introduction

People have always influenced abiotic nature. Nowadays, the human agent is equal to natural factors in the shaping of landforms: natural landforms are modified or destroyed, new landforms are created and new processes even surpass the effectiveness of natural exogenic processes (Szabó, Dávid, & Lóczy, 2010; Goudie, 2006; Hooke, 2000). Furthermore, activities such as quarrying, mining or construction of large communications induce processes that would normally would not exist in certain places, e.g., landslides or subsidence depressions and in some cases, the landscape is completely remodelled (Figure 1).

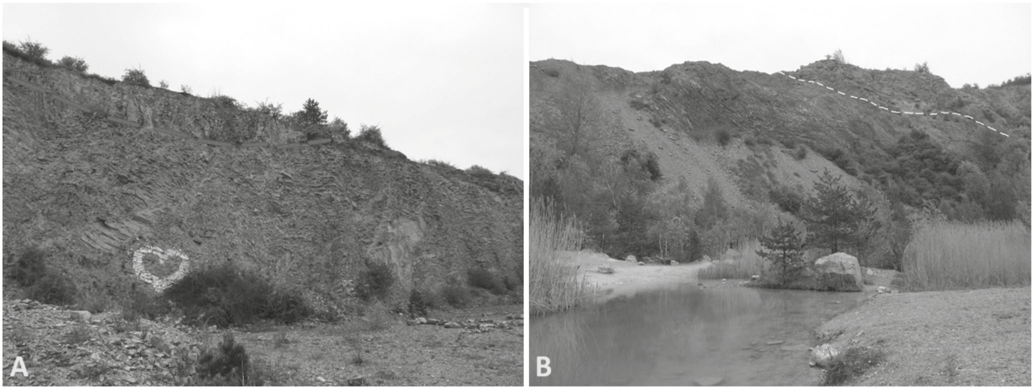
Figure 1 Examples of human impact on the relief in the Czech Republic: A – Superficial brown coal extraction in Sokolovsko (totally remodelled landscape), B – Church of St. Peter of Alcantara near Karviná (the inclination of the building is caused by underground black coal extracting and subsequent subsidence)

Source: own processing

However, people also create new, interesting landforms (e.g., quarries, pits, communication cuttings or agricultural landforms) which are attractive from the scientific, educational, cultural and historical point of view and which provide important scientific (e.g., stratigraphical, tectonic, palaeopedological) information or display features that would normally remain hidden or unrecorded in the maps or literature (Osborne, 2000).

Figure 2 presents an example from Brno city (Czech Republic): in the upper bench of Hády quarry, the transgression of Jurassic (Oxfordian) carbonates over folded Devonian calciturbidites is well visible and in Růženin lom (lower part of Hády quarry), the overthrust of the Proterozoic granitoids over the Devonian - Carboniferous limestones can be observed (Gilíková et al., 2010). On the bottom of the quarry, a small pond, which is important from the ecological point of view, is situated. Currently, there is an educational path that explains the Earth-science and ecological features and the site (where the quarrying was stopped already several decades ago) is considered a favourite place for hiking and walking.

Figure 2 Specific Earth-science features uncovered thanks to quarrying: Hády quarry in Brno: A – the transgression of Jurassic (Oxfordian) carbonates over folded Devonian calciturbidites visible at the upper bench, the overthrust of the Proterozoic granitoids over the Devonian - Carboniferous limestones in the lower part of quarry



Source: own processing

This case and many other anthropogenic landforms (respectively, the mining landforms – quarries, pits, and mines) are important from the geoconservation point of view, they often serve as study or excursion localities, they contribute to the extension of the Earth-science knowledge. Thanks to their scientific and other values, they can also have a potential for geotourism, geoeducation and recreation. These general issues are discussed, for example, by Brilha (2014), who analyses the relationships between mining and geoconservation; Lóczy (2010), who gives an overview of the role of anthropogenic landforms in geoconservation and geotourism; Mata-Perelló et al. (2017), who discuss the relationships between the mining geoheritage (respectively, the geomining heritage) and local/regional development; or Petersen (2002), who describes the potential of road cuttings and quarries for geoeducation. In addition, there are numerous case studies that underpin the importance of mining landforms: Lopéz-García et al. (2011) present an example of mines in SE Spain; Hose (2017) introduces mining geoheritage in the Peak District in the UK; Prosser (2016) presents the issues of the use of quarries for geoconservation purposes in the UK; Stefano and Paolo (2017) focus on the potential of abandoned quarries for local/regional development in Italy; Beranová et al. (2017) analyse the potential of abandoned quarries for geotourism in the České středohoří Mts. in the Czech Republic; Evans et al. (2017) present geotourism within the settings with examples of black coal mining in the UK; or Baczyńska et al. (2017) discuss the attractiveness of quarries in Poland, Austria and UK.

As it can be seen from the aforementioned examples, the importance and potential of mining landforms have been already recognized in many cases and some geoparks, such as Ireland's Copper Coast Geopark and Italy's Tuscan Mining Geopark, preserve and manage old mines and other "disturbed" geosites as an important part of the local geoheritage (Copper Coast Geopark, 2017; Tuscan Mining Geopark, 2017). In the Czech

Republic, some national geoparks (e.g., GeoLoci) also use the tourist potential of old mines and quarries (GeoLoci geopark, 2017), numerous old quarries and pits are a subject of legal protection (e.g., Panská skála National Natural Monument – an abandoned basalt quarry, Vlčí jámy Natural Monument – Middle Age tin mines, Kalendář věků National Natural Monument – a loess pit; http://drusop.nature.cz/portal/), but in some cases (especially outside the legally protected areas or geoparks), their potential is not fully developed and used.

To recognize the potential of mining landforms for geotourism, guidelines for inventorying and assessment method are proposed and one specific example from the area, in which geotourism has not been fully developed yet, is presented.

Conceptual background and methodology

Conceptual background: secondary geodiversity, anthropogenic geoheritage and anthropogenic geosites and geomorphosites

The anthropogenic landforms together with the anthropogenic processes and other features represent the so-called secondary geodiversity.

The concept of secondary geodiversity (firstly introduced by Cílek (2002)) comes out from the general concept of geodiversity. Gray (2013) defines geodiversity as "the natural range (diversity) of geological (rocks, minerals, fossils), geomorphological (landforms, topography, physical processes), soil and hydrological features. It includes their assemblages, structures, systems and contribution to landscapes". This definition represents geodiversity as a value-free entity.

Those elements of natural geodiversity that are of significant value to humans for non-depleting purposes, which do not decrease their intrinsic or ecological values, are called "geoheritage" (Sharples, 2002). A similar definition of geoheritage is presented by Dixon (1996 in Dingwall, 2005): "those components of natural geodiversity of significant value to humans, including scientific research, education, aesthetics and inspiration, cultural development, and a sense of place experienced by communities". These definitions come out from the definition of natural heritage proposed by UNESCO (1972). Specific examples of geoheritage are represented by specific geological and geomorphological sites (Cleal, 2007), respectively, by geosites and geomorphosites.

In the aforementioned definitions of geodiversity and geoheritage, the word "natural" (natural geodiversity or primary geodiversity) appears. However, the secondary (man-made or anthropogenic) geodiversity, defined analogically according to the Gray's definition (Gray, 2013) as "the range/diversity of the man-made/anthropogenic landforms, including their assemblages, relationships, structures and systems" (Kubalíková et al., 2017) should not be omitted as it also represents an issue worth of conservation and as it is considered a significant resource for tourism, recreation and educational activities as discussed in the Introduction.

Consequently, a slightly modified definition of geoheritage can be presented: components or features of primary (natural) and secondary (man-made or anthropogenic) geodiversity, which are of significant value to humans, including scientific research, education, aesthetics and inspiration, cultural development, and a sense of place experienced by communities (Kubalíková et al., 2017).

For the ensemble of anthropogenic landforms (respectively, the anthropogenic geosites and geomorphosites) which form a part of geoheritage, a term "anthropogenic geoheritage" can be used.

