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# The Role of Anthropogenic Landforms in Sustainable Landscape Management

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Received: 27 June 2019; Accepted: 7 August 2019; Published: 10 August 2019



**Abstract:** Anthropogenic landforms are attractive landscape structures. They are linked to the cultural elements of the landscape and they also support biodiversity on the landscape level. Concerning their position within heritage concepts, anthropogenic landforms can be seen as a bridge between natural and cultural heritages. This paper is focused on the relevance of anthropogenic landforms to landscape management and planning. The study is based on the concept of geomorphosites, which can be applied within sustainable management and the conservation of geomorphological heritage. The case study was applied in the urban area of Brno (Czech Republic). The results of the study indicated the importance of anthropogenic landforms for urban landscape conservation and sustainable tourism development. The assessment of landforms in the study area enabled to establish a set of recommendations for the sustainable management of anthropogenic landforms in Brno. This study suggested the assessment of anthropogenic landforms as a support tool for sustainable landscape management in urban areas.

**Keywords:** assessment; geomorphosites; sustainable tourism; conservation; Brno; Czech Republic

## 1. Introduction

Anthropogenic activities result in processes that considerably change the landscape [1] and even surpass the effectiveness of natural exogenic processes [2,3]. These activities often have great importance from the economic point of view (quarrying, mining fossil fuels, urban development, adjusting landscape for agriculture, construction of large dams which provide water reserves for industries and cities etc.), but from the conservation point of view, they lead to degradation of the landscape [4] and protected areas [5]. In some cases the landscape is completely remodeled and there is no evidence of past landforms [6,7]. In addition, these activities induce processes which would normally not exist in certain places [8], e.g., landslides and subsidence depressions, and these processes can also affect items of cultural heritage [9].

An anthropogenic landform is created by human activity, particularly by construction, excavation, hydrological interference and farming [10]. Anthropogenic landforms can be classified by the character of their impact: direct or indirect [11], and respectively intentional or unintentional (primary anthropogenic landforms and secondary anthropogenic landforms). But for the purposes of landscape management, the classification of the landforms based on origin type is probably the most suitable [12].

Specific anthropogenic processes result in anthropogenic landforms (e.g., quarries, pits, communication cuttings and underground landforms) that can be considered important from the

scientific, educational, cultural, historical, environmental and tourism point of view [13–15]. These landforms have multiple functions:

- They can be seen as elements that increase the overall landscape diversity [16] and positively influence biodiversity [17,18], especially disused quarries and flooded pits);
- They provide information about landscape changes and modifications made in the past, and these can be an important resource for understanding the cultural and technical level of a society [19,20];
- They support an ecosystem service provisioning [21];
- They allow us to trace the use of geodiversity in the past and interpret cultural heritage in relation to abiotic nature [22], including the involvement of local communities [23,24] based on applying of historical ecology [25];
- They possess the potential for developing sustainable forms of tourism (or geotourism), which can positively affect local economic development [26,27]—they can be visually attractive [28] or allow us to interpret the technical aspects of using geodiversity resources, e.g., mining and industrial tourism [29,30];
- They allow us to observe stratigraphical, tectonic, palaeopedological and other Earth science features that would normally remain hidden and unrecorded in the literature or on geological maps [31,32] and the information can be used in both formal and informal education, and it is important from the conservation point of view [33];
- Landforms can be considered as an important stepping stones for biological species sensitive to fragmentation of landscape [34,35];
- Specific anthropogenic landforms form an inseparable part of items of cultural heritage, e.g., earth fortifications and ramparts and irrigation channels [36,37];
- In urban areas, the anthropogenic landforms allow us to interpret urban development [38] and they are an inseparable component of urban landscapes [39].

The importance of anthropogenic landforms is indisputable, however their position within heritage concepts still remains a subject of discussion. The Convention concerning the protection of the world's cultural and natural heritage [40] includes some anthropogenic landforms in the cultural heritage: “works of man or the combined works of nature and man, and areas including archaeological sites which are of outstanding universal value from the historical, aesthetic, ethnological or anthropological point of view.” The guidelines for the inclusion of specific types of property on the World Heritage List [37] also specify cultural landscapes and heritage canals. Specific anthropogenic landforms can be respected as a full-value part of the mining heritage [41,42]. This type of heritage is considered a subset of cultural heritage. However, the natural aspects of mining are also included (geological settings, type of material extracted) and anthropogenic modifications, landforms and processes (e.g., silted dams, open cuts, embankments and mounds, tailings dumps) are taken into account as well [43].

