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# Transforming Brownfields as Tourism Destinations and Their Sustainability on the Example of Slovakia

**Bohuslava Gregorová [1], Pavel Hronček [2], Dana Tometzová [2,*], Mário Molokáč [2] and Vladimír Čech [3]**

[1] Department of Geography and Geology, Faculty of Natural Sciences, Matej Bel University in Banská Bystrica, 97401 Banská Bystrica, Slovakia; bohuslava.gregorova@umb.sk
[2] Department of Geo and Mining Tourism, Institute of Earth Resources, Faculty of Mining, Ecology, Process Control and Geotechnologies, Technical University of Košice, 04200 Košice, Slovakia; pavel.hroncek@tuke.sk (P.H.); mario.molokac@tuke.sk (M.M.)
[3] Department of Geography and Applied Geoinformatics, Faculty of Humanities and Natural Sciences, University of Prešov, 08116 Prešov, Slovakia; vladimir.cech@unipo.sk
* Correspondence: dana.tometzova@tuke.sk; Tel.: +421-948-722-920

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**Abstract:** This study analyzes the issue of mining brownfields (sites abandoned after the extraction of minerals) in terms of their secondary use after revitalization as potential new sites of mining tourism. In the first part of the paper, we deal with the theoretical basis of the study, the conceptualization of mining brownfields, possibilities for their revitalization, and their sustainability for mining tourism. In the second part, we analyze mining brownfields as devastated mining sites using a questionnaire survey conducted among students of geotourism and geography at three Slovak universities in Košice, Banská Bystrica, and Prešov. The result of our several years of field research was a database of mining brownfields in Slovakia. According to our findings and the latest theoretical and methodological literature about other types of brownfields, we compiled a comprehensive definition of mining brownfields. The questionnaire survey confirmed that mining brownfields are interesting destinations for (mining) tourism with long-term sustainability. The equipment of the services did not directly determine the number of visitors, who did not perceive the risk and danger of visiting mining brownfields.

**Keywords:** brownfields; postmining areas; derelict areas; revitalization; tourism; evaluation; sustainability

## 1. Introduction

Scientific opinions explaining the term "brownfield" often differ in their identification, understanding, and evaluation of this term; above all, however, they differ in their definition of it. The fundamental difference occurs mainly between the European and American perceptions of the concept.

According to the Concerted Action on Brownfield and Economic Regeneration Network [1], brownfields are sites that [2]:

- have been affected by the former uses of the site and the surrounding land,
- are derelict and underused,
- may have real or perceived contamination problems,
- are mainly in developed urban areas and require intervention to bring them back to beneficial use.

Significant differences in understandings of the meaning of brownfields can be identified in Europe and its regions. Many definitions in the literature differ between disciplines. A review of brownfield definitions from selected scientific communities worldwide is provided in Table 1 and Figure 1.

**Table 1.** Selected definitions of brownfields from different countries of the world (determined on the basis of the authors' research).

| Country | Authors | Definition |
| --- | --- | --- |
| Europe | Ferber et al. (2006) [3] | "Currently derelict or underused sites which have been affected by former uses of the site or surrounding land; they are mainly located in fully or partly developed urban areas and may have real or perceived contamination problems thus require intervention to bring them back to beneficial use." |
| | CABERNET [1] | "A site that has been affected by former uses of the site or surrounding land, is derelict or underused, mainly in fully or partly developed urban areas, require intervention to bring it back to beneficial use; and may have real or perceived contamination problems." |
| UK | Post (1998) [4] | "Brownfield sites are buildings and land either now vacant, or that could become vacant or suitable for development, during a relevant [development] plan period." |
| Ireland | Pavolová, Kyseľová, Bakalár (2012) [5] | "The abandoned areas-areas that have lost or losing their original character and negatively affect their environment due to their dilapidated, disrepair, or the presence of waste." |
| Belgium-Wallonia | Pavolová et al. (2019) [6] | "Places formerly intended for economic recovery, where the status quo is not an efficient use of Flanders: An abandoned or underutilized industrial area with potential for active recovery or expansion, which is further complicated by the development of real or anticipated environmental problems." |
| Belgium-Flanders | Oliver et al. (2005) [7] | "Abandoned or under used industrial sites with an active potential for redevelopment or expansion but where redevelopment or expansion is complicated by a real or perceived environmental contamination (legislation including a definition is in the process of approval)." |
| France | Darmendrail (1999) [8] | "A space that has been temporarily abandoned following the cessation of activity (agricultural, protoindustrial, service, processing, military defense, storage or transport) and that needs to be reclaimed for future use." |
| Germany | Freier (1998) [9] | "Abandoned pieces of land, mainly in inner cities, which are often blocked for economic development due to their ecological and economic risks." |
| Austria | Oliver et al. (2005) [7] | No official definition. Understanding similar to CABERNET definition recognising potential for reuse and with less focus on contamination. |
| Denmark, Finland, Sweden, Norway | Oliver et al. (2005) [7] Cehlár et al. (2019) [10] | "Degradated and contaminated areas." |
| Italy | Pavolová et al. (2019) [6] | "Contaminated areas-areas that are chemically, physically or biologically contaminated in such a way that endangers human health or the surrounding buildings or landscape. The area is considered contaminated when contamination exceeds the limits set by law." |

**Table 1.** *Cont.*

| Country | Authors | Definition |
|---|---|---|
| Spain-Basque | Pavolová et al. (2019) [6] | "Potentially contaminated areas/derelict industrial buildings." |
| USA | USEPA (2018) [11] | "Abandoned, idled, or under-used industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination." |
| Canada | De Sousa (2002) [12] | "Abandoned, idle or underused commercial or industrial sites where previous activities have caused environmental contamination, but where there is an active potential for redevelopment." |
| Australia | Newton (2010) [13] | "A brownfield site is one which has been urbanized or used industrially, subsequently vacated and available for re-urbanization." |
| South Africa | Potts and Cloete (2012) [14] | "A brownfield site is infill land or premises where remedial action is required before redevelopment. It may also be vacant, derelict or contaminated. No specific land use is attributed." |
| Turkey | Mert (2019) [15] | "Brownfield is previously used land (or building) by another economic activity that is not currently used and is contaminated, abandoned or otherwise unoccupied. It can be found in rural or urban environments, and could usually be suitable for re-use, with or without intervention." |

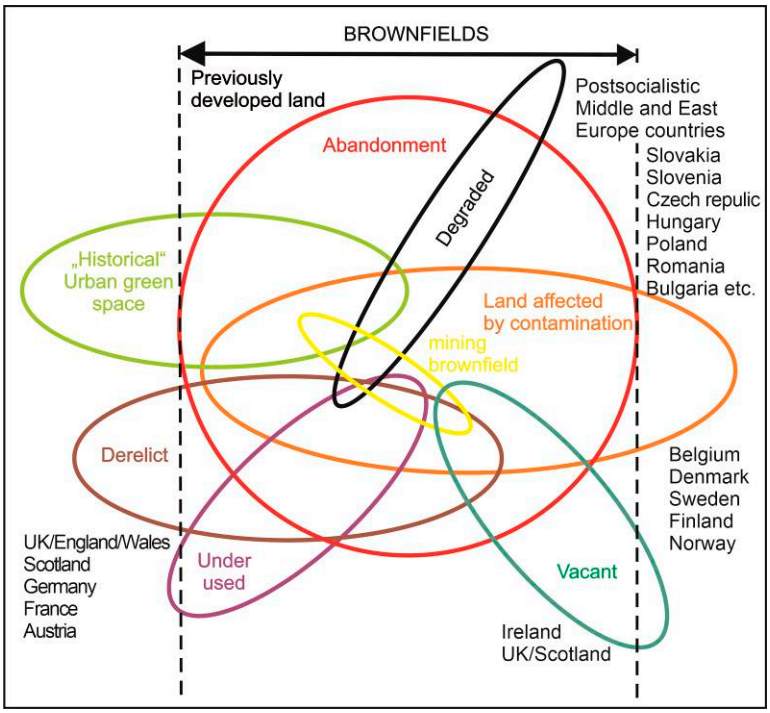


**Figure 1.** Relationships between inconsistent definitions of brownfields in selected countries and the position of the mining brownfield definition (modified according to [2,16]).

In the USA and Canada, the term "brownfields" refers to abandoned areas of various origins that are considered to be ecological burdens significantly harming the environment. Environmental, economic, and legislative obstacles prevent the re-use of these abandoned devastated areas. Therefore, a relatively large number of them exist in almost their "original" states in these countries [17].