The anthropogenic landforms can be sorted by using the genetic criterion, which is probably the most suitable for the purposes of geotourism. According to Szabó, Dávid, and Loczy (2010), Kirchner and Smolová (2010) and Migoń (2012), these landforms can be classified as follows: 1) mining landforms (represented by quarries, pits, collapse sinks, subsident depressions, dumps, heaps, shafts, or adits), 2) industrial landforms (industrial fields, heaps, or underground factories), 3) agricultural landforms (agricultural terraces, piles, or ramparts), 4) urban/residential landforms (terraces, ramparts, waste dumps, urban underground, or emergency shelters), 5) communication landforms (road or railway cuttings, or transport platforms), 6) water system/water management landforms with a subset of littoral landforms (water reservoirs, gravity dams, polders, water canals, mill races, weirs, or wells), 7) military landforms (craters, ramparts, fortification systems, or underground bunkers), 8) funeral landforms (funeral hills, burial mounds, crypts, tombs, or ossuaries), 9) celebration landforms (menhirs, dolmens, or cromlechs), 10) others (recreational landforms, archaeological excavations, or research landforms).

According to this division, one can identify specific groups of anthropogenic geoheritage (mining geoheritage – Mata-Perelló et al. (2017) use the term "geomining heritage", agricultural geoheritage or urban/residential geoheritage) and consequently, the specific types of anthropogenic geosites and geomorphosites: mining geo(morpho)sites, agricultural geo(morpho)sites, or urban/residential geo(morpho)sites. The mining landforms are presented, for example, by Dávid (2008).

Methodology

To assess the potential of the mining landforms for the geotourism and geoeducational purposes, the specific procedure should be carried out. The specific steps were discussed in various papers (e.g., Reynard et al., 2007; Reynard et al., 2016; Kubalíková, 2013; Kubalíková & Kirchner, 2016; Pereira et al., 2007; Brilha, 2016, 2017; Fuertes-Gutierréz & Fernández-Martínez, 2012) and generally, they can be described as follows:

1) inventorying and detailed description of the mining geo(morpho)sites,
2) assessing the geo(morpho)sites (including the SWOT analysis),
3) synthesis (management proposals or conservation measures).

The inventorying of the geodiversity sites (respectively, the geosites and geomorphosites) is the subject of many studies. Already in the 1970's, the first methodologies were developed (e.g., JNCC, 1977) and later they were improved. Based on them, the national inventories were created (e.g., Brilha el al., 2005; Wimbledon, 2011; García-Cortés & Carcavilla, 2013) and specific regional studies (inventory of the geoheritage within specific regions, especially for the geoheritage management or geotourism purposes) were introduced (e.g., Fuertes-Gutierréz & Fernández-Martínez, 2010; Ilies & Josan, 2007; Comanescu & Dobre, 2009; Erhartič, 2010; Pereira et al., 2007; Zouros, 2007; Fassoulas et al., 2012). These projects included both the natural and anthropogenic landforms and other geodiversity features.

In the Czech environment, a remarkable inventorying project is the Database of the important geological localities that is carried out by Czech Geological Survey – the information presented there is rather scientific, but it also includes the information about the conflicts of interest or accessibility of the site (Czech Geological Survey, 2017). The method for inventorying the geoheritage features is also a part of the Methodologies of national geoparks (Zelenka et al., 2014). Several case studies (including the assessment) were done (e.g., Jacková & Romportl, 2008; Kubalíková & Kirchner, 2016; Kubalíková et al., 2017; Beranová et al., 2017), both in rural and urban areas, including both natural and secondary geodiversity features. Within the geoparks, the inventorying of the geo(morpho)sites represents one of the effective tools for the geoheritage management and planning.

Regarding the scope of this paper, Table 1 presents a slightly modified method for the mining landforms. These guidelines follow Zelenka et al. (2014), Reynard et al. (2016) and Brilha (2016). Some information was added due to the specific characteristics of the mining landforms.

Table 1 The guidelines for inventorying and describing the mining landforms

Group of characteristics	individual attributes, notes, specifics
1. General information	• name, identificator position (municipality, region, country, other information)
2. Geological settings	• geological unit/lithology • specific tectonic, stratigraphical, palaeontological, mineralogical, petrographical, pedological features (usually those that were uncovered thanks to mining or quarrying)
3. Geomorphological settings	• main landforms (quarry/pit/underground mining landform) • mezoforms and microforms, especially those induced by anthropogenic activity (e.g., debris cones, caverns, landslides, subsidence depressions) • processes (both past and ongoing, processes that can be observed on the site)
4. Ecological characteristics	• description of ecosystems, its connection to the landforms and processes, specific features (e.g., protected species)
5. Hydrological and hydrogeological features	• original features or those that originated by anthropogenic influence (e.g., water bodies appearing on the bottom of mining spaces)

Group of characteristics	individual attributes, notes, specifics
6. Historical, cultural and aesthetical characteristics	• geohistorical importance (e.g., testimony about the last periods, or about the landuse in the past, the evidence of social/economic/industrial changes) – the mining landforms always have geohistorical importance as they give evidence about the use of natural resources • other specific features (e.g., archaeological aspect, historical events, religious aspect, presence of historically important buildings or constructions, toponyms related to the Earth-science features) • artistic importance (e.g., inspiration for artists, often photographed site, appearance of the site in poetry or prose, contemporary art, myths – both old and new) • use of the material (e.g., stone from the quarry used for buildings, monuments and walls, material is typical of certain area) – applicable especially in the case of stone quarries; in the case of pits (loess pits, sand pits) or underground mining (ores), the identification of these specific features is rather problematic • aesthetic aspect (e.g., landform as a dominant landmark, part of cultural identity of an area), viewpoints
7. Conservation aspect and current use/status of the site	• current use (e.g., tourist/recreational use, hiking, climbing, mineral or fossil collecting, ”new wilderness“) • nature conservation and protection (e.g., legally declared, presence in the database of geological localities) • the degree of disturbance (still active mining/quarrying or revitalisation and restoration activities) • actual and potential risks and hazards, both natural (e.g., growing vegetation) and anthropogenic (e.g., inappropriate “revitalisation”, use of the site as a dump), legislative threats (e.g., damage of the site caused by filling or return to the agriculture land)
8. Scientific aspect	• scientific importance (e.g., stratigraphical or paleoographical importance, the existence of scientific papers about the site, using the site as a traditional excursion locality or site important for geological mapping)
9. Tourist/visitor aspects	• accessibility (access restricted/with permission/normally accessible site) • safety (e.g., danger of rockfall, landslides, hidden underground spaces with a risk of collapsing) • visibility of the site • presence of tourist/recreational and other similar facilities (e.g., marked paths, tourist shelters, catering services in proximity) • transport facilities (e.g., stop of public transport nearby, possibility to get there by car) • number/intensity of visits (e.g., the site is visited by people very rarely, the site is visited and used frequently) • products related to the site (products promoting the site or product/issues/events bearing the name of the site)

Source: own processing

The proposed method for inventorying is relatively detailed, but it allows to see the mining landforms from different points of view and it has strongly interdisciplinary character, which corresponds with holistic and multidisciplinary concept of geotourism (Dowling & Newsome, 2010; Dowling, 2013; Hose, 2012). In some cases, all the characteristics are not possible to obtain, but the selected characteristics can be adapted for specific purposes and regional settings. These guidelines are suitable especially for those specific sites, which can be used for geotourism and geoeducation purposes in future.

Based on the inventory, the assessment of the geotourist potential can be done. During the last three decades, numerous methods for assessing the specific geosites and geomorphosites were developed for various purposes (especially for the geoheritage management, geoconservation purposes or geotourism and educational purposes). The first assessment methods were focused mainly on the scientific value of the sites, e. g., Panizza and Piacente (1993), Barba et al. (1997) or Reynolds (2001).

