GEOSYSTEM SERVICES AND DISSERVICES: AN APPLICATION OF THE CONCEPT ON ABANDONED QUARRIES

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Abstract
The geosystem services concept is, despite certain controversies, widely accepted and reflected in scientific literature with a notable overreach to nature conservation, management, and policies already for several decades.
In contrast, the geosystem disservices approach has not yet received enough attention and is relatively new to the field. Geosystem disservices may be considered as results and outcomes of functions, structures, and aspects related to abiotic entities, processes and interactions that may impact human well-being and are assessed as damaging under a relevant value system at a particular moment. Nevertheless, it is necessary to mention that the attitudes to geodiversity depend on the societal context, time and space; the same entity can be valued as a geosystem service or disservice, depending on the lifestyle, culture, age, experience, or historical period. In this contribution, possible classification frameworks of geosystem disservices are presented and discussed. The qualitative evaluation of both geosystem services and disservices is applied on several examples of abandoned quarries in Czechia, which are usually perceived as important sites with high geoheritage (and eventually ecological, cultural and aesthetic) values. Based on this assessment, management proposals and conservation measures for these specific sites are outlined.

Key words: geoheritage, geohazards, degradation risk, nature conservation, Czechia

Introduction
The ecosystem services (ES) are defined as the benefits that people obtain from ecosystems (Costanza et al., 2017). Originally, the ecosystem services were perceived as benefits provided mainly by living nature, and geodiversity was omitted, however, in the last years, so-called concept of geosystem services (GS) is being developed and used as a basis and justification for conservation efforts and relevant planning and managing of abiotic nature, i.e. geodiversity (Gray et al., 2018, Haines-Young, 2023, Kubalíková, 2024, García et al., 2025, Gray and Fox, 2026).
In recent years, the ES concept has been complemented by the concept of so-called ecosystem disservices (EDS) (Lyytimäki and Sipilä, 2009, von Döhren and Haase, 2015, Vaz et al., 2017, Veibiakkim et al., 2025). Originally, these disservices were simply perceived as negative, harmful or unpleasant impacts of ecosystems on human well-being (Lyytimäki and Sipilä, 2009), however, recently, definitions have shifted towards more complex views, e.g., von Döhren and Haase (2015), or Hardaker et al. (2020) who perceives EDS as outcomes of ecological processes and interactions that impact human well-being and are assessed as damaging under a relevant value system.
Regarding geodiversity and EDS concept, the situation is similar to ES – geodiversity is mentioned only marginally (Rackelmann et al., 2023, Lundin-Frisk et al., 2025), although abiotic components are as relevant as biotic components within ecosystems, and negative or unpleasant impacts of abiotic nature are generally well-known. Kubalíková (2026) provides the following definition of geosystem disservices: "results and outcomes of functions, structures, and aspects related to abiotic entities, processes and interactions that may impact human well-being and are assessed as damaging under a relevant value system at a particular moment". However, it is necessary to mention that it is sometimes difficult to set a clear boundary between what is a service and a disservice, because one geosystem function may be a service in one context and a disservice in another (Saunders, 2020).
The aim of this paper is to present briefly a framework for the qualitative evaluation of GS and GDS that may be applied to geosites, represented here by an abandoned quarry protected as Nature Monument, thus bearing a significant geoheritage value.

Material and methods
At first, it is necessary to identify the ecosystems within the study sites. Usually, in abandoned pits, these are represented by quarry walls, debris accumulations and eventually wetlands on the quarry bottoms – all of them with a significant abiotic component. For effective nature conservation

(geoconservation), planning and management, a complex approach and adequate framework need to be developed reflecting both GS and GDS.
There are numerous classification systems of GS (Garcia et al., 2025). For this study, the following classification of GS based on Gray (2018) is used: a) *provisioning* services (e.g., extraction of material and its use), b) *regulating* services (e.g., influence on micro-climate), c) *supporting* services (e.g., habitat function), d) *cultural and knowledge* services (e.g., aesthetics, tourism, education). Regarding the classification framework for GDS, it is supposed that some EDS frameworks may be converted to GDS classifications (Kubalíková, 2026). There are several classification systems described and discussed in literature (Veibiakkim et al., 2025), e.g., impact-oriented classification (economic, health, environmental impacts on human society), classification based on spatial scale (negative impact at local, regional or global scale), classification based on distinguishing the natural or human-induced types of EDS or classification based on the MEA framework. For this study, the following impact-oriented classification of GDS based on Vaz et al. (2017) is used: a) GDS related to *geological/geomorphological processes with negative influence on properties and infrastructure*, b) GDS related to *fears, health risks and harms* (e.g., safety, health complications), c) GDS related to *aesthetic issues* (negative perception or connotations of geodiversity), d) GDS related to *inhibition of human activities* (e.g., geosystems represent an obstacle in urban or infrastructure development).