A special situation can be found in urbanized areas that are usually heavily affected by anthropogenic transformations of the relief and thus the abundance of anthropogenic landforms is high there [11]. In these cases, the anthropogenic landforms can be respected as a component of “urban geoheritage” [44,45]. Some authors [46] include anthropogenic landforms in the concept of “geomorphological heritage” or “geocultural heritage”, using examples such as Petra (Jordan) or Cappadocia (Turkey). These sites are clearly not natural, yet they have strong links to geological and geomorphological aspects. According to Coratza and Hobléa [47], geomorphological heritage is defined as the set of landforms worthy of being protected and transmitted to future generations. Geomorphological heritage includes not only geomorphological objects *sensu stricto*, but also cultural (man-made) components with their heritage value determined by geomorphological conditions. In this context, anthropogenic landforms can be seen as specific examples of geomorphosites [48] and defined as “geomorphological objects or wider landscapes. They may be modified, damaged, and even destroyed by the impact of human activities”, or they can be “geocultural sites” (a term proposed by [46] and used e.g., by [49]), which are defined as places where geoheritage interacts with cultural

assets. Thus, specific anthropogenic landforms can be assessed through similar methods to those used within the geomorphosite concept.

Geomorphosite assessment has been widely used in natural and rural areas [50,51]. However, assessment methods within urban areas are rather scarce [52]. In addition, the use of the geomorphosite concept for anthropogenic landforms has not yet been applied, mainly due to the ambiguous position of anthropogenic landforms within heritage concepts. This paper intent to fill the following knowledge gaps:

- (1) the possibility of using the geomorphosite concept for anthropogenic landforms as a special case of geomorphological heritage
- (2) the application of the geomorphosite assessment in an urban area.

Based on the assessment of specific anthropogenic landforms in Brno (Czech Republic), we have designed the management proposals for sustainable use (with an emphasis on conservation issues and sustainable tourism development) that can be applied in other urban areas.

## 2. Methods and Material

### 2.1. Methodological Approach

In recent decades, numerous geomorphosite assessment methods have been introduced and used, especially in geoheritage and geotourism studies [44,53–63]. Later, these methods were critically reviewed and discussed in several papers [64–68]. All the methods respect the links between geology, culture and tourism [69,70], and they also accept the holistic approach to geotourism [71–73].

In this study, the assessment of anthropogenic landforms is based on expert-based approach [74–76]. For the study we decided to apply a set of criteria based on methods presented by Pereira and Pereira [56] and by Reynard et al. [51]. Both methods have been verified in several studies and used on different types of sites, including the geocultural ones [49]. As the assessment is intended for anthropogenic landforms, minor changes were made and supplements added:

- Exclusion of the “palaeogeographic importance” criterion within the Scientific values: in the case of anthropogenic landforms, the palaeogeographical value can be a discriminative criterion as the specific anthropogenic landforms are recent and therefore they have a low value in terms of the possibilities for reconstructing the palaeogeography of the studied area [51].
- Inclusion of the “educational value” criterion: education and learning represent an important tool for conservation activities [77]. They play an essential role in the development of sustainable forms of tourism, especially geotourism [78], so they should be assessed separately.
- Inclusion of the “diversity of cultural values” criterion: anthropogenic landforms always have a relationship to cultural aspects (as they are created by human activity or refer to the use of natural resources by people). Originally the methods allowed only the assessment of present/absent and did not reflect the diversity and number of these added values and elements—that’s why the criterion of “diversity of cultural values” was added.
- Exclusion of the “aesthetic value” criterion: generally, this criterion is assessed by using visibility, number of colours, or the structuration of a space and it is considered relatively subjective [79]. In the case of anthropogenic landforms, this aspect is very difficult to assess due to the diversity of origin types of landforms. The criterion “visibility” partly substitutes for the “aesthetic value”.