In 2001, Panizza introduced the concept and definition of geomorphosites: "geomorphological landforms that have acquired a scientific, cultural/historical, aesthetic and/or social/economic value due to human perception or exploitation" (Panizza, 2001), which was extended later: (geomorphosites can be) "single geomorphological objects or wider landscapes and may be modified, damaged, and even destroyed by the impacts of human activities" (Panizza & Reynard, 2005).

Panizza (2001) also proposed the first assessment method, which included different groups of criteria to make the assessment more complex and objective and to set the links between geology, culture and tourism (Panizza & Piacente, 2005, 2008). Later, both quantitative and qualitative methods for assessing the geomorphosites were developed and used (e.g., Coratza & Giusti, 2005; Serrano-Cañadas & González-Trueba, 2005; Cendrero & Bruschi, 2005; Reynard et al., 2007; Pereira et al., 2007; Pereira & Pereira, 2010; Bruschi et al., 2011; Fassoulas et al., 2012; Suzuki & Takagi, 2017) and critically reviewed (Kubalíková, 2013; Reynard et al., 2016; Brilha, 2016; or Zwoliński et al., 2017b). In some cases, the methods were designed directly for the geotourism purposes (e.g., Pralong, 2005; Pralong & Reynard, 2005; Kubalíková, 2013; Beranová at al., 2017).

These methods generally included various groups of values (scientific, educational, cultural, tourist, economical, or conservation). Therefore, they could serve better for the geotourism purposes as these activities are now viewed in a more complex way, e.g., geotourism is not only about geology, but it also counts with educational activities, cultural heritage or tourist satisfaction and local development (Dowling & Newsome, 2010). For assessing the geotourism potential of the mining geo(morpho)sites (or geo(morpho) sites), the educational value should be assessed extra as it is an important feature of geotourism and as geoeducational activities go hand in hand with the tourist ones.

Following the concept of geomorphosites and already used assessment methods and taking into account the holistic approach to geotourism, a method for assessing the geotourist potential of the mining landforms is proposed (see Table 2). In this case, the method is designed as a set of questions to be answered, respectively, the criteria to be described. However, the adaptation to the numerical assessment is possible, too (especially for the case where more sites need to be compared).

Table 2 An integrated approach for assessing the potential for geotourism and geoeducational activities

Values	criteria / questions	numerical assessment proposal
Scientific value	Integrity or current status of the site: Is the site (including the specific Earth-science features) well conserved or is it damaged?	1 – conserved 0.5 – partly conserved 0 – damaged
	Diversity of the Earth-science features: How many Earth-science features are displayed within the site? (specific landforms – macro, mezo and microforms, stratotypes, lithological boundaries, fossils, minerals, soil profiles, or current processes)	1 – more than 5 different features 0.5 – 2-4 features 0 – 1 feature
	Rarity: How many similar sites lie within the study area? Is the site unique or is it the current landform within the area?	1 – the site is unique within a region 0.5 – there are 2 or 3 similar sites 0 – more than 3 similar sites in the region
	Scientific knowledge of the site: Is the site known within the scientific community? Are there some papers or monographies?	1 – world known site 0.5 – regionally/nationally known site 0 – the site has not been researched yet
Educational value	Exemplarity and representativeness of the site: Are the features (both landforms and processes) visible and comprehensible? Is there a possibility of simple explication of the corresponding processes?	1 – good exemplarity and representativeness of the features 0.5 – features are comprehensible, but short explication is needed 0 – features are not legible to general public, professional explication is needed
	Presence of educational facilities: Are there any educational trails or information panels on the site?	1 – presence of educational trails or information panels with relevant information 0.5 – existing educational facilities but with limited information 0 – no educational facilities on the site
Tourist value	Accessibility: Is the site accessible or is the access limited/restricted?	1 – access without problems 0.5 – limited access (e.g., only with permission or with special equipment) 0 – site is inaccessible for public
	Safety: Are there any phenomena that can endanger the visitor? (the risk of rock fall, or landslides)	1 – safety is not a problem 0.5 – some specific limitations (e.g., the risk of landslides) 0 – visiting site is not recommended and it is dangerous
	Tourist infrastructure: Are there any tourist facilities nearby? (transport – parking place, catering, shelters, marked paths)	1 – tourist infrastructure situated within walking distance 0.5 – limited tourist infrastructure is accessible 0 – no tourist infrastructure
	Viewpoints and visibility: Are there many viewpoints from which the site can be observed?	1 – more than 3 different viewpoints 0.5 – 1-3 viewpoints 0 – no viewpoint, the visibility is limited

Values	criteria / questions	numerical assessment proposal
Added values Added values	Hydrological aspect: Are there any hydrological features related to the anthropogenic activities? (e.g., a lake on the quarry/pit bottom, the spring uncovered due to the anthropogenic activity)	1 – yes, there are some specific hydrological features 0 – without specific hydrological features
	Ecological aspect: Are there any specific species that exist here thanks to the existence of the landform, specific ecosystems that were created here thanks to the anthropogenic activity?	1 – yes, there are some specific ecological features 0 – without specific ecological features
	Geohistorical aspect: What type of evidence about the landscape memory can be found here? (mining history and evidence of social/economic/industrial changes and development, historical events or even tragic events can be included in relation to dark tourism, different use of landforms – other purposes than mining, e.g., underground landforms as shelters)	1 – more than 3 different geohistorical aspects 0.5 – 2-3 different geohistorical aspects 0 – 1 geohistorical aspect
	Architectonical aspect: Is the material from the quarry/pit/mine used for buildings/walls/pavement? Does the material represent the typical material of this specific area?	1 – existing and evident architectonical aspect (incl. examples of buildings) 0 – the architectonical aspect is not so important or it is very difficult to trace it
	Artistic aspect: Are there any myths, paintings, photographs related to the site? Does the site appear in literature or does it serve as inspiration for artists? (e.g., land art)	1 – existence of more than 2 different artistic aspects 0.5 – 1 or 2 different artistic aspects 0 – no artistic aspect
Conservation value	Existing legislative protection: Is the site somehow protected? ((national) natural monuments or reservations, part of the protected landscape area or national park, database of geological localities, important landscape element, natural park)	1 – existing legislative conservation 0.5 – the site is proposed for geoconservation 0 – no legal protection or proposals for geoconservation
	Current threats: Which threats that can contribute to the damage of the site are present? (both natural, respectively, natural threats induced or supported by human activity that can lead to the destruction of the site or its degradation or disappearing of specific geo-features (e.g., vegetation growth, invasion species, landslides) and anthropogenic (e.g., dump fill, vandalism, "revitalisation" that can cause disappearing of the specific Earth-science and related features))	1 – no big threats, risks or hazards 0.5 – existing threats, risks and hazards, but they are already managed 0 – existing threats, risks and hazards which are not managed and resolved

Source: own processing

Based on this assessment, the SWOT analysis is done. The SWOT analysis is a simple assessment tool, which presents Strengths, Weaknesses, Opportunities and Threats. It helps with strategic planning and decision-making and it is widely used both for planning in companies and planning the community or regional development. It has been successfully used in several case studies concerning geoconservation and geotourism (Kirchner et al., 2017; Kubalíková et al., 2017). Since it is quite comprehensible and allows to summarize the most important points, it can be used in the case of the assessment of geotourism and geoeducational potential of the mining landforms as well.

Results: Assessment of geotourism potential of Červený kopec (Red Hill) in Brno, Czech Republic – an example of a geotourist destination in the urban area

To illustrate the proposed integrated approach to the assessment of geotourism and geoeducational potential, an example from the area where geotourism has not been fully developed yet, is presented. The selected site is situated within Brno city (South Moravian Region, Czech Republic) and it represents an interesting geotourist potential in the area. Currently, geotourism is developed mainly within rural areas, but within the urban areas it shows a considerable tourist potential, too (e.g., Zwoliński et al., 2017a; Pica et al., 2014, 2016, 2017; Palacio-Prieto, 2015; Kubalíková et al., 2017). Analysing and describing the specific features of urban geotourism is out of the scope of this article. Nevertheless, urban geotourism is a new, emerging form of sustainable tourism which uses hidden potentials of urban geodiversity and which enables to promote urban geoheritage, including a wide range of the Earth-science features, both in situ (geosites and geomorphosites) and ex situ (e.g., building material or museum collections) (London Geodiversity Partnership, 2014; Pica et al., 2017; Reynard et al., 2017; Kubalíková & Bajer, 2018). Urban geotourism (if managed and promoted well) can also represent an alternative to traditional tourist destinations within the urban areas.