Study site: Panská skála u Habrovan
The abandoned quarry is situated approx. 2 km west of Habrovany village (South-Moravian Region, Czechia). It covers an area of 300×100 m, with quarry walls reaching up to 40 m, where the deposition of conglomerates (namely Luleč conglomerate of Myslejovice Formation consisting mainly of granitic metamorphites, i.e., granulites, gneisses, quartzites) on the eroded surface of Carboniferous greywackes can be observed (Czech Geological Survey, 2026). In the 19th century, greywacke and conglomerate started to be extracted, in the 1970s, the quarrying was finished, and the site was left abandoned. At the bottom of the quarry, there is a wetland, important from the ecological point of view as a refuge of amphibians (e.g., *Lissotriton vulgaris, Triturus cristatus*) and hydrophilic flora. Under the walls, the debris cones are present conditioning the development of debris forests. Several protected and endangered plant species can be found here, e.g., *Cephalanthera damasonium, Campanula moravika* (Jurek, 2020). The site is protected as a Nature Monument (Figure 1).

Fig. 1: Panská skála Quarry near Habrovany (South Moravia, Czechia). A: an overall view of the quarry wall with blocky accumulation, B: a detail of the Luleč conglomerate, C: a wetland at the bottom of the quarry (photo: author).

Results and discussion
The selected study site has been qualitatively evaluated in terms of GS and GDS (Table 1). Generally, the geosystem functions of abandoned quarries may be perceived ambiguously, both positively and negatively, which is supported by this case study. Very often, these geosystems are important from the scientific, and educational point of view, they increase the overall landscape diversity, positively influence biodiversity, they bear an information necessary for understanding the cultural, industrial and technical level of the society including the use of natural resources in relation to geomining heritage, or they enable developing sustainable forms of tourism, which can positively affect local economic development. However, all the above-mentioned benefits can be seen as negative if the perspective is

opposite. Disused or abandoned quarries are very often perceived as “scars on the landscape”, or as sites that are dangerous and unpleasant. The negative connotations may be related to active geomorphological processes (rock fall) that may damage infrastructure or endanger human lives, or they may represent an obstacle to the construction development, or a complication for economically suitable land-use (agriculture, forestry). On contrary, the disservices and geohazards may be considered knowledge services that enable a deeper understanding of natural processes.

Tab. 1: Geosystem services and disservices of Panská skála Quarry

Geosystem services	Regulating	Influence on mesoclimate and water regime (dry quarry walls, wet quarry bottom)
	Provisioning	Source of material (conglomerate and greywackes)
	Supporting	Specific vegetation of bare rock walls, debris forests, wetland ecosystem – presence of protected species, e.g., amphibians or hydrophilic flora
	Cultural and knowledge	Scientific (geoheritage) values, importance for geological mapping, aesthetic values, use of local material at cultural monuments, educational value for visitors
Geosystem disservices	Impact of geohazards	Potential slope processes and instability of debris accumulation, possible contamination of water sources
	Fears, health risks and harms	Rock fall, slope processes, instability of debris and block accumulation may influence the visitor safety
	Aesthetical	For some visitors, the wetland may be disgusting and evoke negative connotations (muddy terrain, mosquitoes, unpleasant biota). Sometimes, there are black dumps that may also be perceived negatively.
	Inhibition of human activities	Practically not possible to use the site for other purposes (its settings, wetlands and unstable walls, are not suitable for economic development), legal protection (the site as a part of natural heritage) also significantly decreases the economic potential (e.g., use of the site for legal dump, potential construction activities, or forestry).

Conclusion

The geosystem services and disservices concept may become a new integrative approach that enables a complex evaluation of natural heritage sites where the geodiversity plays a substantial role. Thanks to the fact that it covers all the spectrum of attributes of the particular geosystems, it provides a holistic view of the site that may contribute to a more effective nature conservation and sustainable use of natural resources. It may also help to understand that nothing is only “positive or negative” and all the values are situated on a spectrum which depends on and may change according to different societal or historical context (e.g., slope processes may be perceived as dangerous, but at the same time, they have an important educational value). This inclusive approach may be more relevant, effective, and fair than applying traditional “black and white” points of view on natural resources.

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Souhrn
Příspěvek představuje koncept tzv. Geosystem services a Geosystem disservices (geosystémové služby a ne-služby, případně geosystémové nevýhody). Na základě již používaných klasifikací geosystémových služeb a s využitím adaptace klasifikací tzv. ekosystémových ne-služeb (nevýhod) je představena metodika, kterou lze využít pro kvalitativní hodnocení lokalit, kde geodiverzita (neživá složka) hraje významnou roli. Pomocí tohoto přístupu je zhodnocena modelová lokalita (opuštěný lom, dnes chráněný) a geosystémové služby a ne-služby (nevýhody) jsou stručně diskutovány.

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