Concerning the terminology, Reynard et al. [51] distinguish between the scientific “values” and management “characteristics”, and the educational and tourism “potential”. However, the definition of geomorphosite [79] uses the term social/economic values, under which we can include these aspects (tourism, management, education, conservation). Thus, for the purposes of this study we use the term value to avoid ambiguities.

A numerical value can be assigned to every criterion. A total value is represented by the sum of all the values. The criteria used for the assessment are presented and briefly explained in Table 1.

**Table 1.** Assessment method for anthropogenic landforms.

Values	Criteria/Questions	Numerical Assessment Proposal
<b>Scientific value</b>	Integrity or current status of the site: related to the conservation status of the main elements	1—conserved 0.5—partly conserved 0—damaged
	Diversity of the Earth science features: a number of different elements with scientific interest	1—4 and more different features 0.5—2–3 features 0—1 feature
	Rarity: number of similar sites in the area of study	1—the site is unique within study area 0.5—there are 2 or 3 similar sites 0—more than 3 similar sites
	Scientific knowledge of the site: the existence of published scientific studies about the site	1—world known site 0.5—regionally/nationally known site, several scientific papers 0—the site has been researched marginally
<b>Educational value</b>	Exemplarity and representativeness: capacity of a site to illustrate Earth science elements or processes, possibility for people with no geological background to understand the elements and 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 the lay public; professional explication is needed
	Presence of educational facilities, e.g., educational trails or information panels	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
<b>Tourist value</b>	Accessibility	1—access without problems 0.5—limited access (e.g., only with permission or with special equipment) 0—site is inaccessible to the public (or access is possible at own risk)
	Safety: high or low risk conditions for visitors	1—safety is not a problem 0.5—some specific limitation (e.g., the risk of landslides) 0—visiting site is not recommended and it is dangerous
	Tourist infrastructure: facilities for receiving tourists (accommodation, food, toilets)	1—tourist infrastructure situated within walking distance 0.5—limited tourist infrastructure is accessible 0—no tourist infrastructure
	Viewpoints and visibility: the conditions for observation of all the elements on the site	1—more than 3 different viewpoints 0.5—1–3 viewpoints 0—no viewpoint, the visibility is limited

Table 1. Cont.

Values	Criteria/Questions	Numerical Assessment Proposal
<b>Added value</b>	Ecological aspect: the relevance from the ecological or biological point of view (e.g., species/ecosystems that exist here due to the existence of landform/anthropogenic activity)	1—yes, there are some specific ecological features 0—without specific ecological features
	Cultural aspects: a number of different cultural aspects (e.g., historical aspect—evidence of social/economic/industrial changes and development; artistic aspect—site as an inspiration for artists; architectural aspect—visible evidence of the use of material especially from mining landforms; presence of religious features on the site; geomorphological aspect—myths about the site; technical aspects etc.)	2—5 and more different cultural aspects 1.5—4 different cultural aspects 1—3 different cultural aspects 0.5—2 different cultural aspects 0—1 cultural aspect
<b>Conservation value</b>	Existing legislative protection (site declared as natural monument or reservation, part of the large protected landscape area, protected as a significant landscape element, cultural protection etc.)	1—existing legislative conservation 0.5—the site is proposed for conservation or is registered as an important landscape element 0—no legal protection or proposals for conservation
	Current threats [80]: the existence of any threats that can lead to the damage of the site (both natural respectively natural threats induced or supported by human activity that can lead to the destruction of a site or its degradation or disappearance of specific geo-features, e.g., vegetation growth, invasive species, landslides) and anthropogenic (e.g., dump fill, vandalism, “revitalization” that can cause disappearance of specific Earth science and related features)	2—no threats, risks or hazards 1.5—existing threats, but the risk is low or already being managed 1—existing threats with an average or high risk, but there is a certain conception how to manage them or how to mitigate the impacts 0.5—existing threats with high risks which are not managed and resolved 0—currently the site is in danger, there are some processes that can lead to its devastation