The situation is diametrically different in the postsocialist countries of Central and Eastern Europe (Table 2). The economic situation significantly changed in the last decade of the 20th century after the collapse of the planned socialist economy and the onset of the market economy. During this period, several large companies focused on the heavy, chemical, engineering, and mining industries went bankrupt, leaving extensive, devastated, significantly ecologically damaged, visually unattractive sites in the landscape. In many cases, these sites are dangerous and harmful to human health, e.g., in Ukraine (Chernobyl—explosion of nuclear power plant), Hungary (Ajka—alumina plant accident), Slovakia (Žiar nad Hronom—aluminum processing heap accident), Russia (Norilsk, Magnitogorsk, Novokuznetsk—mining, steel and chemical industries; environmental degradation of the landscape), and many more. The developing and reforming economy does not allow for their extensive reclamation (which is more of an exception rather than the rule), subsequent transformation, and secondary use. Their gradual transformation in these countries tends to begin in urbanized and residential zones especially, represented by less extensive areas in these cases.

**Table 2.** Selected definitions of brownfields from postsocialist countries of Central and Eastern Europe (determined on the basis of the authors' research).

| Country | Authors | Definition |
| --- | --- | --- |
| Czech republic | Vráblík (2009) [18]; Pavolová et al. (2019) [6] | "Brownfield is a property (land, building, complex), which is underused, neglected and may be contaminated. There is a remnant of the industrial, agricultural, residential, military or other activities. Brownfield is not used appropriately and effectively without the normal process of regeneration." |
| Hungary | Pavolová et al. (2019) [6] | "The territory which had formerly been used economically efficient, but are currently underused, stopped. The main feature is the neglect, dereliction and contamination." |
| Poland | Oliver et al. (2005) [7] | "Degraded areas due to diffuse soil contamination-high density of landfill sites." |
| Bulgaria | Pavolová et al. (2019) [6] | "Contaminated land-areas in which previous activity has ceased, however, still have influence on their surroundings." |
| Romania | Oliver et al. (2005) [7] | "Polluted lands (soils)." |
| Slovenia | Oliver et al. (2005) [7] | "Degradated/abandoned building land usually inside urban areas." |
| Latvia | Oliver et al. (2005) [7] | "A place that has been previously used or built up, but currently is derelict or abandoned-can also be contaminated (adapted CABERNET definition)." |
| Russia-Siberia and Arctic | Cehlár et al. (2019) [10] | "(Mining) Browfields as potential areas for the resumption of mining using modern technological and environmental approaches with an emphasis on economic benefits for investors and local communities." |
| Slovakia | Pavolová et al. (2019) [6] | "Brownfields can be various types of former industrial, commercial, transport and other logistics facilities, various technical infrastructure facilities, former landfills, areas affected by mining or other human activity and other unused facilities and lands that or partially or completely contaminated." |
|  | Gregorová, Hronček, Tometzová, Molokáč, Čech (defined in this paper) | "Mining brownfields are understood as old mining and related areas, areas and buildings in the country (to a lesser extent in the urban area of settlements), which remained abandoned after mining, thereby losing their original use, or are little used and gradually decay. These areas are often associated with real or perceived contamination of the landscape and the environment." |

Positive examples of reconstruction and transformation of postmining brownfields for tourism can be found in, e.g., the Czech Republic (Podkrušnohorie, Ostrava, Český Krumlov), Poland (Wieliczka, Bochnia), Slovakia (Banská Štiavnica, Kremnica), and Hungary (Sajgótarján). In the postsocialist countries, mainly due to the lack of funding, various regional nonprofit organizations are currently making efforts to transform postmining brownfields with minimal adjustments and financial costs for secondary use in tourism. Such localities can be found in, e.g., Slovakia (Handlová, Gelnica, Novoveská Huta, and many others) and the Czech Republic (Hromnické Jezírko in the Pilsen region, Quarries Mořina in Central Bohemia).

Given the understanding of the term "brownfields" in the postsocialist countries, especially with regard to methodological identification, evaluation, and secondary use possibilities, it is more accurate to understand this term in the sense of "brownfallow."

For densely populated Western European countries with high economic potential, such as the United Kingdom, the Benelux countries, France, Germany, and Austria, the development aspect of these abandoned areas, buildings, or entire brownfield sites of various origins, in the form of their secondary (economically beneficial) use, is the priority, regardless of their ecological burden [19].

Countries in Europe with low population density and high competitiveness have different perspectives on brownfields, focusing on tackling environmental pressures with potential risks to human health, especially in urban areas. These countries consider brownfields as degraded or contaminated areas (ecological burdens). Examples of this trend are the northern European countries, such as Denmark, Finland, Sweden, and Norway [10].

## 2. Aims and Hypotheses

Devastated abandoned mining areas—mining brownfields—have become a frequent destination for organized and individual tourists in the last two decades in Slovakia. Specialized excursions of university students to these locations are also increasing. As a state located in the Western Carpathians, Slovakia has a vibrant mining past; it was one of the most important mining centers in the world during the Middle Ages and early modern times. Even in the 20th century, there were several mining plants in Slovakia. At present, these areas have been abandoned and represent a vast potential for the development of tourism in mining brownfields.

This research paper aims to identify and make a list/database of secondarily used mining brownfields for tourism or mining tourism purposes in Slovakia (after adaptation). Another objective is to suggest a definition of mining brownfields based on literary sources and our research in the Western Carpathian region. Furthermore, we aim to analyze the possibilities for secondary use and the sustainability of mining brownfields (abandoned mines) in tourism, specifically in mining tourism, based on data obtained through a questionnaire survey conducted among geotourism and tourism university students. The research sample (students) was chosen deliberately in order to study their views as future experts who will solve the issue (revitalization of mining brownfields in tourism) in practice.

The definition of hypotheses, their subsequent verification, and the setting of objectives and devising of methodology were also preconditions of successful research in this study. We formulated hypotheses as conditional statements concerning the relationship between potential (professionally educated) participants in mining brownfields tourism and qualitative and quantitative characteristics or properties of the mining brownfields themselves. We also examined the respondents' levels of knowledge and opinions on the potential and attractiveness of mining brownfields in the development of tourism. These were the prerequisites for verifying the necessary connections between the studied phenomena and mining brownfields tourism processes [20].

We formulated the following research hypotheses by analyzing the possibilities of mining brownfields secondary use in tourism:

**Hypothesis 1.** *We assume that most respondents are familiar with the term "brownfield" and have already visited such an object or area in the past, with most respondents considering mining brownfields as extralocal elements in the landscape that have a visually negative effect and an adverse impact on all parts of the landscape.*

**Hypothesis 2.** *We assume that most respondents are not afraid of environmental disasters or safety risks concerning mining brownfields, provided that they are adequately secured and monitored.*

**Hypothesis 3.** *We assume that most respondents consider the mining brownfield object as suitable for mining tourism. The respondents prefer installing information boards, marked sidewalks, and professional guidance in the given locality.*

**Hypothesis 4.** *We assume that most respondents would revitalize mining objects of brownfields for mining tourism with minimal economic costs to preserve their natural and original features and appearance to secure their long-term use and sustainable operation or attendance.*

## 3. Materials and Methods

The methodological procedures and methods of research and elaboration of the study were divided into several directly related and parallel-implemented steps or stages, which systematically led to the fulfillment of the research objective and the processing of its results into an original scientific work (Figure 2).

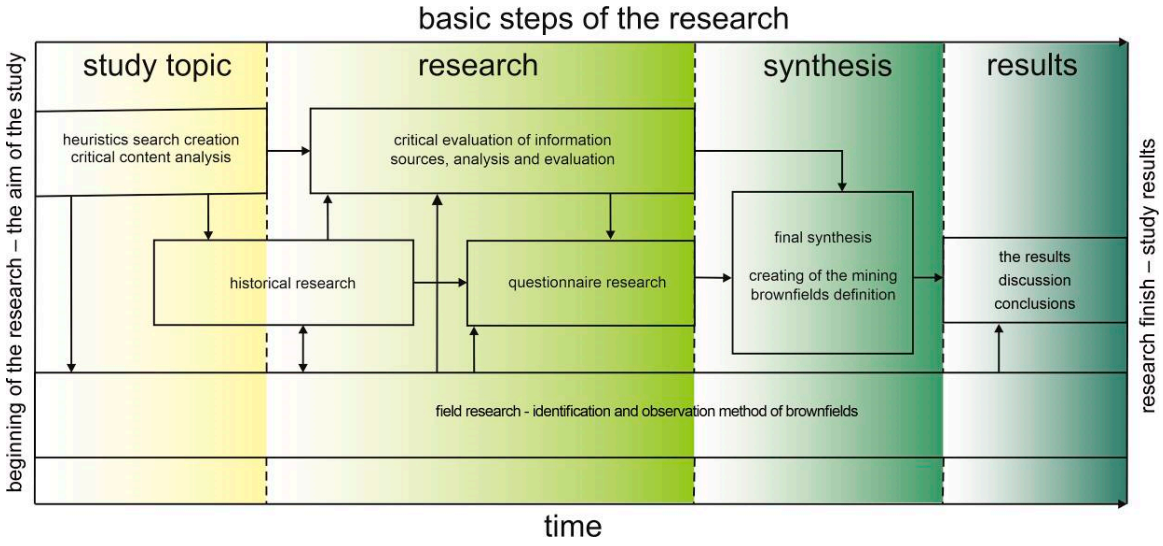


**Figure 2.** Schematic representation of theoretical and methodological procedures of the research and work (source: authors' research).