The inventory and description of the site is presented in Table 3. The information is based on the detailed field work and literature review (e.g., Tůma et al., 2011; Müller & Novák, 2000; Zeman, 1992; Demek at al., 2005). Figure 3 then represents visual aspects of the site.

Table 3 Inventorying and description of a specific geomorphosite: Červený kopec, Brno, Czech Republic

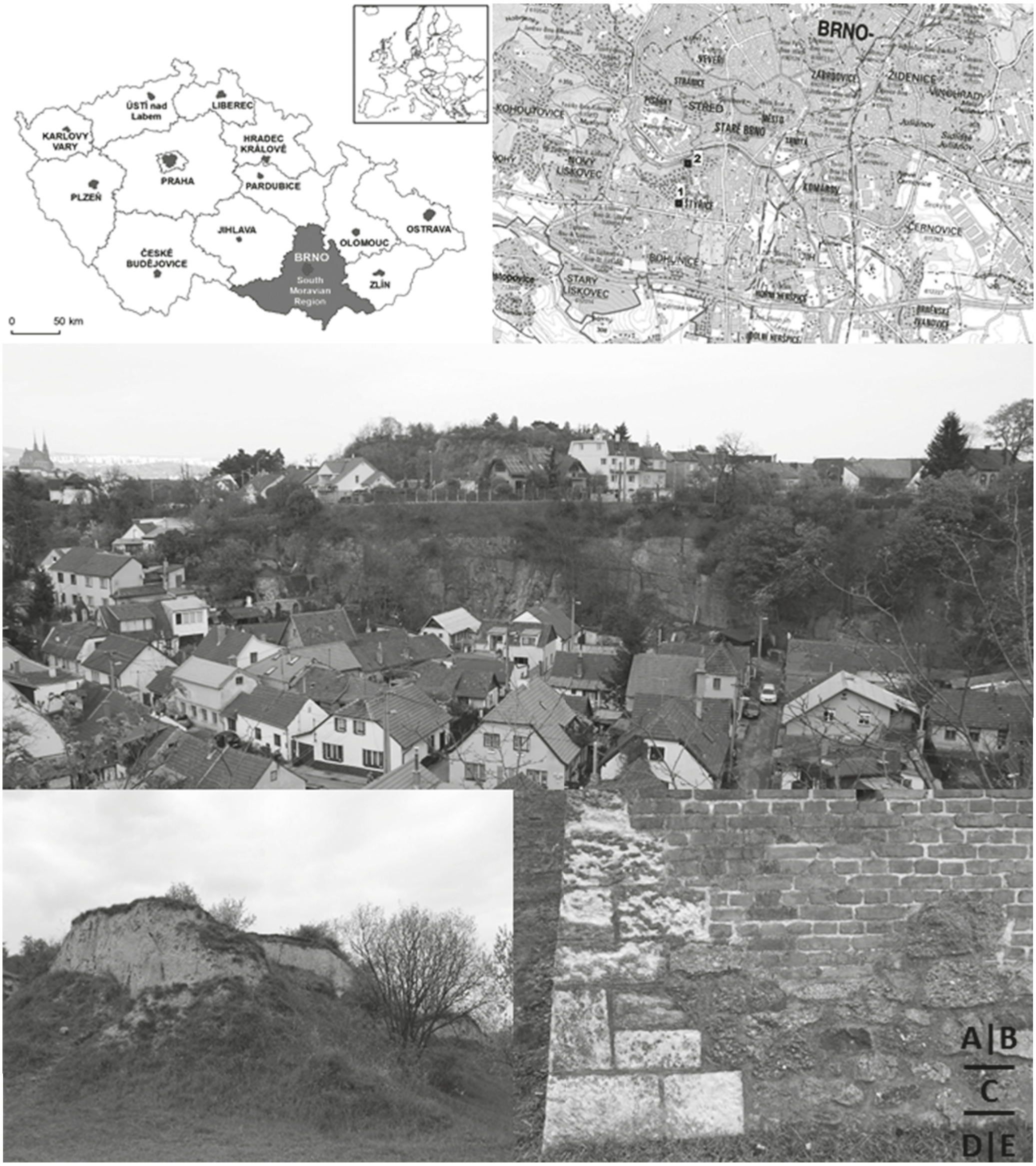
Group of characteristics	individual attributes, notes, specifics	
1. General information	name, identificator	Červený kopec (loess pit and conglomerate quarries)
	position	in the central part of Brno city, 218 – 294 m asl, cadastre: Brno – Štýřice and Brno-Střed, municipality of Brno, South Moravian region, Czech Republic
2. Geological settings	geological unit/ lithology	Lower-Devonian conglomerate and sandstone, Neogene sands and calcic clays (of marine origin), Quaternary fluvial gravels and sand, Quaternary loess
	specific Earth-science features	soil profiles in the former loess pit (a unique complex of loess and fossil soils: an internationally recognized profile with magnetic inversion interface Brunhes-Matuyama (the border between the middle and the lower pleistocene)), presence of calcium concretion in loess, the loess is palaeontologically rich; the contacts of conglomerates and sandstones

Group of characteristics	individual attributes, notes, specifics	
3.Geomorphological settings	main landforms	loess pit, quarries, the bottom of the main conglomerate quarry adapted as a residential plain
	mezoforms and microforms	gullies, small landslides, debris accumulations
	processes	debris fallout, landslides, sufosion, gullying
4. Ecological characteristics	description of ecosystems, species	steppe ecosystem on loess, xerotermic vegetation, presence of several protected, threatened and critically threatened species (e.g., Hilpertia velenovskyi – a moss with the unique appearance in the Czech Republic)
5. Hydrological and hydrogeological features	original or induced	no
6. Historical, cultural and aesthetical characteristics	geohistorical importance	the old loess pit and brick kiln (Kohn brick kiln, est. in 1881), historically important quarrying, on the bottom of the quarry, a worker quartier was created (the so-called Stone colony)
	other specific features	a lot of toponyms in the surrounding area related to the ”stone“ or ”red stone“ (esp. the names of the streets – Stone Colony, Stone Street, Red Hill, Under the Red Rocks Street)
	artistic importance	Stone Colony is a place of artists or galleries, regular cultural events are held there, but usually not related to the geo-aspects
	use of material	the material from the conglomerate quarries has been used on various walls and buildings within Brno (e.g., walls on Špilberk castle and around Petrov)
	aesthetic aspect, viewpoints	the dark red colour is emblematic and it implies the name of the site (Červený kopec means Red Hill), viewpoints on the upper part of the quarry, other viewpoint on the loess pit, visually, the landforms are very attractive and red ”cliffs“ can be even ”dramatic“
7. Conservation aspect and current use/status of the site	current use	walks, hiking, educational trail leading around (but focused on municipal forests, not on the geo-educational aspects), excursions for students, scientific excursions to the loess pit
	nature conservation and protection	National Natural Monument Červený kopec (protected loess profile with soils), the site is in the database of CGS