## 2.2. Study Area and Selected Anthropogenic Landforms

The study area (town Brno) is situated in the region of southern Moravia (southeastern part of the Czech Republic). It lies on the contact point of two different units: Variscan Central Europe (respectively the Bohemian Massif) and Alps–Carpathian area (respectively the Carpathian Foredeep), so the geology and landscape of the area is quite complicated and varied. Most geological eras are represented in the relatively small area of the city: The Cadomian Brno Massif (composed of metamorphosed basalts [~725 Ma old] and granodiorites), the Paleozoic cover (represented by Devonian basal clastic sediments), Jurassic limestones, Neogene sediments of the Carpathian Foredeep (Ottangian gravels, Badenian calcareous clays) and Quaternary sediments (represented by loess, fluvial deposits and anthropogenic sediments) [81,82].

The study area is in two different geomorphological provinces: the Bohemian Highlands and the Western Carpathians [83,84], and this suggests that there will be a rich variety of landforms. In the northern and central parts, the relief is tectonically influenced (occurrence of horsts and grabens and tectonically conditioned valleys) and more pronounced; the southern part is rather flat and was mainly formed during the Neogene and Quaternary. The uniqueness of Brno's relief lies in the “chessboard” layout of the ridges and valleys, and this has influenced the situation concerning communication, buildings and urban development in general.

The relief of the study area is strongly influenced by anthropogenic activity (the occurrence of numerous urban/residential, communications, industrial, mining and other anthropogenic landforms). The exploitation of construction materials (loess, sand, building stone—limestone, sandstone, conglomerate, granodiorite, metabasalt) can be traced back to the 12th century and it has markedly influenced the landscape [85–87].

The choice of representative landforms was based on a detailed literature review and a field survey using the genetic aspect. Nearly every group of anthropogenic landforms is represented. As diversity exists within the groups, we selected various types within each group. In some cases, two or more types of anthropogenic landforms are present on the site. In total, 21 anthropogenic landforms were selected for the assessment. For details about the sites, see Table 2.

**Table 2.** Selected sites and anthropogenic landforms.

Number and Name	Type of Anthropogenic Geomorphosite and Short Characteristics
S1 Červený kopec A	mining (loess pit)
S2 Červený kopec B	mining (conglomerate and sandstone quarries)
S3 Hády—plain	mining (medieval Devonian limestone quarries)
S4 Hády—upper bench	mining (recent Jurassic/Devonian limestone quarry)
S5 Hády—Růženin lom	mining (limestone and granitoid quarry), communication/industrial (tunnels)
S6 Žabovřesky quarry	mining (metabasalt quarry)
S7 Černovice sandpit	mining (sand pit with occurrence of clays and gravels)
S8 Stránská skála	mining (Jurassic limestone quarry) and industrial (underground factories)
S9 Želný trh—labyrinth	residential (system of cellars)
S10 Ossuary of St. James Church	funeral (underground spaces)
S11 Bunker 10-Z	military (war or nuclear bomb shelter)
S12 Obřany castle	residential/military (ramparts, banks, trenches), communication/traffic (old hollow ways)
S13 Říčka valley	water management (reservoirs, millraces, boreholes, wells)
S14 Water reservoirs Tvrdého	water management (underground water reservoirs)
S15 Abrasion cliffs at Brno dam	water management/littoral (abrasion cliffs in loess)
S16 Bosonožský hájek	agricultural (terraces), communication/traffic (old hollow ways)
S17 Jedovnická street cutting	communication/traffic (road cutting in granodiorites)
S18 Vejrostova street cutting	communication/traffic (road cutting in the rocks of Brno massif)
S19 Old highway	communication/traffic (artificial communication embankments)
S20 Tišnovka railway	communication/traffic (remains of railway embankments)
S21 Úvoz	urban/communication (outcrops of the rocks of Brno massif which has been considerably remodelled by human activity—the part of the site does not exist due to road construction)