The heuristics of the information database, specifically the critical content analysis of literary sources [21–23] focused on brownfields in general (e.g., [5,7–9,12–14,16,18,24–27]), was the basis of the research in and elaboration of mining brownfields secondary use in (mining) tourism.

As stated in the theoretical background section, this research is not exclusively methodologically based on the works mentioned above. Theoretical and methodological procedures and results from research on mining brownfields and their secondary use applications for purposes other than tourism (e.g., [10,15,28–38]), although also those concerning mining tourism or tourism in general, were used (e.g., the recent works [6,39–41]; for more details, see the theoretical background section). Based on the study of the abovementioned studies, we conducted a search of the latest studies on the researched topic (for more details, see the references section), which we analyze in terms of content in the theoretical background section.

Historical research. An essential step in the elaboration of the topic was the use of historical research methods [42–46], especially the critical analyses of historical archival sources (reports, documents, historical maps, and plans) aimed at identifying historical mining areas (abandoned mines)—mining brownfields.

Field research. Following the historical research, we continued with comprehensive field research [47–53] focused on the identification of mining brownfields, which are secondarily used (after remediation) as targets of mining tourism, or tourism in general, in Slovakia. We have dealt with the research of mining brownfields in Slovakia in several stages since 2008. The field research ensured their subsequent inventory, mapping, and sorting according to the types of tourism concerned with mining brownfields. The resulting database was the basis for the creation of the questionnaire form. Together, the database and questionnaire formed the basis for the final elaboration of the specifics and possibilities of mining brownfields secondary use in mining tourism, or tourism in general, following the given research goals and study processing. The preparation of the authors' photo documentation was also a part of the field research. Following the results of the critical content analysis of sources from the literature and the results of historical and field research, we used a combination of a range of evaluation, comparison and synthesis methods [54] to compile a definition of mining brownfields. Our several years of research have confirmed the necessity of an interdisciplinary approach to the identification and evaluation of mining brownfields, as understood in Central Europe in the Carpathian Mountains area, and thus also in Slovakia.

Questionnaire survey. We prepared a public opinion survey in terms of the general methodology for questionnaires [20,48,55,56]. The survey consisted of 23 questions with a predetermined range of possible answers. The questions were conceived in light of this study's aim, focusing on the alternative use of mining brownfield sites, especially from the mining tourism point of view.

The survey was conducted through a selected target group (research sample) of students of geography, tourism, and geotourism at three Slovak universities during February 2020. The testing subjects were: graduates of the study program Geography, specifically the subject Geography of Tourism in the Department of Geography and Geology of the Faculty of Natural Sciences, Matej Bel University (UMB) in Banská Bystrica; students of the study program Geotourism from the Department of Geo- and Mining Tourism, Institute of Earth Resources, Faculty of Faculty of Mining, Ecology, Process Control and Geotechnologies, Technical University in Košice; and students of the Geography and Applied Geoinformatics program, the subject Geography Tourism, from the Department of Geography and Applied Geoinformatics, Faculty of Humanities and Natural Sciences, University of Prešov (PU). A total of 138 students took part in the research: 32 students from the UMB in Banská Bystrica, 65 students from the Technical University in Košice, and 41 students from the PU in Prešov.

Respondents (students) completed a route through at least three postmining brownfields secondarily used in tourism. The questionnaire survey for the purposes of the research was carried out in full compliance with the rules of the questionnaire survey and public opinion survey and the applicable rules of the GDPR. The results of the public opinion survey were then analyzed, recalculated, rounded to a percentage, and evaluated in terms of hypothesis verification.

The public opinion survey (the wording of questions and the predefined range of answers). The questionnaire's items represented so-called closed questions in terms of typology [20], for which the respondent chose one of the offered alternatives. The vast majority of questions were also of the scaled items type, for which the respondents evaluated the selected aspect by choosing an answer from a range between the most favorable option and the most negative one, or vice versa. The advantages of closed items are their high reliability and relatively easy statistical evaluation. Semiclosed questions or open questions offer alternatives to the predefined options. Free answers from respondents would not allow us to achieve a specific goal and obtain answers to the established hypotheses (Figure A1).

## 4. Theoretical Background

The term "brownfield" was initially an urbanistic term referring to sites, especially in urban areas, that were used for industrial or commercial purposes in the past. These areas could be contaminated with hazardous waste and polluted by environmental burdens in many cases. Later, this term acquired another, much broader meaning in which it applies to all factory (industrial) areas, including their historical facilities. At present, all abandoned sites are understood as brownfields—urban, industrial, mining, agrarian, military, transport, and others. The opposite of the term "brownfield" is the term "greenfield," used in urbanism when a newly built building is built on an empty, or minimally built-up, plot of land, i.e., on a green field [16,27].

One of the first detailed definitions of brownfields was established in 2000. It was based on the government policy of the UK. A brownfield was understood to be any land or space previously used or developed and not fully used currently, although it may be partially used. It can also be empty, abandoned, or contaminated [24].

As spaces in urban areas, brownfields are also linked to another definition, which defines them as land and buildings in urban areas that lost their original function during the development of the settlement or are only little used nowadays. They often include (or are assumed to include) environmental burdens and devastated residential, industrial, and other buildings. They have adverse economic and visual effects on their surroundings [25] (Table 1).

According to Kadeřábková and Piecha et al. [26], we can generally describe brownfields as areas that are losing or have already lost their original functional use. They are usually located near settlements (in the center or on the outskirts; exceptionally, outside it), extend over a large area, and are mostly bearers of environmental burden. These are mainly former industrial areas or land damaged by the extraction of minerals, including abandoned military, agricultural, or transport areas, and other genetically similar areas.

Brownfields are highly heterogeneous and their categorization may therefore not always be clear and unambiguous. In principle, they can be divided using several evaluation attributes, according to which these objects can be classified into individual categories. The most unambiguous criterion and the most used in many fields and practices is the division based on previous (original) use, e.g., residential, agricultural, industrial, transport, mining, military, and similar [18]. These brownfields represent one of the main components of the industrial heritage and thus also one of the main destinations of postindustrial tourism.

Due to the wide potential within the postindustrial heritage, mining brownfields can be considered as the main tourist destinations of mining tourism. However, their use in postindustrial tourism was not the aim of our study.

> *We can state that post-industrial tourism is understood more broadly than mining tourism, which also follows from the conclusions of the World Tourism Organization (https://www.unwto.org/) and also from the works of other authors researching the issue, e.g., Stašáková and Kulla [57], C. Schejbal [58,59], J. Jelen [60].*

### *4.1. Mining (Postmining) Brownfields*

Mining brownfields are the most extensive, significant, and numerous brownfields in the landscape of Slovakia [61]. The rich mining past of Slovakia accounts for their number and significant areal expansion. It is encyclopedically elaborated in a two-volume work dealing with the history of mining in Slovakia [62,63] and in the comprehensive map entitled "Old mining works and Recent mining works in Slovakia", compiled by the State Geological Institute of Dionýz Štúr in Bratislava [64]. The importance of the ecological and economic problem related to brownfields in Slovakia, including mines located in the open landscape, was pointed out by Finka and Jamečný [65].

Based on our research (and literature analysis), we can define mining brownfields (in the Central European understanding) as old mining and related activities areas, areas and objects in the landscape

(in urban areas to a lesser extent) that remained abandoned after the end of mining, thus losing their original use and gradually decaying (Figure 3). If these mining brownfields are already secondarily used, e.g., in tourism, then we use the term "postmining brownfields" for their designation, following the results of the research by Krzysztofik, Runge, and Kantor-Pietraga published in 2013 [32].

