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In recent decades, geomorphological heritage, its protection and management has acquired more attention and particular conservation measures are being continuously implemented in local and regional policies or structures. Despite all this, some **threats** may occur resulting from the multiple uses, land-use changes or human society demands on particular geomorphosites. Thus, the identification, assessment and management of these threats, risks and conflicts of interest should become an integral part of every geoconservation effort.

Goal: to design a method for risk assessment on dynamic sites of Earth Sciences interest. Application of the method on abandoned sand, loess or clay pits.

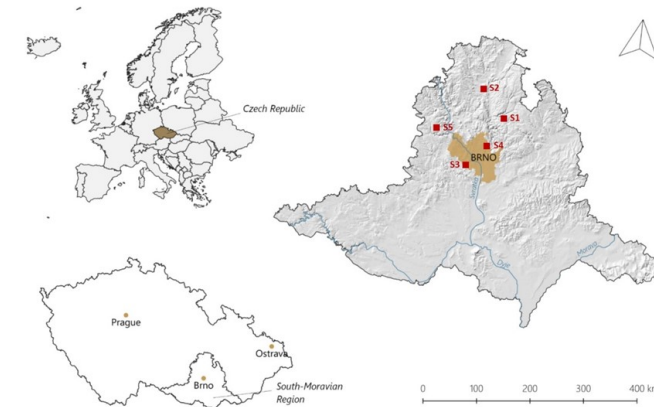
For this purpose, a two-level risk assessment is applied to identify and evaluate the level and intensity of threats:

- 1) Geomorphosite concept (degradation risk evaluation)
- 2) Risk Assessment Matrix (used in regional development or project planning)

Using both approaches provides a complex view of the threats and allows to propose particular measures that could contribute to the balance of the different demands and more effective geoconservation management on a specific site.

STUDY SITES and their GEOSYSTEM SERVICES

| GS | Description | Example |
|------|---|---|
| REG | Local climate regulation and contribution to the microclimate (different orientation of the walls of the pits, possible climatic inversions due to the occurrence of steep slopes and closed depressions) Geomorphological processes (weathering, slope processes, erosion, accumulation) If flooded: participation in water cycling, importance in water infiltration, draining and the recharging of water elements | Slope processes at Červený Kopec loess pit obscuring the Earth Science phenomena |
| SUPP | Habitat provision and influence on flora and fauna (very often conditioned by texture, structure and chemical composition of the sedimentary rocks) Soil processes (initial stages of soil development) If flooded: specific conditions for development of aquatic ecosystems and formation of wetlands | <i>Lycopodium Clavatum</i> found in Rudice-Seč sand pit: its occurrence is conditioned by acid pH of sands |
| PROV | Geomaterials such as sand, loess, clay, kaolin used not only in industry and constructions, but also for research and archaeological studies Specific materials accompanying the sand or clay deposits such as cherts, ferruginous ores or coal | Ferruginous ores as an accompanying geo-resource in Malý Chlum |
| CULT | Aesthetical aspects (coloured layers, steep slopes, outcropping rocks) Recreation, leisure and tourism Fossil and mineral collecting Part of natural heritage Links to cultural and technical heritage (mining infrastructure) Reflection in arts (paintings, photographs) Societal development (field trips, participation of local organisation on management) | Cultural aspects of Písečnick sand pit – anthropogenic landforms (cellars) in the sand wall |
| KNOW | Possibility of reconstruction of past climates and environments Contribution to the knowledge of different aspects of Earth Sciences (palaeontology, sedimentology, stratigraphy, geomorphological processes) Study of anthropogenic geomorphology and history (historical landuse, mining history, ways of extraction) High potential regarding environmental education and dissemination of Earth Sciences | Fossils of <i>Innoceramus</i> in Malý Chlum sand pit contributed to the palaeontological studies and are of high importance in geoeducation |



Dynamic sites of Earth Sciences interest: a) S1—Rudice-Seč sand pit, b) S2—Malý Chlum sand pit, c) S3—Červený Kopec loess pit, d) S4—Písečnick sand pit, e) S5—Maršov kaolin pit.