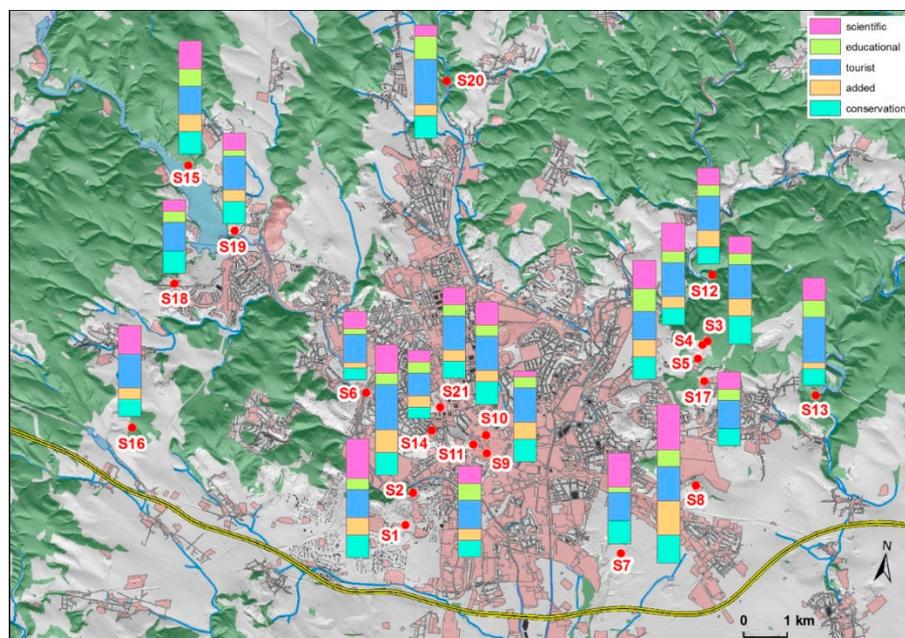
### 3. Results

#### 3.1. Results of the Assessment

The landforms were assessed using the method outlined above. The results of the numerical assessment are presented in Table 3 and Figure 1.

**Table 3.** The results of assessment (interpretation and ranking in the following text).

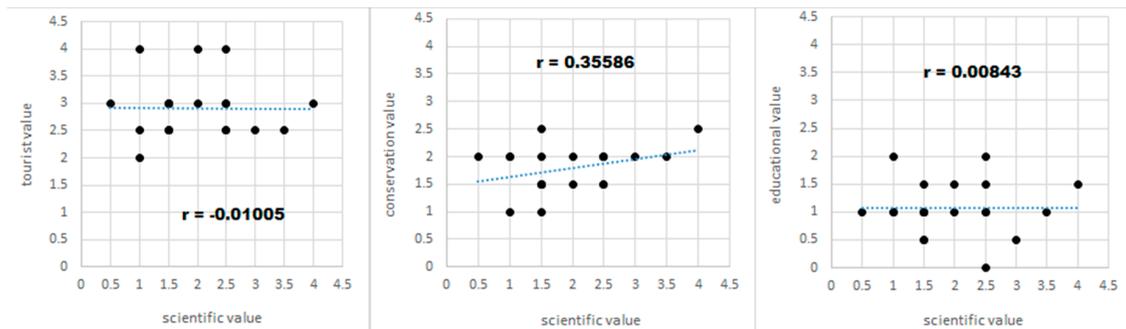
Sites	Scientific Value	Educational Value	Tourist Value	Added Value	Conservation Value	Total Value
S1 (Červený kopec A)	3.5	1	2.5	1.5	2	10.5
S2 (Červený kopec B)	2.5	1	4	2	2	11.5
S3 (Hády—plain)	1.5	1	3	1.5	2.5	9.5
S4 (Hády—upper bench)	2.5	1	3	1	1.5	9
S5 (Hády—Růženin lom)	2.5	2	2.5	1.5	2	10.5
S6 (Žabovřesky quarry)	1.5	0.5	2.5	0.5	1	6
S7 (Černovice sandpit)	3	0.5	2.5	0	2	8
S8 (Stránská skála)	4	1.5	3	3	2.5	14
S9 (Zelný trh—labyrinth)	0.5	1	3	1.5	2	8
S10 (Ossuary St. James)	2	1	3	1	2	9
S11 (Bunker 10-Z)	1.5	1.5	2.5	1	1.5	8
S12 (Obřany castle)	1.5	1	3	1.5	1.5	8.5
S13 (Řička valley)	2	1.5	4	0.5	1.5	9.5
S14 (Water reservoirs Tvrdého)	1	1	2	1	1	6
S15 (Abrasion cliffs at Brno dam)	2.5	1.5	2.5	1.5	2	10
S16 (Bosonožský hájek)	2.5	0	3	1	1.5	8
S17 (Jedovnická street cutting)	1.5	1	2.5	0	1.5	6.5
S18 (Vejrostova street cutting)	1	1	2.5	0	2	6.5
S19 (Old highway)	1.5	0.5	3	1	2	8
S20 (Tišnovka railway)	1	2	4	1	2	10
S21 (Úvoz)	1.5	1	3	1	1.5	8