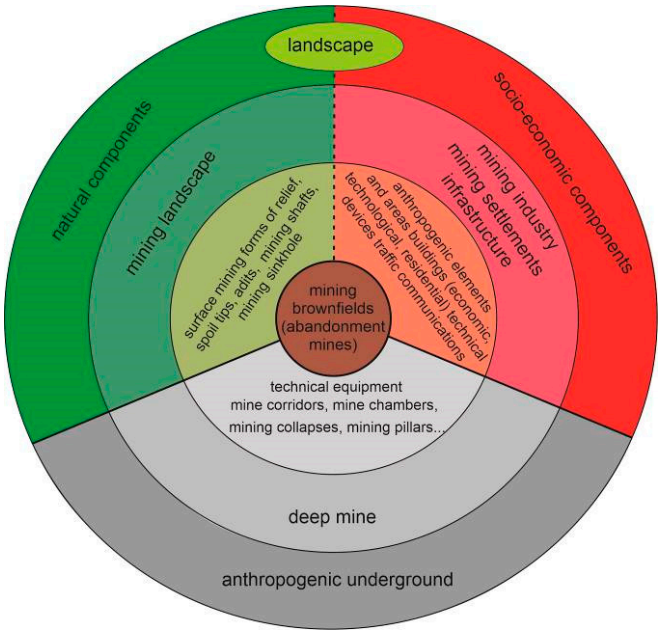


**Figure 3.** Basic qualitative and quantitative characteristics determining the content form of the definition of (mining) brownfields in Slovakia from the point of view of a broad historical-geographical and montanistic approach to landscape perception (source: authors' research).

These areas are often associated with real or perceived contamination of the landscape and the environment. Devastated and dangerous buildings or various construction objects and facilities (e.g., administrative or residential buildings or technical objects, processing facilities, warehouses, concrete structures, roads) are typical of mining brownfields. Anthropogenic mining forms of relief (surface or subsurface), created either directly during the extraction of minerals or which arose in response to the extraction of minerals, are an integral part of mining brownfields. Typical surface anthropogenic mining forms of relief include heaps, sinkholes, pings, old tunnels and shafts, and sludge ponds, to which unsecured freely accessible underground mining is connected. Therefore, their revitalization in terms of re-use for purposes other than the extraction (or processing) of minerals is necessary. Revitalization of these sites brings new economic uses, including tourism, and several positive factors, such as removing (presumed) environmental burdens, increasing the aesthetic value of the landscape, creating new spaces for construction, creating new jobs, and developing local (rural) communities.

### *4.2. Mining Tourism*

Mining tourism represents a relatively new form of tourism combined with adventure and adrenaline experiences and a new visual perception (human-made or conditioned) of the mining landscape, but especially of underground and mining technology. The participants in mining tourism create experiences based on a combination of their own experience or knowledge and the perception of the visited mining site, city or region, or mining museum, which do not necessarily have to be out of operation. The tourist gets to know historical (but also contemporary) material objects—mining facilities, buildings, tools, relief relics, and similar—through direct contact (touch), but also the intangible specifics through immediate sensory perception—mining technologies, methods of raw materials processing, traditions, personalities.

The first more detailed definition of mining tourism came from Pavol Rybár: "Mining tourism is a form of adventure tourism, where the presence of a tourist in underground mining areas provides him with new feelings and sensations. Mining tourism is defined as a phenomenon describing unique mining machinery and facilities, enabling exploration of the underground spaces with specific abiotic and biotic components, allowing one to admire the cultural heritage linked to historical mining, which is opened to the general and professional public" [66]. The work of Rybár and Hronček also provided an extended but very similar definition in terms of content [67]. Hronček and Gregorová and their team [68], in their analyses of virtual mining tourism, also based their research on this definition.

Another definition provides a much more general view of mining tourism: "Mining tourism brings together the aspects of industrial, technological, cultural and ethnographic heritage into a cognitive-educational-experience oriented form of tourism" [69]. A similar view was offered by Rózycki and Dryglas: "Mining tourism is any form of tourist activity in industrial sites, technological sites, and industrial heritage sites. Most frequently, these sites are carefully prepared as tourism products" [70].

The authors Costa and Santos understand mining tourism as the product of geological heritage (which is a working object of geotourism) and industrial heritage (which is a working object of industrial tourism) [71]. A basic explanation of the interest of mining tourism (some authors use the term "montane tourism") has been given in many publications [72–77].

### *4.3. Revitalization of Postmining Brownfields for (Mining) Tourism*

Theoretical-methodological issues of postmining brownfields secondary use (mining of devastated areas and abandoned mines) after revitalization and commercial re-use in practice in other economic areas are addressed by, e.g., [15,38,78–84].

The revitalization of postmining brownfields for tourism or mining tourism has been addressed in Germany [85,86], Italy [39,40], the Czech Republic [18,87], Slovakia [6,61], Romania [88], Poland [84,89–91], and Australia [92].

Baczyńska et al. [93] have researched postmining brownfields resulting from surface stone quarrying and their secondary use in tourism in Poland, the United Kingdom, and Austria. Similar issues in Poland have been partially addressed in the works of [94,95].

Łacny et al. [41] studied abandoned mining degraded areas (brownfields), the possibilities of their secondary use in tourism (mining tourism), and their comparison in the territories of two countries, using the examples of postmining brownfields in cities in Poland and Vietnam. The work of Dias et al. [96] dealt with this issue using the examples of Portugal and Estonia.

Interesting solutions for the use of ancient mercury mines, currently used as historical brownfields in mining tourism, are provided in some studies, e.g., works dealing with the ancient mercury mines of Almadén-Idrija in Spain [97–99], which were designated in a UNESCO World Heritage list. Scientific communities from various scientific fields worldwide have also dealt with the specific secondary uses of postmining brownfields in economic areas other than tourism. The restoration of the original land devastated by mining to the original or quasi-original land that was present at the sites before the start of mining is the main issue. Restoration is possible through planting of the original vegetation (afforestation) and recultivation into agricultural, lake, or park landscapes, or other cultural landscapes. There are a large number of studies on this topic, e.g., from the Czech Republic [18,87], Poland [31,32], Romania [36], Spain [100], Italy [101], Canada [30], the USA [33,35], Canada and Brazil [102], Australia [34] and China [28,29,37,103].

The sustainability of mining brownfields is an essential issue following the revitalization of postmining brownfields for secondary use, including tourism. This phenomenon has been addressed by, e.g., [15,79,104–106].

## 5. Results

We included the created definition of mining brownfields in the theoretical background section because we had to define this term precisely as the first step in using and applying the methodological procedures leading to the fulfillment of the study's goal. In elaborating the definition, we relied on a critical evaluation of the latest scientific sources, but also, above all, on our field research (Figure A2).

Based on field research, we were able to identify two types of mining brownfields in terms of the in situ preservation of their original infrastructure, technical buildings, and terrain relics. For the first type, the definition of which is based on the fundamental understanding of brownfields in urbanism as abandoned areas in an urban environment, the dominant relics included surface buildings; administrative, residential, technical, and various other objects; processing facilities, warehouses; and other similar buildings, including their underground facilities. Many authors have dealt with the identification of secondary use possibilities for this type of brownfield, e.g., [18,19,26,107]. The relics of an individual underground mine may be secondary even though they are located in the area. These mining brownfields are mostly from the more recent period, representing abandoned mining plants built in recent decades.

The second type was represented by postmining brownfields of older provenance, often from the medieval period. Many for which large parts of the surface and subsurface parts of the original plants have been preserved have been rebuilt into mining museums (e.g., Banská Štiavnica in Slovakia, Hallstatt in Austria, Kutná Hora in the Czech Republic, Wieliczka in Poland and many others), which belong to the world cultural mining heritage. Many historical mining sites are already in such a stage of degradation that only a minimum of construction elements can be preserved from surface plants, while the surrounding landscape is significantly dominated by relief surface and subsurface mining shapes. There are currently several sites of this character in Slovakia. Their revitalization and restoration of mining attractions (water-powered ore crushers, trip hammers, various technological processes, tunnel portals) transform them into new destinations for mining tourism. In Slovakia, we can mention, as examples of these sites, the surroundings of Špania Dolina, Ľubietová, Gelnice, Smolník, and many others. Mining geomorphology [108] and mining archeology [109] are necessary to identify and research mining brownfields of this nature.

Postmining brownfields as tourist destinations were divided into brownfields modified by remediation for mining tourism and those modified for other types of tourism, according to the types of tourism realized at the sites.

Research on brownfields in Slovakia was implemented regionally, but in accordance with the basic priorities and references valid for the research of industrial heritage focused on the European geographical area, the basic rules of which were drawn up in Nizhny Tagil, Russia.