Group of characteristics	individual attributes, notes, specifics	
7. Conservation aspect and current use/status of the site	degree of disturbance	the loess pit is strongly influenced by human activity (buildings, communications, proximity of garden allotments, presence of homeless people who disturb the loess pit with small accumulations of waste, or the black dumping), the vegetation growth on the loess pit, the destruction of the profiles due to the activity of the water; the conglomerate quarries are in a relatively good condition
	actual and potential risks and hazards	the vegetation growth and other natural processes endanger the loess pit (it can cause the disappearance of the profile if not regulated and managed), invasive and ruderal species can hide the profiles and endanger the protected species, the proposals of building the new houses in vicinity (the areas of garden allotments are as the ”area for housing“ in the Urban planning documentation), the future land use of former Kohn brick kiln is a subject of discussions (currently, it is a brownfield, the future use can be the ”revitalisation“ or building-up of the area, which can affect the loess pit); conglomerate and sandstone quarries are not generally endangered
8. Scientific aspect	scientific importance	internationally important site (sequence of buried soils in the loess pit), numerous papers, the site appears in the textbooks
9. Tourist/visitor aspects	accessibility	accessible on foot, by bike and car
	safety	no grave problems with safety
	visibility of a site	good visibility of the loess pit, but worse visibility of some profiles, good overview of conglomerate quarries, but in detail, some of them are not observable as they are situated in the gardens of detached houses
	tourist/recreational facilities	marked paths, an educational path about the municipal forests in vicinity, a small information panel on the loess pit, as the site is situated within the urban area, the catering services or grocery shops are in walking distance
	transport facilities	stops of public transport up to 500 m, possibility to park a car in the streets of Stone Colony (sometimes problematic) or near the loess pit
	number/intensity of visits	a frequently visited site
	products related to the site	no commercial or promotional products

Source: own processing

Figure 3 Červený kopec in Brno, Czech Republic. A, B – position of the site; C – conglomerate/sandstone quarries and Stone Colony; D – loess pit; E – the use of red conglomerate and sandstone on the walls of Špilberk castle



Source: http://geoportal.gov.cz, Bajer (2016), Kubalíková (2017)

The assessment of the geotourist and geoeducational potential is presented in Table 4. Following these procedures, the SWOT analysis is done (Table 5).

Table 4 The assessment of the geotourism and geoeducational potential of Červený kopec, Brno, Czech Republic

Values	criteria / questions	description / answers
Scientific value	Integrity or current status of the site	The site is partly damaged (vegetation growth on the loess pit and damaged soil profiles), however, small conglomerate quarries are well conserved.
	Diversity of the Earth-science features	There are three phenomena on the loess pit: sequence of Quaternary soils, palaeontologically important findings and the boundary between lower and middle Pleistocene, and two phenomena concerning conglomerate and sandstone quarries: the mining landforms and contact between the conglomerate and the sandstone.
	Rarity	The site is not unique, but it is not so current - there were various loess pits within Brno and in its surrounding, but the conglomerate quarries are situated only on Červený kopec and another one (very small) is situated on Žlutý kopec. The soil profiles are world-unique.
	Scientific knowledge of the site	The site is described in research studies and the phenomenona are well-known. The profile is world-known as it allows to see all the Quaternary soils.
Educational value	Exemplarity and representativeness	The features are visible and comprehensible within the conglomerate quarry, but the soils in the loess pit need some explication as the visibility and interpretation are a little bit harder.
	Presence of educational facilities	There is an educational trail in vicinity, but it is related to the municipal forests. There is no information about quarrying the conglomerate and near loess pit, there is only a small information panel about the site.
Tourist value	Accessibility	The site is accessible on foot, but some of the quarries are not accessible as they are situated in the gardens of detached houses.
	Safety	No risks at the conglomerate quarries, low risk on the loess pit – small landslides
	Tourist infrastructure	There are marked paths and some basic tourist equipment (banks), restaurants within walking distance.
	Viewpoints	There are several viewpoints where the conglomerate quarries can be observed, the loess pit is also well visible.
Added values	Hydrological aspect	No
	Ecological aspect	Xerophyts on the loess pit, occurrence of critically endangered species (moss Hilpertia velenovskyi)

ARTICLES

Values	criteria / questions	description / answers
Added values	Geohistorical aspect	The loess pitting related to the production of bricks (Kohn's brick kiln), the oldest conglomerate quarries date back to the Middle Ages, however, it is very hard to say which exactly. On the bottom of the main conglomerate quarry, a worker's quartier was built which is today an artistic quarter (called Stone Colony). The toponymic aspect is also important – e.g., Červený kopec (Red Hill), Kamenná kolonie (Stone Colony).
	Architectonical aspect	Conglomerate and sandstone have been used in various walls and buildings (since the Middle Ages) (e.g., walls at Špilberk castle and around Petrov); tracing the use of the bricks of Kohn's brick kiln is problematic.
	Artistic aspect	The sites (both Stone Colony and surrounding of the loess pit and Kohn's brick kiln) are often in the old photographs.
Conservation value	Existing legislative protection	The loess pit protected in the category of the National Natural Monument, the site is also in the CGS; the conglomerate quarries are not legally protected.
	Current threats	In the loess pit, the vegetation growth that can endanger loess profiles, although in the Care plan for the NNM, there is one of the management measures concerning the vegetation reduction, also the dumping is considered a risk; at the conglomerate quarries – limited risks and threats

Source: own processing

Table 5 SWOT analysis of the geotourism and geoeducational aspects of Červený kopec

Strengths	Weaknesses
• high scientific value • high inner diversity and representativeness of the Earth-science features • visual attractivity • high added values (geohistorical, architectonical) • good accessibility (even for people with limited??? possibility of moving or disabled persons) and visibility • existing legal protection of one part of the site (loess pit) • existing marked paths • approved Care plan for the loess pit	• the geotourist potential is not fully developed • the site is known mainly among professionals (geoscientists and students), average visitor does not have a possibility to acquire the knowledge • some geoscience features are hidden in the gardens and not accessible • the growing vegetation, wash down and erosion can endanger the profiles in the loess pit • unfavourable situation of the Kohn's brick kiln in vicinity (which is slightly connected to the geohistorical aspect of the site) and surrounding area

Opportunities	Threats
• geotourist and geoeducational potential for general public or students of primary and secondary schools • integration of different types of heritage – mining heritage, architectonical heritage • possibility to enrich the architectonical information about Brno buildings and to connect it to the specific site • proposal of geo-trail within the site (it would connect the loess pit, Stone Colony and conglomerate quarries and explain the specific geo-features, it would probably exploit the existing tourist paths and street network)	• low interest of municipality for developing the geotourism potentials • invasive and ruderal species • further vegetation growth in the loess pit can cause a hard damage of this unique site • further unfavourable situation about the Kohn's brick kiln and surrounding area can cause low interest about the Earth-science features of the site • lack of finances to support the geotourism and geoeducational activities • continuing „bad image" of the site (surrounding of the loess pit is a favourite place for homeless people, the sites are used for dumping)

Source: own processing

The last step (synthesis) includes proposals for the specific geotourism and geoeducational activities. These are especially based on the opportunities in the SWOT analysis and partly correspond with the proposals presented in the Care Plan for the National Natural Monument Červený kopec (Tůma et al., 2011) and discussion with specialists from the Municipality Office of Brno city. Generally, this step includes two parts: what activities and management measures are proposed and how they should/could be achieved. The proposed activities include:

- a proposal of the geo-path which would connect the loess pit and conglomerate quarries (by using the existing paths and street network, however, certain segments which could be used for this purpose, are not very attractive);
- an installation of the information panels which would explain the importance of the area (geology, geomorphology, pedology, paleontology, architectonical importance, mining history, or geohistorical importance), installation of small visitor facilities and improvement of current paths;
- adaptation of some profiles in the loess pit (cleaning the profiles, building shelters to protect them against running water, wash down and erosion) – this could be appreciated especially by geoscientists who come to study the soil profiles;
- guided geo-walks for public (on the proposed geo-path), possibility to offer guided walks also at international symposia or conferences;
- suitable care about vegetation cover (reduction of invasive and other undesirable species that can endanger or disturb the Earth-science features);
- integration of the information about the architectonical significance of the conglomerate quarries to already existing tourist products (information about architecture and interesting buildings, Brno architectonical manual etc.);
- reduction of the undesirable phenomena as dumping and waste accumulation.