**Figure 1.** The results of the assessment of the anthropogenic geomorphosites within Brno (numbers S1–S21 see Table 3).

Based on the assessment, the basic statistical analysis was carried out. A simple comparison between the groups of values was elaborated. Figure 2 presents crossed values and linear correlations ( $r$ ) for each pair of measurements. Between scientific/tourist value and scientific/educational value, there is no significant correlation. The correlation between scientific and conservation value is higher

( $r = 0.3559$ ), however it is still considered weak. But these preliminary results cannot be regarded as conclusive because the number of assessed geomorphosites is relatively low. In addition, the interpretation of relationships requires more detailed analysis.



**Figure 2.** Graphic presentation of the comparison between scientific and tourist values, and conservation and educational values.

The Spearman's rank correlation coefficient for the first approach revealed no significant correlation between scientific/tourist value ( $\rho = 0.014$ ) and scientific/educational value ( $\rho = 0.016$ ). The correlation between scientific and conservation value is slightly higher ( $\rho = 0.273$ ), however it is still considered weak. But these preliminary results cannot be regarded as conclusive because the number of assessed geomorphosites is relatively low.

### 3.1.1. Scientific Values

High scientific value in this study was attributed to the mining landforms due to the high diversity (because of these landforms numerous Earth science features were observable). It was supported by local scientific knowledge (these landforms are often used for geological mapping or they were the subject of specific research - both geoscientific and archeological). Low scientific value was generally attributed to the underground anthropogenic landforms and road cuttings. In the case of underground anthropogenic landforms, the low value was caused by the low diversity of Earth science features and the low geoscientific knowledge of the site. In the case of communication/traffic landforms, the low scientific values were mainly caused by low scientific knowledge (there were only mentions of them in the documentation of the municipal office in Brno or on geological maps) and by the fact that the number of Earth science features were not considered as unique.

### 3.1.2. Educational Values

The educational value of the anthropogenic landforms is independent of the landform genesis and it does not have a strong link to the scientific value (see Figure 2). The high educational value is usually related to the easy legibility of the landforms. Low scores of educational value are caused by limited visibility or absence of educational facilities on the site. In some cases the landforms are visible and recognizable in the terrain, but a professional explication is needed as there are various interpretations of the landforms origins and there is the possibility of misunderstanding some of them.

### 3.1.3. Tourist Values

The tourist value of the anthropogenic geomorphosites probably does not depend on the landform genesis and there is no clearly defined link to or dependence on scientific value (see Figure 2). A high tourist value for the sites is attributed to sites with good accessibility and safety, and the presence of a developed tourist infrastructure, including numerous viewpoints from where the landforms can be observed. Nevertheless, in some cases, the safety reasons contribute to the low tourist value.

#### 3.1.4. Added Values

The high added values were generally attributed to the mining geomorphosites, particularly due to the many and diverse cultural aspects and important ecological aspects. In contrast, the lowest added value was attributed to road cuttings and other communication landforms.

#### 3.1.5. Conservation Values

There is a correlation between scientific and conservation value, however the conservation value probably does not depend on landform genesis and this is proven by the results of the assessment. The mining sites usually reached a high score in conservation value because they are already legally protected, which means that possible threats and risks are somehow managed. Nevertheless, relatively high conservation values were also achieved by the other sites of different origin. Legal protection is usually related to surface (not underground) sites, but there are also higher risks and threats (e.g., conflicts with vegetation, risks of degradation of the landforms due to natural or anthropogenic processes, inappropriate use of the landform that can lead to its destruction). The underground spaces usually have no legal protection, but there are lower risks of damage. Nevertheless, there can be conflicts with urban development and landscape planning that can suggest some further threats.