> *This document briefly summarizes the importance of industrial (including minning) heritage, at the same time draws attention to its social values and defines the main priorities and ways of its protection, preservation and secondary use.* [110]

### *5.1. Mining Brownfields in (Mining) Tourism in Slovakia*

With the term "mining brownfields", we refer to mining sites created in recent decades and historical mining landscape structures, including medieval and modern abandoned mines (historical mining brownfields), which are currently very attractive and encountering a significant increase of interest in their exploration. As a part of historical mining heritage, historical mining brownfields are becoming increasingly common objects of both organized and unorganized (mining) tourism. However, it is clear that these objects, including those objects from the 20th century, must first be adapted to serve for tourist and recreational purposes.

Revitalization adjustments should be carried out with particular caution, as these brownfield sites usually have a very high cultural, technical, or natural potential. If properly transformed, they have

the potential to significantly increase interest in the currently most economically backward regions of countries.

Therefore, the revitalization process requires the cooperation of several experts from different fields, e.g., montanists, environmental engineers, landscape architects, tourism experts, economists, geologists, urban planners, architects, biologists, and forest and agricultural engineers. Such a wide range of professionals need to be coordinated with each other, but their efforts should also be coordinated with the local people living in the area, taking their requirements and expectations into account [15].

We have dealt with the research and mapping of mining brownfields in Slovakia in several stages since 2008 (Figure A2), with the partial results published in several scientific works. Surface mining (quarries) was the subject of the research (e.g., [111–116]), together with wild, old, abandoned mines (e.g., [117–123]). As a result of our research and analysis of the web platform Old mining works and Recent mining works in Slovakia, compiled by the State Geological Institute of Dionýz Štúr in Bratislava [64], a preliminary database of mining historical brownfields was compiled (abandoned mines and open pits), but also including mining brownfields created in the 20th century (research and mapping are still not completed for these brownfields). At present, the number of identified old (abandoned) mining locations (which can be identified as mining brownfields) is around 20,000. Our research of surface mining (pits), completed in 2018, has determined the number of these locations, which can also be identified as mining brownfields, in Slovakia as 11,359 [116].

Only selected examples, from a wide range of objects, that can be described as essential tourist attractions with high attractiveness or cognitive and didactic value are presented here. Also, they must have an impact on the level of the local or regional economy and its sustainability.

The sites in Slovakia are often adapted to the conditions of tourism spontaneously without modifications (recultivation), or the modifications are carried out with only minimal inputs, including economic ones (Figure 4).

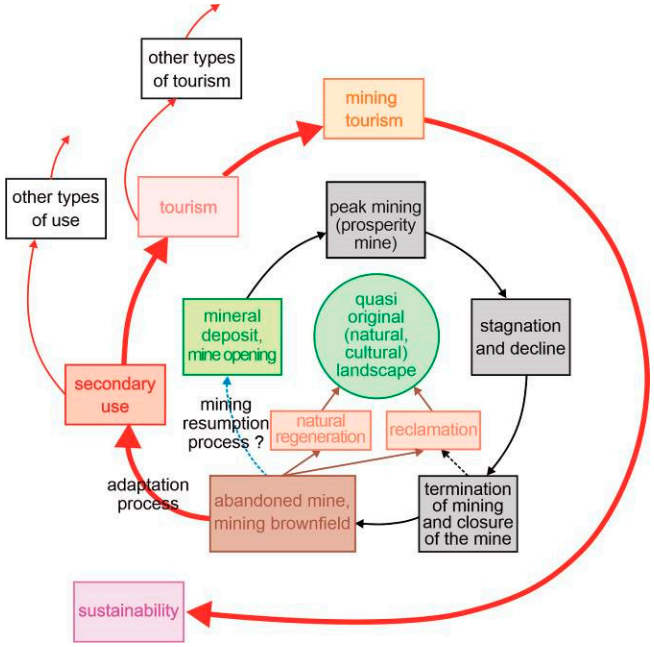


**Figure 4.** Graphical representation of mining and postmining brownfield transformation process for the secondary use of sites in tourism (source: authors' research).

Based on our research, we divided the remediation of mining brownfields for mining tourism into four stages according to the extent of recultivation or adaptation adjustments. We relied on a proven and often used methodical classification of the agricultural landscape in Slovakia based on

its historical development through anthropogenic transformation. However, each historical period has given it a specific character, which is why the created phenomena of the cultural landscape are different. The cultural landscape can be understood as a material reality, resulting from the constant impact of man and his activities on the natural landscape [124]. In our case, the cultural landscape is represented by the mining landscape, abandoned mines, and mining brownfields (Figure 5).

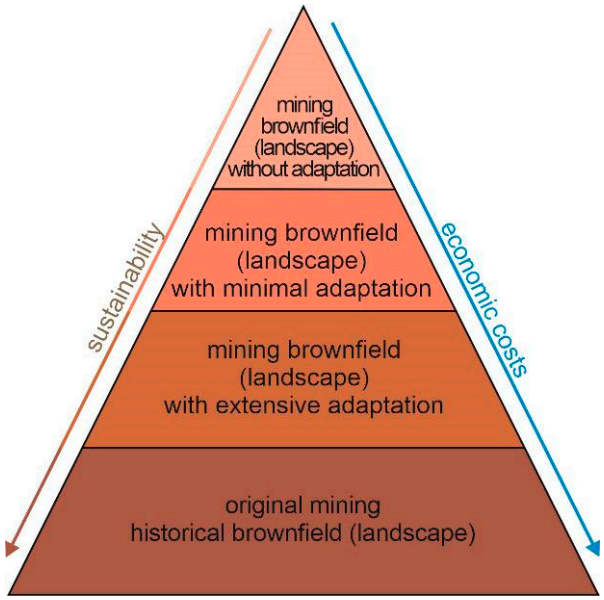


**Figure 5.** Relation of the extent of mining brownfield adaptations towards sustainability.

Use of mining brownfields (mining) without adaptation for mining tourism, including mining landscapes with relics (especially relief relics) without any secondary interventions. Access to these sites is through natural, free-walking trails, with uncontrolled entry of tourists—that is, unorganized (individual) tourism (often on the edge of the law)—for instance, in Rejdová, Lovinobaňa, Stredné Plachtince, Jasenie, Medzibrod, Bacúch, Čierny Balog, Hronec, Mýto pod Ďumbierom, or Bystrá. Many of these sites are located in protected areas and national parks.

Minimal adaptations of mining brownfields (land) for mining tourism purposes. These are the most frequent and economically most accessible modifications of the mining landscape—that is, mining brownfields in Slovakia accessed through modified mining trails marked with accompanying information boards. We have dealt with educational mining trails, including their analysis and methodological descriptions of the creation of information panels, in separate research [125]. Mining trails with information boards and with original architectural and relief monuments relics are located in, e.g., Špania Dolina, Kremnica, Nová Baňa, Hnilčík, Zlatá Ida, Pezinok, Ľubietová, Pukanec, and Banská Štiavnica. Dozens of mining-oriented trails have been built in Slovakia today.

Extensive adaptations of mining brownfields (land) for mining tourism. These include mining trails with reconstructions (replicas) of technical facilities and tunnels in situ, e.g., in Čučma, Gelnica (part of Turzov), Ľubietová–Podlipa, and elsewhere. Open-air mining museums in mining settlements that are not in their original locations, e.g., in Košické Hámre, Štiavnička, and elsewhere, are a particular group of this type.

Original-historical objects (underground and surface) adapted to the needs of mining tourism. These are represented by open-air mining museums, e.g., in Banská Štiavnica, Kremnica, Banská Hodruša, Dubník, etc.

Mining brownfields used and adapted for other types of tourism (these were not the objects of this study, so we will only mention them as part of the overview). Slovakia is a country without natural lakes that could be used for recreational purposes. Therefore, this function has been taken over by large gravel pits, sandpits, or quarries filled with water, which are used for water recreation and sports.

This type of tourism can be divided into organized and spontaneous forms. The first uses official swimming pools, e.g., in Veľké and Malé Leváre, Kuchajda, Štrkovec, Zlaté piesky, Kalné jazero in Bratislava, Slnečné jazerá near Senec, Čaňa near Košice, Jazero in Košice, and many others. Spontaneous water tourism is carried out at the participants' own risk in several water-filled mines or quarries, the most famous of which include Šútovo-Rieka, Beňatiná, Devičie, Šiatorská Bukovina, Veliká nad Ipľom, and others).

Adrenaline sports are an exciting and sought-after phenomenon. Here we can include climbing walls in the quarries in Tatranská Kotlina, Bystrička near Kraľovany, Bratislava—Dúbravka, Borinka, Hrádok—those near Kamenec pod Vtáčnikom, and many others. We should also mention the motocross and autocross tracks in abandoned clay pits near old brickyards located in Senec, Pezinok, Veľký Klíž, Trnava and Šenkvice, as well as bike trails, e.g., in the sandpit at Jasenie.