The possibilities how the activities should be implemented:

- including aforementioned measurements into the urban development strategies and action plans (installation of the information panels on the loess pit, adaptation of soil profiles and relevant care about the vegetation cover have been already included in the Care Plan (Tůma et al., 2011));
- seeking for suitable finance resources for the implementation of the proposals (geo-path, information panels, propagation materials, shelters over loess profiles) and for their sustainability (e.g., care about the information panels in the future, care about the shelters over the loess profiles);
- further development of the cooperation with non-governmental organisations and volunteers (they already help with the vegetation management), universities (they can provide commented geo-walks), Municipal police (helping with undesirable behaviour of visitors or homeless people);
- discussion with specialists at the Tourist Information Centre of Brno, Office of Municipal Architect, officers at Municipality office of Brno (Department of Environment, Department of Culture, Department of Education) about the proposals and other specific issues, discussions with other subjects (research institutions, universities, schools, potential users, local community, general public).

The implementation of these activities can contribute to a better image of the site and to use and fully develop the geotourist and geoeducational potential effectively and in a sustainable way. In addition, the implementation of the geo-path connecting the loess pit and the conglomerate quarries can offer a new type of tourist attractiveness and serve as an alternative to the current tourist attractions within Brno.

Conclusion

The human impact on relief is often very destructive, however, in some cases, new and interesting landforms are created. They are important especially from the geoconservation point of view as they display the Earth-science features that would normally remain hidden. Thanks to these and other aspects (e.g., geohistorical or architectonical), they also possess a considerable potential for the geotourism development. These landforms (anthropogenic or man-made landforms) and processes that led to their formation, represent the so-called secondary geodiversity; specific examples of these landforms can be included into anthropogenic geoheritage which can be divided into several groups according to the genesis (mining geoheritage, agricultural geoheritage). The mining landforms (quarries, pits, mines) are probably the most distinctive anthropogenic landforms and they have undoubtedly a great potential for the geotourism and geoeducational activities as proved by numerous case studies.

For the assessment of geotourism and geoeducational potential of the mining landforms (respectively, the geo(morpho)sites), guidelines for inventorying and describing are proposed. This method is very detailed and it expects a multidisciplinary and complex view on the evaluated geo(morpho)site. Based on the detailed description of the site, the assessment of the geotourism and geoeducational potential has been done. The proposed method represents an integrated approach to the assessment anchored especially in the concept of geomorphosite assessment, taking into account wide spectrum of possible values of the site (scientific, added, tourist, conservation and educational values) according to the currently accepted holistic concept of geotourism. The method is designed as a set of questions, however, for the case of assessing numerous sites, the numerical assessment has been proposed, too. Consequently, the SWOT analysis offers the possibility of an overview about the real situation of the site and based on all aforementioned steps, the synthesis, which includes specific proposals for the rational use of geotourism potential and management measures, has been done. This procedure is supposed to be used especially for the sites where the future geoeducational and geotourist use is expected.

Červený kopec in Brno, Czech Republic, represents a mining geomorphosite with strong interdisciplinary overlaps and issues. It consists of two different sites: the loess pit with world known soil profiles (which is also protected as the National Natural Monument and which has its own care plan with some management proposals) and the conglomerate/sandstone quarries with specific geohistorical (Stone colony – an old worker quartier that was built on the bottom of the quarry) and architectonical (the red conglomerate was used for various buildings and walls in Brno city centre) issues. The geoscientific value of the loess pit has been already recognized and the site is regarded and used as a geosite, however, the users are usually geoscientists and students. The geotourism and geoeducational potential of the conglomerate quarries has not been fully developed yet.

The site was described by using the proposed guidelines and assessed by using the proposed method. Then, specific management measures were designed. Thanks to the assessment, some specific issues were "discovered", respectively, the geotourist and geoeducational potential was identified. It can be seen that even in the densely populated urban areas, the geodiversity plays an important role and it can represent a significant source for geotourism, geoeducation and recreation.

The development of geotourist activities (especially the implementation of the geopath that would connect the loess pit and the conglomerate quarries, the installation of information panels and adapting some loess profiles) can contribute to a better image of the site. Moreover, it can help better understanding of the uniqueness of this site. As the site is situated within the urban area, the implementation of the proposed activities can represent an alternative to the traditional urban tourist destinations and extend the tourist offer of the city.

The proper implementation (and financing) of the proposed activities is a subject of further discussion between the Municipality Office of Brno, administration of PLA Moravský kras (who cares about the National Natural Monument), universities, schools and other entities that could be interested in promoting and improving the current status of this unique site. As it has been proved by assessment, this specific site deserves it, but suitable and sustainable management can be implemented only by effective cooperation among the aforementioned subjects. However, it is in the interest of all of us, because these activities can help better acceptance of the geoconservation activities on the site and to preserve this heritage for the future generations.

References

Baczyńska, E., Lorenc, M. W., & Kaźmierczak, U. (2017). The Landscape Attractiveness of Abandoned Quarries. *Geoheritage*, 1–15. DOI: 10.1007/s12371-017-0231-6.

Barba, F. J., Remondo, J., & Rivas, V. (1997). Propuesta de un procedimiento para armonizar la valoración de elementos del patrimonio geológico (Proposal of a procedure to harmonize the valuation of geological heritage elements). *Zubia,* 15, 11–20. DOI: 10.1007/s12371-017-0231-6.

Beranová, L., Balej, M., & Raška, P. (2017). Assessing the geotourism potential of abandoned quarries with multitemporal data (České Středohoří Mts., Czechia). *GeoScape,* 11(2), 93–111.

Brilha, J. (2014). Mining and Geoconservation. In G. Tiess G., T. Majumder, & P. Cameron (Eds.), *Encyclopedia of Mineral and Energy Policy.* Berlin: Springer.

Brilha, J. (2016). Inventory and Quantitative Assessment of Geosites and Geodiversity Sites: a Review. *Geoheritage,* 8(2), 119–134. DOI: 10.1007/s12371-014-0139-3.

Brilha, J. (2017). Geoheritage: Inventories and Evaluation. In E. Reynard & J. Brilha (Eds.), *Geoheritage: Assessment, Protection and Management* (pp. 69-85). Amsterdam/Oxford/Cambridge: Elsevier

Brilha, J., Andrade, C., Azerêdo, A. C., Barriga, F. J. A. S., Cachão, M., Cunha, P. P., & Granja, M. H. (2005). Definition of the Portuguese frameworks with international relevance as an input for the European geological heritage characterisation. *Episodes,* 28(3), 177–186.

Bruschi, V. M., Cendrero, A., & Albertos, J. A. C. (2011). A statistical approach to the validation and optimisation of geoheritage assessment procedures. *Geoheritage,* 3(3), 131–149. DOI: 10.1007/s12371-011-0038-9.

Cendrero, A., & Bruschi, V. M. (2005). Geosite Evaluation; Can we measure intangible values? *Il Quaternario - Italian Journal of Quaternary Sciences,* 18(1), 293-306.

Cílek, V. (2002). Geodiverzita - opomíjený aspekt ochrany přírody a krajiny (Geodiversity – neglected aspect of landscape and nature conservation). *Zprávy o geologických výzkumech v roce 2001*, 13–15.

Cleal, C. J. (2007). Geoconservation – what on Earth are we doing? In B. Hlad & U. Herlec (Eds.), *Regional Conference on Geoconservation: Geological heritage in the South-European Europe* (p. 25). Book of abstracts.

Comanescu, L., & Dobre, R. (2009). Inventorying evaluating and tourism valuating the geomorphosites from the central sector of the Cealhau National park. *GeoJournal of Tourism and Geosites,* 1(3), 86–96.

Copper Coast geopark. (2017). *Mining heritage.* Retrieved October 26, 2017, from https://coppercoastgeopark.com/mining-heritage/.