#### 3.1.6. Total Values

Generally, the highest total values were obtained by mining sites. High total values can indicate that the sites have a considerable tourist and educational potential and they are very valuable from the conservation point of view. However, the sites with high total values are usually already legally protected and partly used for (geo)tourism, so in this case the high total value alerts us to the necessity of preserving the current positive status, and to ensure rational and sustainable use of the site and existing conservation management measures. Practically it means that the care plan (planning document for the protected site) should be consistently maintained in the future and different sources of finance for the preservation activities should be sought. The preservation of the current conservation status, including the protective buffer zones has to be maintained and respected in urban planning documentation. The low total score indicates that the scientific and added values of the sites are average, the tourist value is relatively low and the conservation value is also low due to the presence of threats that can endanger or damage (or destroy) the sites.

### 3.2. *Proposals for the Management of the Anthropogenic Landforms*

Based on the results, proposals for sustainable urban landscape management and a strategy of urban landscape conservation are presented.

In the case of a site with a high scientific value, detailed documentation of the site and the establishment of legal protection are necessary in order to avoid the possible loss of this value. Legal protection then ensures the inclusion of the site in urban planning documentation and strategies. The use of the sites with a high scientific value for geotourism purposes should be developed in relation to the current status or conservation of the site. In the case of average and low scientific values, the site should at least be documented.

In the case of high educational value, it is crucial to ensure sustainable educational use (in the case where there is already an educational use, e.g., by adopting the visitors' orders or rules) and to emphasize the relationship of the educational value to the conservation aspect (mentioning the importance of protection when using the site for educational proposals). In the case of average or low educational value and high scientific value, the development of an adequate tourist and interpretative infrastructure which respects the geoconservation aspects is desirable. The sites with high and average educational values are an important resource for local schools and informal educational activities, so ensuring the appropriate educational use of the sites is linked to the quality of education in urban areas.

In the case of a high tourist value of a site, it is necessary to assure the sustainable use of the site by setting the links between tourist/recreational use and conservation activities in order to avoid potential conflicts of interest and to establish a balance between conservation needs and tourist use. It is also necessary to ensure the future treatment and management of the tourist infrastructure regarding visitor safety and to inform visitors about possible risks. In the case of low tourist value but high scientific, educational or added values, the development of an adequate tourist infrastructure can be considered, but always with respect for the conservation aspects.

In the case of high added values it is important to set the links between added values and scientific values—in the case of currently protected sites or sites proposed for legal protection this can help with the acceptance of conservation measures. The added values can also be used for geoeducational purposes. In the case of low added values, it is possible to combine and increase added values (e.g., use of the site for cultural events) for future tourism development.

In the case of high conservation value, ensuring the sustainability of the positive status of the site (including financial measures), it is necessary to offer information to visitors about management measures from the geoconservation point of view and to ensure the acceptance of conservation values within landscape planning. In the case of low conservation value, it is crucial to adopt immediate measures to stabilize the site (in the case of high scientific value) and to analyse the relationships between the behaviour of visitors and the current status of the site, including anthropogenic threats in general (in the case of average or high tourist value). It is also desirable to include the public in planning the management of a site and to develop volunteering as regards management proposals or lack of finances.

#### 4. Discussion

Total value must be considered in the context of particular values of cultural landscape [88]. A high total value did not automatically mean that a site was suitable for geotourism and worthy of conservation, but it could indicate the need for the preservation of the current positive status [89]. Similarly, the sites with low total value may spark discussion about new possibilities for rational and sustainable use, which can increase their value and reduce the uncertainties [90]. One methodological approach is to strengthen conservation measures—these can decrease potential threats to the site, but when there is a conflict of interest or conflicts with urban development where considerable changes to or destruction of a site is in the public interest, the reinforcement of conservation is disputable. Another approach is to include the endangered sites in so-called rescue geological and geomorphological research activities [91–93], with the aim of keeping scientific information which can serve educational purposes, even after serious damage or destruction of a site. This study is generally based on holistic approach, which includes biosphere alternations caused by human activities [94–96].