Many postmining brownfield recreation zones, which became parts of urban areas due to urban sprawl, are used for suburban recreation after their reclamation, e.g., the Urpín sightseeing route and recreation zone in Banská Bystrica, the former brown coal quarry Konštantín in Handlová, the quarry Turecké studne in Krupina, and other similar sites. Many of these sites have remained only in the project documentation stage, such as the recultivation of the quarry Kostiviarska in Banská Bystrica, which was to be transformed into an extensive urban recreation, sports and cultural center connected to a large park.

We have also identified the religious use of postmining brownfields. The most famous object is the Church of Our Lady of the Snows, built in a medieval quarry used for construction stone quarrying in Bratislava (the capital of Slovakia) for several centuries.

Also, we must not forget to mention scientific or cognitive tourism. One essential fact is that after the opening of the earth's crust through mining, the location automatically becomes a geological site, which in combination with other phenomena (e.g., archaeological findings, mineral findings, the opening of caves, opening of impressive geological structures) can lead it to become an exciting and sought-after tourist destination. Many sites of this kind are small protected areas, often of supranational importance as significant anthropogenic geosites (e.g., the quarry Sandberg in Devínska Kobyla, the quarry Megoňky in Kysuce, or the basalt waterfall in Cerová vrchovina, among many others).

### *5.2. Questionnaire Survey*

Based on the questionnaire survey (Figure A1), we can state that approximately 67% of respondents knew how to define the term "brownfield." For the most significant number (63%), a brownfield represented unused and abandoned industrial areas. For 56% respondents, the term referred to abandoned and unused areas that are exceptionally environmentally burdened or affected by a catastrophic event—e.g., the Chernobyl complex. As many as three-quarters of respondents considered brownfields as areas with terminated mining activities, and 36% had not yet visited such areas. The visual perception of mining brownfields was interesting. Most respondents (49%) perceived these objects negatively and depressively as foreign elements in the landscape. At the same time, up to 46% of them understood these objects as a natural part of the landscape after intensive anthropogenic activity. As many as 67% of respondents assessed the security state of mining brownfields sites as unsatisfactory. The majority of respondents (56%) expected a slightly negative impact of these objects on the state of the environment and human or animal health. According to 57% of respondents, these areas represented risks of potential outbreaks of environmental catastrophes due to insufficient security. Almost half of the respondents (49%) would be very annoyed to live permanently within a distance of about 5 km from such areas, and approximately the same number (47%) would not mind living within such a distance if these objects were adequately secured and monitored. Only 4% of respondents lived within such a distance at the time of the questionnaire. Regular monitoring of these sites is the primary role of the competent authorities, according to 31% of respondents. Approximately 75% of the respondents thought that these objects were suitable locations for geotourism (tourism). They considered it beneficial for the sustainable development of these sites to set up orientation and

information boards, mark tourist trails, and have professional guides accompany tourists. At the same time, up to 60% of the interviewed students thought that the sustainability of mining brownfields could be ensured without high economic costs, even from a long-term (more than five years) point of view (49% respondents). Given that the respondents were young people (under the age of 25), up to 57% of them perceived the Internet and social networks as the most appropriate types of information and communication tools to ensure sustainable promotion and attendance of brownfields (abandoned mines). This fact was also confirmed in similarly focused research on abandoned old mining sites assessing the possibilities of their use in virtual mining tourism (Figure 6) [68].

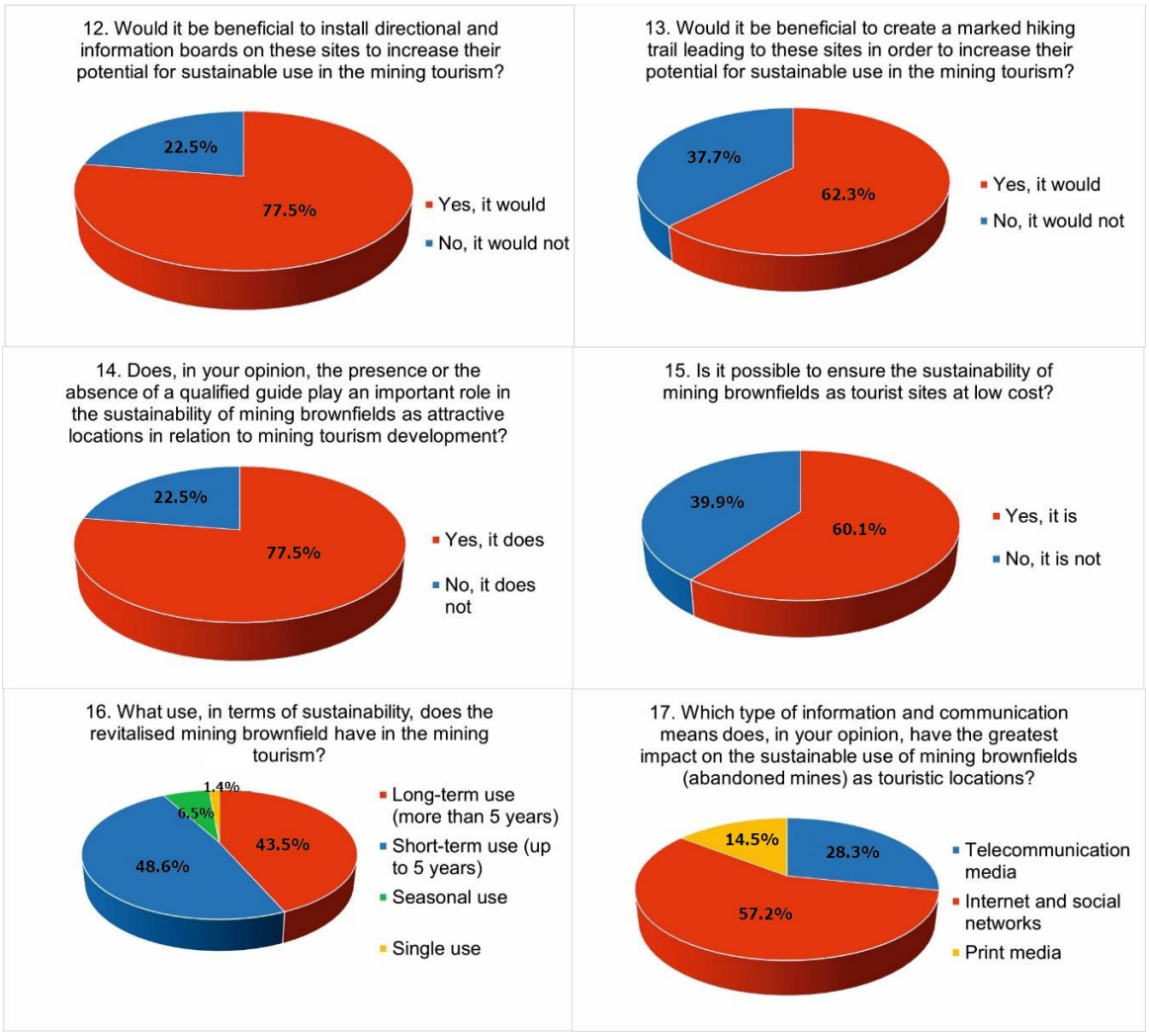


**Figure 6.** Examples of respondents' answers to questions from the questionnaire survey concerning the sustainability of mining tourism.

## 6. Discussion

Mining or postmining brownfields are often located in or close to attractive tourist destinations and interact with their existing primary, secondary, and tertiary tourism offers. In many cases, they represent high historical, architectural, or urban values and are part of the cultural and technical heritage [126]. e.g., Špania Dolina, Solivar, Kutná Hora, Stříbro, and other sites. They can make specific tourist destinations significantly more attractive if treated with the appropriate revitalization or reconstruction. On the contrary, they can also have a significant adverse effect, as they significantly reduce the value and image of the surrounding landscape, which reduces its attractiveness not only for investors but also for tourists [5].

Therefore, their revitalization for tourism is the logical starting point [127]. If these spaces were re-used, the potential for the development of new tourist destinations would be created, which would be reflected in the improved quality of the environment and the creation of new jobs, new facilities providing various services in tourism, and new infrastructure. The origin and development of tourist destinations based on mining brownfields conditions the expansion of accommodation, catering, entertainment, and other recreational facilities. In general, mining brownfields are vital territorial reserves with the potential to contribute to the development and creation of new, specifically targeted tourist destinations [128].

Many peculiarities and obstacles accompany the re-use of mining brownfields for tourism. First of all, there is the actual (perceived, potential) ecological burden to the area, which in many cases inhibits the re-use of these sites in tourism [83] and discourages many investors and future clients.