Coratza, P., & Giusti, C. (2005). Methodological proposal for the assessment of the scientific quality of geomorphosites. *Il Quaternario - Italian Journal of Quaternary Sciences,* 18(1), 305–313.

Czech Geological Survey. (2017). *Database of significant geological localities of the Czech Republic.* Retrieved October 26, 2017, from http://lokality.geology.cz.

Dávid, L. (2008). Quarrying: an anthropogenic geomorphological approach. *Acta Montanistica Slovaca*, 13, 66–74.

Demek, J., Havlíček, M., Kirchner, K., Nehyba, S., & Lisá, L. (2005). K rozšíření poznatků o kvartérních sedimentech na Červeném kopci v Brně (Distribution of Quaternary sediments on the Červený kopec (Red Hill) in Brno). In *Geomorfologický sborník* (pp. 159–163). České Budějovice: University of South Bohemia.

Dingwall, P. (2005). *Geological world heritage: a global framework. A Contribution to the Global Theme Study of World Heritage Natural Sites.* IUCN, WCPA, UNESCO.

Dixon, G. (1996). Geoconservation: An International Review and Strategy for Tasmania. Parks and Wildlife Service, *Occasional Paper No. 35*. Tasmania: Parks and Wildlife Service, Department of Environment and Land Management.

Dowling, R. (2013). Global Geotourism – an Emerging Form of Sustainable Tourism. *Czech Journal of Tourism*, 2(2), 59–79. DOI: 10.2478/cjot-2013-0004.

Dowling, R., & Newsome, D. (Eds.). (2010). *Geotourism. The tourism of Geology and Landscape.* Oxford: Goodfellow Publishers Ltd.

Erhartič, B. (2010). Geomorphosite assessment. *Acta geographica Slovenica*, 50(2), 295–319. DOI: 10.3986/AGS50206.

Evans, B. G., Cleal, C. J., & Thomas, B. A. (2017). Geotourism in an Industrial Setting: the South Wales Coalfield Geoheritage Network. *Geoheritage,* 10(1), 93–107. DOI: 10.1007/s12371-017-0226-3.

Fassoulas, C., Mouriki, D., Dimitriou-Nikolakis, P., & Iliopoulos, G. (2012). Quantitative assessment of geotopes as an effective tool for geoheritage management. *Geoheritage,* 4(3), 177–193. DOI: 10.1007/s12371-010-0012-y.

Fuertes-Gutiérrez, I., & Fernández-Martínez, E. (2010). Geosites inventory in the Leon Province (Northwestern Spain): a tool to introduce geoheritage into regional environmental management. *Geoheritage*, 2(1–2), 57–75.

Fuertes-Gutiérrez, I., & Fernández-Martínez, E. (2012). Mapping Geosites for Geoheritage Management: A Methodological Proposal for the Regional Park of Picos de Europa (León, Spain). *Environmental management*, 50(5), 789–806. DOI: 10.1007/s00267-012-9915-5.

García-Cortés, A., & Carcavilla Urquí, L. (Eds.). (2013). *Documento metodológico para la elaboración del inventario español de lugares de interés geológico (IELIG), version 18-07-2013 (Document for the elaboration of the Spanish inventory of geosites).* Madrid: Geological and Mining Institute of Spain.

GeoLoci geopark. (2017). *Hornictví a montanistika (Mining and m*ontanistics). Retrieved October 26, 2017, from https://geoloci.webnode.cz/geotopy-a-lokality/hornictvi/.

Gilíková, H. et al. (2010). *Vysvětlivky k základní geologické mapě České republiky 1:25 000, 24-413 Mokrá-Horákov (Explanatory notes to the basic geological map of the Czech Republic 1:25 000, 24-413 Mokrá-Horákov).* Prague: Czech geological Survey.

Gray, M. (2013). *Geodiversity: Valuing and Conserving Abiotic Nature*. Second Edition. Chichester: Wiley Blackwell.

Goudie, A. (2006). *The Human Impact on the Natural Environment.* Sixth Edition. Oxford: Blackwell Publishing.

Hooke, R. L. (2000). On the history of humans as geomorphic agents. *Geology,* 28(9), 843–846. DOI: 10.1130/0091-7613(2000)28<843:OTHOHA>2.0.CO;2.

Hose, T. A. (2012). 3G's for Modern Geotourism. *Geoheritage,* 4(1–2), 7–24. DOI: 10.1007/s12371-011-0052-y.

Hose, T. A. (2017). The English Peak District (as a potential geopark): mining geoheritage and historical geotourism. *Acta Geoturistica,* 8(2), 32–49.

Ilies, D. C., & Josan, N. (2007). Preliminary contribution to the investigation of the geosites from Apuseni Mountains (Romania). *Revista de geomorfologie*, 9, 53–59.

Jacková, K., & Romportl, D. (2008). The relationship between geodiversity and habitat richness in Šumava National Park and Krivoklástsko PLA (Czech Republic): a quantitative analysis approach. *Journal of Landscape Ecology*, 1(1), 24–38.

JNCC (Joint Nature Conservation Committee). (1977). *Guidelines for selection of Earth Science SSSIs.* Retrieved October 26, 2017, from http://jncc.defra.gov.uk/page-2317.

Kirchner, K. et al. (2017). Local geoheritage: its importance and potential for geotourist and recreational activities (a case study from Lomnicko area). In J. Fialová & D. Pernicová (Eds.), *Public recreation and landscape protection – with nature hand in hand?* (pp. 202–211). Brno: Mendel University in Brno.

Kirchner, K., & Smolová, I. (2010). *Základy antropogenní geomorfologie (Fundamentals of anthropogenic geomorphology)*. Olomouc: Palacký University.

Kubalíková, L. (2013). Geomorphosite assessment for geotourism purposes. *Czech Journal of Tourism,* 2(2), 80-104. DOI: 10.2478/cjot-2013-0005.

Kubalíková, L., & Kirchner, K. (2016). Geosite and Geomorphosite Assesment as a Tool for Geoconservation and Geotourism Purposes: a Case study from Vizovická vrchovina Highland (Eastern Part of the Czech Republic). *Geoheritage,* 8(8), 5–14. DOI: 10.1007/s12371-015-0143-2.

Kubalíková, L., Kirchner, K., & Bajer, A. (2017). Secondary geodiversity and its potential for urban geotourism: a case study from Brno city, Czech Republic. *Quaestions Geographicae,* 36(3), 63-73.

Kubalíková, L., & Bajer, A. (2018). Geotourism within urban areas: new ways of promotion of natural and cultural heritage (case study from Brno city) In L. Lněnička (Ed.), *Conference proceedings from Central-European geographical conference* (in prep.). Brno: Masaryk University.

Lóczy, D. (2010). Anthropogenic Geomorphology in Environmental Management. In J. Szabó, L. Dávid, & D. Loszy (Eds.), *Anthropogenic Geomorphology. A Guide to Man-Made Landforms* (pp 25–38). Dordrecht/Heidelberg/London/New York: Springer.

London Geodiversity Partnership. (2014). *London Geodiversity Action Plan 2014-2018*. London: Capita Symonds with assistance from the London Geodiversity Partnership and Natural England. Retrieved November 17, 2017, from http://www.londongeopartnership.org.uk/downloads/LGAP%202014-2018.pdf.

López-García, J. A., Oyarzun, R., Andrés, S. L., & Martínez, J. I. M. (2011). Scientific, Educational, and Environmental Considerations Regarding Mine Sites and Geoheritage: A Perspective from SE Spain. *Geoheritage*, 3(4), 267-275.

Mata-Perelló, J., Carrión, P., Molina, J., & Villas-Boas, R. (2017). Geomining Heritage as a Tool to Promote the Social Development of Rural Communities. In E. Reynard & J. Brilha (Eds.), *Geoheritage: Assessment, Protection and Management* (pp. 167–177). Amsterdam/Oxford/Cambridge: Elsevier

Migoń, P. (2012). *Geomorfologia (Geomorphology).* Warszawa: Wydawnictwo Naukowe PWN, 461 p.