A comparison of the presented study with other studies that used geomorphosite assessment methods would probably be a bit misleading as the sites included in the presented study were of anthropogenic origin and other studies mainly consider natural sites, e.g., [59,61,97]. Thus, we made a comparison in the context of the relationships between particular site values: while in the case of natural areas and natural sites, the higher the scientific value, the higher the tourist value [58,97], in the case of anthropogenic sites this correlation is weak (Figure 2). However, in order to prove this hypothesis, a more detailed study should be done (with a higher number of assessed geomorphosites) in the future. It is a similar situation with the relationships between scientific and conservation values and scientific and educational values where there was no statistically proved correlation.

Proposals for a management strategy and the sustainable using the sites of anthropogenic origin have been the subject of several studies [98]. These studies were mainly focused on abandoned quarries in rural areas, however some proposals for landscape management, including conservation aspects, are common. Margiotta and Sanso [27] confirmed that some abandoned quarries are part of the natural and cultural heritage as an important resource for geotourism development. Baczynska et al. [28] also confirmed these landscape forms (quarries) as elements that enrich the value of particular areas

in terms of tourism. Authors of the study [26,29] concluded that abandoned quarries could be of geoconservation significance and some of them were very important for geoscientific tourism. Prosser [33] suggested that quarries were important sites from a scientific point of view and should be conserved as protected areas and highlighted the importance of involvement of local communities and stakeholders to the geomorphosite management in order to better support of conservation effort. The proposals for anthropogenic landforms in urban areas differ, especially in conservation—we suggested that scientifically valuable sites should immediately be conserved in order to avoid their loss and conflicts with urban development. All the sites should be seriously documented in case of their loss. Other anthropogenic landforms have not yet been the subject of geomorphosite assessment in literature.

## 5. Conclusions

Human impact on relief does not always have to be destructive; on the contrary, some anthropogenic landforms (thanks to their scientific, educational, cultural, historical, tourist or other values) are important and indisputable parts of the natural and cultural heritage of certain areas and should be treated and assessed accordingly. The use of geomorphosite concepts for the assessment of sites with anthropogenic landforms is one of the support tools for establishing future sustainable landscape management and conservation measures. Based on the assessment, some final remarks can be presented:

- Anthropogenic landforms can achieve high scientific value, they can be included in the natural and cultural heritage and thus can be the subject of conservation efforts;
- Setting legal protection for these sites ensures their acceptance by urban strategic planning and development;
- The educational value of anthropogenic landforms within urban areas should be reconsidered and accepted as an important resource for on-site learning, and for both formal and informal education;
- Anthropogenic landforms possess the potential for the development of sustainable forms of tourism—they can represent an interesting alternative to the traditional tourist destinations, and as such they should also be treated as a tourist resource;
- Anthropogenic landforms are typical for their close relationship between natural and cultural features. The promotion of the links between scientific and added (cultural) values may help in the acceptance of the need for conservation measures by local communities and authorities.

The results of anthropogenic landform assessment can serve landscape planning purposes and can assist in arguments for conserving specific sites (e.g., registration of new important landscape elements, declaration of new protected monuments), as it has been applied in studies [99,100]. Likewise, they can justify the inclusion of conservation, tourism, education and related activities in the local/regional landscape, as well as land use planning and development strategies. Anthropogenic landform assessment can help to avoid potential future conflicts of interest and even the loss of valuable sites.

**Author Contributions:** Conceptualization, L.K., I.M. and K.K.; methodology, L.K., F.K.; writing—original draft preparation, L.K., K.K., I.M.; writing—review and editing, I.M., L.K., K.K., F.K.; visualization, F.K.

**Funding:** This research was funded by the Ministry of Culture of the Czech Republic as a part of the NAKI II program, grant number DGB 16P02B014 (Cultural heritage of landscape of the Archdiocese of Olomouc—research, presentation and management).

**Conflicts of Interest:** The authors declare no conflicts of interest.

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