The authors' research confirms that the unmapped mining underground and its manifestations on the surface and lousy statistics on the preserved surface and underground objects, whether construction or relief, are often hidden dangers.

Therefore, a detailed field survey and documentation of these sites using the latest equipment, methodologies, and technological procedures, which is usually expensive, is necessary for the revitalization of mining brownfields. Field research and detailed reports should precede the sale of these sites to potential investors or their informal (temporary) operation. They should be temporarily or permanently closed in the absence of such expert opinions [129]. There is also interest in contaminated mining sites as part of regulated tourism [87], which may pressure competent authorities and society to decontaminate and clean such mining brownfields as soon as possible.

Another critical but negative aspect of mining brownfields revitalization is the unfortunate social situation of the given area in relation to sociopathological phenomena [130] and the inadaptable population in these localities in the eastern part of Slovakia (Spiš, Gemer, Malohont). Many brownfields with excellent potential for the development of (mining) tourism receive a negative response at the local, regional, but also national level, regardless of the actual or only perceived (environmental or social) risks [78].

A methodically correct adaptation and reconstruction of mining brownfields or abandoned mines for tourism is one vital and irreplaceable step in the development of mining tourism. Costa and Santos [71] describe a natural and logical sequence of transformation from an active mining plant to a tourist destination in three steps: 1. operation of mine; 2. interruption of mining activities and mine closure; 3. adaptation of the mine to mining tourism [60,70,71,73]. These authors see the future of mining tourism in the creation of thematic "mining" parks by adapting mining brownfields or abandoned mines based on the models of geothermal parks, geoparks, or various cultural parks.

As for the unused historical mining sites with almost no touristic attractions and flooded or inaccessible underground spaces, there is plenty of room for revitalization through the development of computer modeling and visualization (surface and subsurface) and technical facilities and processes. Creation, protection, and presentation of digital mining heritage [125] play an irreplaceable role in this modern trend in mining tourism.

The research goals elaborated in this paper were fulfilled by the database of postmining brownfields secondarily (after adaptation) used for mining tourism, or tourism (in general) in Slovakia, as described in the results section. We identified these brownfields in situ using historical and field research. They were included in the database divided into four groups according to the extent of secondary interventions (adaptations) necessary for their use in mining tourism: 1. use of mining brownfields (landscape) for mining tourism without adaptation; 2. minimal adaptations of mining brownfields (landscape) for mining tourism; 3. extensive adaptations of mining brownfields (landscape) for mining tourism; and 4. original-historical objects (underground and above ground) adapted for the needs of mining tourism. The database was enhanced by including basic mining brownfields used in other types of tourism. Based on sources from the literature and our research, we created a comprehensive definition of mining brownfields in terms of the Central European understanding of this concept, which became the starting conceptualization element for the study, as presented in the theoretical background section.

The second objective of the study was to analyze the possibilities of the secondary use and sustainability of mining brownfields (abandoned mines) in tourism, specifically in mining tourism, using a questionnaire survey conducted among geotourism and tourism students. The results were processed both statistically and graphically and the research hypotheses were finally verbally confirmed or refuted.

For the first hypothesis, it was clear that the respondents were familiar with the concept of brownfields, or mining brownfields, and had already visited such objects, but especially in connection with their professional education. The majority (67) replied that such an object was a foreign element in the landscape and had a visually negative effect, with an adverse impact on all landscape components. This statement was valid only for mining brownfields without adaptations or with only minimal adjustments for mining tourism. On the contrary, after extensive secondary modifications and revitalization, mining brownfields have a markedly positive aesthetic effect on the landscape and do not necessarily resemble the initially devastated mining landscape (e.g., lake landscapes, ecologically modified landscapes, revitalizations of the original cultural landscape, and others). Sixty-three respondents agreed with this statement.

For the second hypothesis, we evaluated that 78 respondents were concerned about environmental disaster, specifically with regard to safety risks in mining brownfields without sufficient security and monitoring. While this is the most common type of brownfield in Slovakia (without or with only minimal adaptations), it can be assumed that their attractiveness and adrenaline elements connected with the potential danger will allow their sustainability for (mining) tourism despite the given specifics.

Respondents considered mining brownfields suitable for mining tourism (with regard to the third hypothesis), particularly after they are equipped with information boards, accessible by marked trails and qualified guides, or equipped with the necessary tourist infrastructure.

The majority of respondents (60%) would revitalize brownfields for mining tourism with minimal economic costs to preserve their specific original features and appearance and enable long-term use and sustainable operation or attendance.

We have succeeded in confirming all the hypotheses set out at the beginning of the research, except the second one.

*The Position of Mining Brownfields in Mining Tourism, the Tourism Industry, and Their Sustainability*

The re-use of mining brownfields for mining tourism (Figure A3) should be conducted very carefully, using all available scientific evidence and conclusions. Such sites are often contaminated and remediation interventions are crucial given the risks associated with existing infrastructure and the local population. Another essential aspect of mining brownfield reclamation is their sustainability not only in terms of society's interests but also in terms of the interests of residents [87]. The main goal of the revitalization of mining brownfields for mining tourism is to regain ecological, economic, and aesthetic values from abandoned (degraded, unused) localities to secure their further sustainability [87].

Our research has shown that the emergence of mining brownfields has several stages (Figure 4). The processes leading to the mine's opening can be considered the first step towards the emergence of mining brownfields (geological survey, construction of surface and underground infrastructure, the opening of the underground and the beginning of mining). Next, the mine is in operation (mining), reaches the peak of mining prosperity, then declines and closes, at which point it becomes abandoned (surface and subsurface operations). The last stage is the decay of the abandoned mine, which leads to the emergence of mining brownfields (in the sense of previously mentioned definitions).

After the creation of the postmining brownfield, its further development may, according to the life cycle methodology [15], lead into a closed circle if the mine is put back into operation, i.e., if mining is resumed; for example, after the introduction of new mining technologies (e.g., Pezinok, Špania Dolina, Smolník, and Merník). A more frequent case is when the development of a mining brownfield leads to an open development curve, i.e., to a secondary use or extinction. Extinction can take place over a long period of natural recultivation or can be a matter of brief periods after reclamation (e.g., Veľký Krtíš, partly Ružiná or Lovinobaňa).

Detailed research, mapping and assessment of health risks, pollution, and hazards are necessary for the secondary use of postmining brownfields. Proposals for their secondary use (e.g., agriculture, lake landscape, park, cultural institution, recultivation leading to the revitalization of the original landscape, sports facilities, and others) can be made only after complete research has been conducted by a wide range of experts and expert opinions and documentation have been processed. Currently, a new trend is their use after adaptations for mining tourism.

Revitalized brownfields must meet several basic principles or dimensions applied to mining tourism in terms of methodology [131] in order to be sustainable for mining tourism or other types of tourism (Figures 7 and A3 and Figure 8).

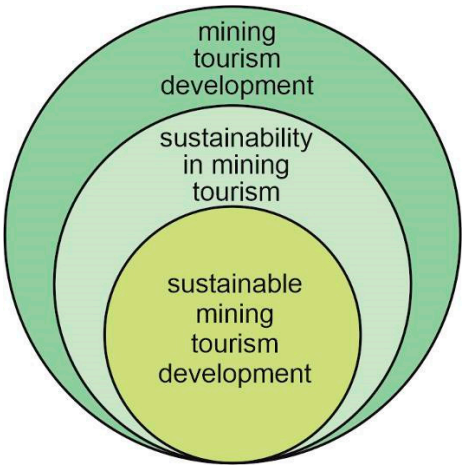


**Figure 7.** Conceptualizing sustainable mining tourism development (according to [125], modified by the authors).

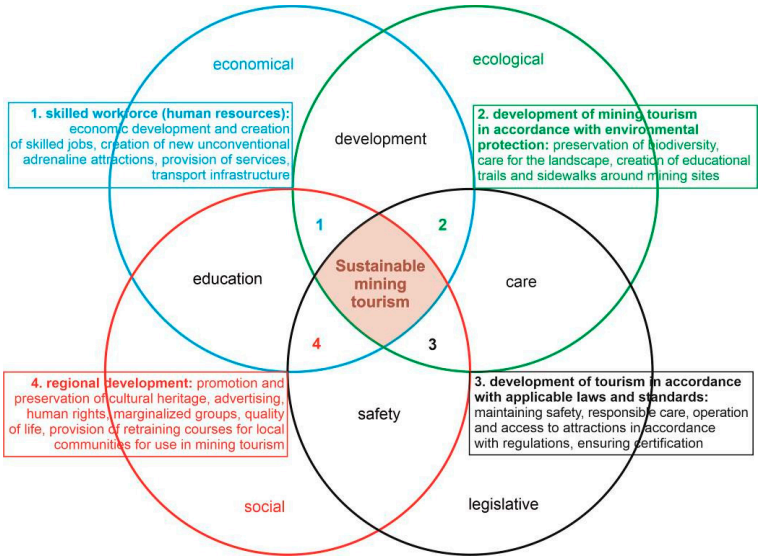


**Figure 8.** Four basic dimensions of sustainability of mining tourism (according to [124,126], created by the authors).