Müller, P., & Novák, Z. (2000). *Geologie Brna a okolí (Geology of Brno and its surroundings)*. Prague: Czech geological institute.

Osborne, R. A. L. (2000). Presidential Address for 1999-2000. Geodiversity: „green“ geology in action. *Proc. Linn. Soc. NSW,* 122, 149–173.

Palacio-Prieto, J. L. (2015). Geoheritage Within Cities: Urban Geosites in Mexico City. *Geoheritage,* 7(4), 365–373. DOI: 10.1007/s12371-014-0136-6.

Panizza, M. (2001). Geomorphosites: concepts, methods and example of geomorphological survey. *Chinese Science Bulletin,* 46, 4–6. DOI: 10.1007/BF03187227.

Panizza, M., & Piacente, S. (1993). Geomorphological assets evaluation. *Zeitschrift fur geomorfologie*, Supp. Band, 87, 13–18.

Panizza, M., & Piacente, S. (2005). Geomorphosites: a bridge betwenn scientific research, cultural integration and artistic suggestion. *Il Quaternario – Italian Journal of Quaternary Sciences,* 18(1), 3–10.

Panizza, M., & Piacente, S. (2008). Geomorphosites and geotourism. *Rev. Geogr. Acadêmica,* 2(1), 5–9.

Panizza, M., & Reynard, E. (2005). Géomorphosites: définition, évaluation et cartographie (Geomorphosites: definition, assessment and cartography). *Géomorphologie: relief, processus, environnement,* 1(3), 177–180.

Pereira, P., Pereira, D. I., & Alves, M. I. (2007). Geomorphosite assessment in Montesinho Natural Park (Portugal). *Geographica Helvetica,* 62(3), 159–168.

Pereira, P., & Pereira, D. (2010). Methodological guidelines for geomorphosite assessment. *Géomorphologie: relief, processus, environnement,* 1(3), 215–222.

Petersen, J. (2002). The role of roadcuts, quarries, and other artificial exposures in geomorphology education. *Geomorphology,* 47, 289–301. DOI: 10.1016/S0169-555X(02)00095-8.

Pica, A., Fredi, P., & Del Monte, M. (2014). The Ernici Mountains Geoheritage (Central Apennines, Italy): Assessment of the Geosites for Geotourism Development. *GeoJournal of Tourism and Geosites,* 7/14(2), 193-206.

Pica, A., Vergari, F., Fredi, P., & Del Monte, M. (2016). The Aeterna Urbs geomorphological heritage (Rome, Italy). *Geoheritage,* 8, 31-42.

Pica, A., Luberti, G. M., Vergari, F., Fredi, P., & Del Monte, M. (2017). Contribution for an urban geomorphoheritage assessment method: proposal from three geomorphosites in Rome (Italy). *Quaestiones Geographicae,* 36(3), 21–36. DOI: 10.1515/quageo-2017-0030.

Pralong, J. P. (2005). A method for assessing tourist potential and use of geomorphological sites. *Géomorphologie: relief, processus, environnement,* 1(3), 189–196.

Pralong, J. P., & Reynard, E. (2005). A proposal for a classification of geomorphological sites depending on their tourist value. *Il Quaternario - Italian Journal of Quaternary Sciences,* 18(1), 315–321.

Prosser, C. (2016). Geoconservation, Quarrying and Mining: Opportunities and Challenges Illustrated Through Working in Partnership with the Mineral Extraction Industry in England. *Geoheritage,* 1–12. DOI: 10.1007/s12371-016-0206-z

Reynard, E., Fontana, G., Kozlik, L., & Scapozza, C. (2007). A method for assessing „scientific“ and „additional values“ of geomorphosites. *Geographica Helvetica,* 62(3), 148–158.

Reynard, E., Perret, A., Bussard, J., Grangier, L., & Martin, S. (2016). Integrated approach for the Inventory and Management of geomorphological Heritage at the Regional Scale. *Geoheritage,* 8, 43–60.

Reynard, E., Pica, A., & Coratza, P. (2017). Urban geomorphological heritage. An overview. *Quaestiones Geographicae,* 36(3), 7–20. DOI: 10.1515/quageo-2017-0022.

Reynolds, J. (2001). Notes to accompany RIGS recording, assessment and designation and notification sheets. In *Notes on the UKRIGS Conference 2001*. Penirth: UKRIGS Conference. Retrieved November 17, 2017, from http://wiki.geoconservationuk.org.uk/images/8/8d/Assessinfo.pdf.

Serrano-Cañadas, E., & González-Trueba, J. J. (2005). Assessment of geomorphosites in natural protected areas; the Picos de Europa National Park (Spain). *Géomorphologie: relief, processus, environnement*, 1(3), 197–208.

Sharples, C. (2002). *Concepts and principles of geoconservation*. Tasmanian Parks & Wildlife Service website, September 2002. Retrieved November 17, 2017, from http://dpipwe.tas.gov.au/Documents/geoconservation.pdf.

Stefano, M., & Paolo, S. (2017). Abandoned Quarries and Geotourism: an Opportunity for the Salento Quarry District (Apulia, Southern Italy). *Geoheritage,* 9(4), 463–477. DOI: 10.1007/s12371-016-0201-4.

Suzuki, D., & Takagi, H. (2017) Evaluation of geosites for sustainable planning and management in geotourism. *Geoheritage*, 1–13. DOI: 10.1007/s1237-017-0225-4.

Szabó, J., Dávid, L., & Loczy, D. (Eds.). (2010). *Anthropogenic Geomorphology*. A Guide to Man-Made Landforms. Dordrecht/Heidelberg/London/New York: Springer.

Tůma, A. et al. (2011). *Plán péče o Národní přírodní památku Červený kopec na období 2012–2021. (Care plan of National Natural Monument Červený kopec for the years 2012–2021).* Nature Conservation Agency of the Czech Republic. Retrieved October 21, 2017, from http://drusop.nature.cz/ost/archiv/plany_pece/index.php?frame&ID=24299.

Tuscan Mining Geopark. (2017). Tuscan Mining Geopark. Retrieved February 26, 2017, from https://www.coopcollinemetallifere.it/en/parco-colline-metallifere.

UNESCO. (1972). *Convention concerning the protection of the world cultural and natural heritage.* Retrieved October 22, 2017, from: http://whc.unesco.org/archive/convention-en.pdf.

Ústřední seznam ochrany přírody (Central database of nature conservation). (2017). Retrieved October 26, 2017, from http://drusop.nature.cz/portal.

Wimbledon, W. A. (2011). Geosites—a mechanism for protection, integrating national and international valuation of heritage sites. *Geologia dell'Ambiente,* 2, 13-25.

Zelenka, J. et al. (2014). *Metodiky národních geoparků (Methods for national geoparks)*. Chrudim/Prague: Vodní zdroje Chrudim a Ministerstvo životního prostředí (Ministry of Environment, Czech Republic).

Zeman, A. (1992). New data on the Quaternary at Červený kopec hill in Brno. *Scripta Geology,* 22, 123–131.

Zouros, N. (2007). Geomorphosite assessment and management in protected areas of Greece. Case study of the Lesvos Island - coastal geomorphosites. *Geographica Helvetica,* 62(3), 169–180. DOI: 10.5194/gh-62-169-2007.

Zwoliński, Z., Hildebrandt-Radke, I., Mazurek, M., & Makohonienko, M. (2017a). Existing and proposed urban geosites values resulting from geodiversity of Poznań City. *Quaestiones Geographicae*, 36(3), 125–149. DOI: 10.1515/quageo-2017-0031.

Zwoliński, Z., Najwer, A., & Giardino, M. (2017b). Methods for Assessing Geodiversity. In E. Reynard & J. Brilha (Eds.), *Geoheritage: Assessment, Protection and Management* (pp. 27–52). Amsterdam/Oxford/Cambridge: Elsevier