## 7. Conclusions

Reclamation of historical mining brownfields (abandoned mines) and those that originated in the 20th century is a complex process and requires the cooperation of various scientific disciplines. Despite the scientific nature of the problem, the most critical factors for sustainability in this process are the local communities (or the rural settlements where the mining brownfields are located). Mining brownfields in the development of mining tourism represent a hidden reserve in the development of the Slovak economy in the situation after the first wave of the SARS-CoV-2 pandemic. We must understand them as potential tools for further regional development in accordance with the local communities of the poorest regions of Slovakia.

Problems related to the further development of mining brownfields have been solved separately in Slovakia so far and only marginally within other sectorial operational programs because their formation is associated with the restructuring of the Slovak economy and the subsequent termination of mining activities. Therefore, state intervention is necessary to support intensive development [132–134]. The problem of mining brownfield transformation for tourism conditions requires a systemic approach to their definition and evaluation, the definition of risks, and to restoration and further development, accepting the principles of sustainable development from the point of view of local (rural) communities.

We understand the use of mining brownfields for tourism on two levels. The first is in the adaptation of mining brownfields for in situ mining tourism through direct modification (or their restoration) for tourism. This classic use is currently widely found in Slovakia, and more and more tourists are heading to destinations focused on historical mining (abandoned mines and mining brownfields). However, the future of mining tourism must also be sought in shared and virtual tourism, as the crisis caused by the SARS-CoV-2 pandemic has shown in recent months. We have already pointed out the progressivity of virtual mining tourism in separate research [68].

**Author Contributions:** Conceptualization, B.G. and P.H.; methodology, B.G., P.H. and M.M.; formal analysis, D.T. and B.G.; investigation, P.H., B.G., V.Č. and M.M.; resources, D.T., V.Č., P.H., M.M. and B.G.; data curation, D.T. and M.M.; writing—original draft preparation, P.H. and B.G.; writing—review and editing, B.G., P.H., V.Č., M.M. and D.T.; visualization, B.G. and P.H.; supervision, B.G. and P.H.; project administration, B.G.; funding acquisition, B.G. All authors have read and agreed to the published version of the manuscript.

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

## Appendix A

1. Can you define the term "brownfield"?
1a) Yes, I can.
1b) No, I cannot.

2. What kind of environment or area do you understand under "brownfield"?
2a) No longer used and abandoned industrial sites.
2b) No longer used and abandoned agricultural areas and sites.
2c) No longer used and abandoned residential and administrative buildings, and shopping and cultural centers.
2d) No longer used and abandoned traffic sites and buildings.
2e) No longer used and abandoned military sites and buildings.
2f) No longer used and abandoned areas of extremely environmental burdens or affected by catastrophic events, e.g. the Chernobyl disaster.

3. Can brownfields also be considered post mining (activity) sites, e.g. extraction and mining areas, heaps, abandoned mine premises, tailings ponds, etc.?
3a) Yes, they can.
3b) I do not know.
3c) No, they cannot.

4. Have you ever visited mining brownfield regions?
4a) Yes, I have. Several times.
4b) Yes, I have. Once.
4c) No, I have not.

5. What is your visual perception of mining brownfield objects?
5a) I find them unappealing and depressive, seeing them as an element not fitting in the landscape.
5b) I consider them a natural part of the landscape created after an intensive anthropogenic activity.
5c) I find them appealing, seeing them as an interesting anthropogenic landscape element.

6. Evaluate the degree of safety of brownfield sites:
6a) The sites are safe.
6b) The site safety is not sufficient.
6c) The sites are nowhere near safe.

7. What impact, do you think, these objects have on environmental conditions and on the people and animals' health?
7a) They have a very negative impact.
7b) They have a slightly negative impact.
7c) Their impact is neither negative nor positive.

8. Do these sites represent the outbreak centres of potential environmental disasters?
8a) When secured well, they do not represent an environmental risk.
8b) When not secured well, they represent an environmental risk.
8c) Regardless of the level of security, they always represent an environmental risk.

9. Would you mind to permanently live within a distance of about 5 km from such areas?
9a) Yes I would. Very much so.
9b) No, I would not if the area were properly secured and monitored.
9c) I live in such an area.

10. What is the primary task of the stakeholders in relation to these sites?
10a) To ensure regular monitoring of the territory.
10b) To transfer site ownership from private to state hands.
10c) To use them in geotourism (tourism) and to make them part of the educational process.
10d) To rehabilitate and gradually reclaim them.
10e) To restore industrial, agricultural, mining or other activities on their premises.
10f) To prevent unauthorised access to these sites.

11. Are these sites suitable for their use in geotourism (tourism)?
11a) Yes, they are.
11b) No, they are not.

12. Would it be beneficial to install directional and information boards on these sites to increase their potential for sustainable use in the mining tourism?
12a) Yes, it would.
12b) No, it would not.

**Figure A1.** *Cont.*

13. Would it be beneficial to create a marked hiking trail leading to these sites in order to increase their potential for sustainable use in the mining tourism?
13a) Yes, it would.
13b) No, it would not.

14. Does, in your opinion, the presence or the absence of a qualified guide play an important role in the sustainability of mining brownfields as attractive locations in relation to mining tourism development?
14a) Yes, it does.
14b) No, it does not.

15. Is it possible to ensure the sustainability of mining brownfields as tourist sites at low cost?
15a) Yes, it is.
15b) No, it is not.

16. What use, in terms of sustainability, does the revitalised mining brownfield have in the mining tourism?
16a) Long-term use (more than 5 years).
16b) Short-term use (up to 5 years).
16c) Seasonal use.
16d) Single use.

17. Which type of information and communication means does, in your opinion, have the greatest impact on the sustainable use of mining brownfields (abandoned mines) as touristic locations?
17a) Telecommunication media.
17b) Internet and social networks.
17c) Print media.

18. Is it necessary to have services provided in brownfields?
18a) Yes, it is.
18b) I do not know.
18c) No, it is not.

19. If so (your answer to question 18 was 'a'), which services do you consider to be of priority?
19a) Parking, toilets, information centre.
19b) Catering facilities.
19c) Shops and other extra services (pastry shop, cafe, souvenir shop...).
19d) Amusement attractions.

20. Is it important to secure mining brownfield sites and buildings in order to keep tourists in their safe areas?
20a) Yes, it is.
20b) I do not know.
20c) No, it is not.

21. Are you aware of the potential security risks of mining brownfields (unsafe shafts, cave-ins, buildings and technical equipment)?
21a) Yes, I am.
21b) I do not know.
21c) No, I am not.

22.) Would you enter inaccessible and unsafe underground mining sites (mines, adits)?
22a) Yes, I would.
22b) Probably not.
22c) No, I would not.

23. Does the brownfield mining tourism have the elements of the adrenaline tourism?
23a) Yes, it surely does.
23b) It probably does.
23c) It probably does not.
23d) No, it surely does not.

**Figure A1.** Questionnaire from the public opinion survey concerning mining brownfields and their secondary use in mining tourism, or tourism generally, focusing on mining brownfields' general characteristics, safety, and sustainability. The wording of the questions was formulated using predefined scales of answers (source: authors' research).


**Figure A2.** Examples of brownfield localities studied during field research. (**1**) Senec, (**2**) Vajnory (Bratislava), (**3**) Draždiak (Bratislava), (**4**) Kuchajda (Bratislava), (**5**) Podrečany, (**6**) Lubeník, (**7**) Hnúšťa, (**8**) Ľubietová, (**9**) Špania Dolina, (**10**) Jelšava, (**11**) Nižná Slaná, (**12**) Mútnik. Photos by B. Gregorová and P. Hronček.

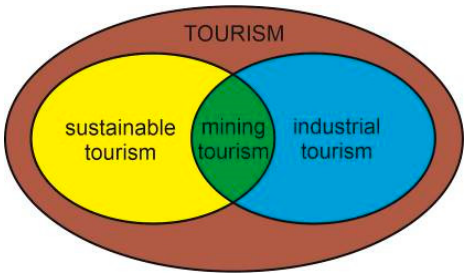


**Figure A3.** The position of mining tourism within the tourism industry.

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