Evaluation of particular threats by using Risk Assessment Matrix

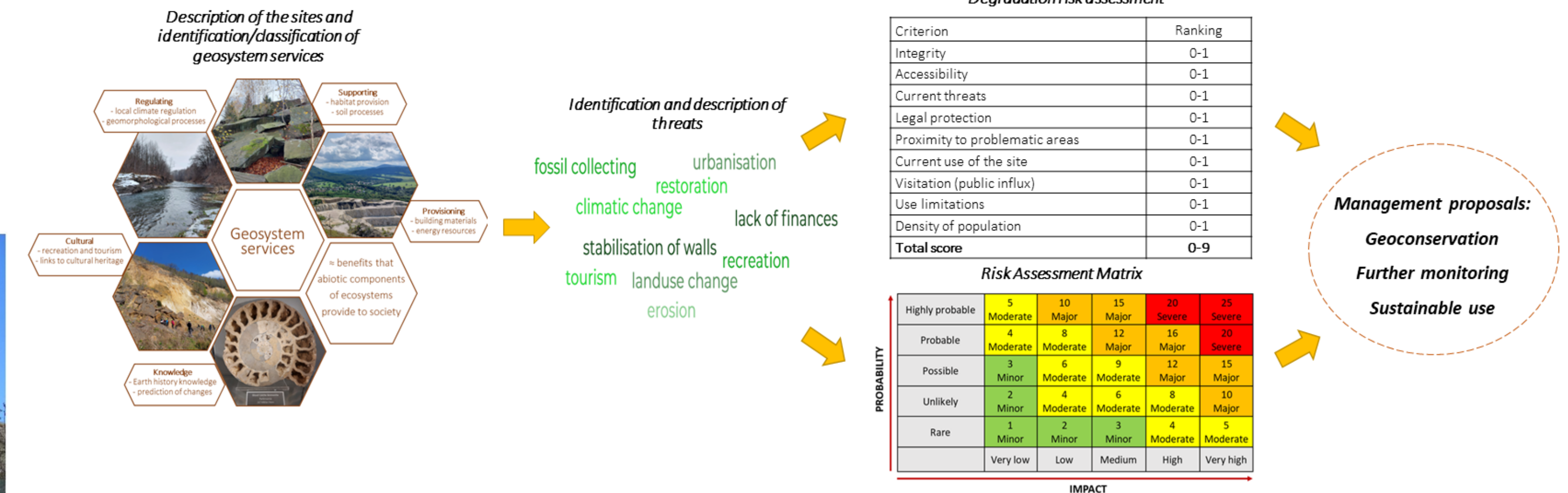
| Threats | S1 – Rudice-Seč | | | S2 – Malý Chlum | | | S3 – Červený Kopec | | | S4 – Písečnick | | | S5 – Maršov | | | Average |
|-------------------------------|-----------------|-----|-------|-----------------|-----|-------|--------------------|-----|-------|----------------|-----|-------|-------------|-----|-------|---------|
| | prob | imp | total | prob | imp | total | prob | imp | total | prob | imp | total | prob | imp | total | |
| Urbanisation | 2 | 5 | 10 | 1 | 5 | 5 | 4 | 5 | 20 | 4 | 5 | 20 | 2 | 5 | 10 | 13,00 |
| Re-opening the pit | 1 | 5 | 5 | 1 | 5 | 5 | 1 | 4 | 4 | 1 | 3 | 3 | 1 | 3 | 3 | 4,00 |
| Changes in land use | 3 | 5 | 15 | 3 | 4 | 12 | 4 | 5 | 20 | 4 | 5 | 20 | 3 | 5 | 15 | 16,40 |
| Recreation, tourism | 5 | 5 | 25 | 3 | 5 | 15 | 4 | 5 | 20 | 3 | 4 | 12 | 3 | 4 | 12 | 16,80 |
| Change of climatic conditions | 3 | 5 | 15 | 3 | 5 | 15 | 3 | 5 | 15 | 3 | 4 | 12 | 3 | 5 | 15 | 14,40 |
| Natural processes | 5 | 2 | 10 | 5 | 2 | 10 | 5 | 4 | 20 | 4 | 3 | 12 | 4 | 4 | 16 | 13,60 |
| Restoration of pits | 1 | 5 | 5 | 1 | 5 | 5 | 3 | 5 | 15 | 1 | 5 | 5 | 1 | 5 | 5 | 7,00 |
| Stabilisation | 1 | 5 | 5 | 1 | 5 | 5 | 3 | 5 | 15 | 3 | 5 | 15 | 1 | 5 | 5 | 9,00 |
| Collecting rock and fossils | 3 | 4 | 12 | 3 | 3 | 9 | 1 | 3 | 3 | 1 | 3 | 3 | 1 | 3 | 3 | 6,00 |
| Lack of finances | 4 | 4 | 16 | 4 | 3 | 12 | 4 | 5 | 20 | 5 | 3 | 15 | 5 | 3 | 15 | 15,60 |
| Confusion in legal protection | 2 | 4 | 8 | 2 | 4 | 8 | 3 | 5 | 15 | 2 | 3 | 6 | 2 | 4 | 8 | 9,00 |
| Emphasizing the living nature | 2 | 4 | 8 | 2 | 3 | 6 | 2 | 4 | 8 | 1 | 3 | 3 | 2 | 4 | 8 | 6,60 |
| Vegetation | 5 | 5 | 25 | 4 | 5 | 20 | 5 | 5 | 25 | 2 | 5 | 10 | 5 | 5 | 25 | 21,00 |

CONCLUSIONS

- **Natural processes** should be perceived as an integral part of the specific site. In some cases, they contribute to the renovation of **visibility** of Earth Sciences phenomena.
- **The indifference and lack of interest** (both general public and authorities) may contribute to the faster degradation and even disappearance of specific sites, so it is necessary to cooperate with local communities and authorities
- Further and regular **monitoring** needed as well as **education** and **raising awareness**. This can be achieved e.g. by elaborating **Geodiversity Action Plan** for specific sites or areas.

Abandoned sand, clay or loess pits are very important sites from different points of view, they have numerous functions in landscape and provide numerous geosystem services. **Geosystem / abiotic ecosystem services** are benefits that abiotic components of ecosystems provide to society. It usually follows the traditional scheme of ES as provided already in Millennium Ecosystem Assessment: *regulating, supporting, provisioning, cultural and knowledge services*.

METHODS



RESULTS—Degradation risk assessment

| Criterion/site | S1 | S2 | S3 | S4 | S5 |
|--------------------------------|--------------|-----------------|-----------------|----------------|-----------------|
| Integrity | 0,5 | 0,25 | 0,75 | 0,5 | 0,75 |
| Accessibility | 1 | 0,5 | 0,75 | 1 | 0,75 |
| Current threats | 0,75 | 0,5 | 0,75 | 1 | 1 |
| Legal protection | 0,25 | 0,5 | 0 | 1 | 0,75 |
| Proximity to problematic areas | 0,5 | 0 | 1 | 1 | 0 |
| Current use of the site | 1 | 0,5 | 0,5 | 0 | 0,5 |
| Visitation (public influx) | 1 | 0 | 1 | 0 | 0,5 |
| Use limitations | 1 | 1 | 1 | 1 | 1 |
| Density of population | 0 | 0 | 1 | 1 | 0 |
| Total score (ranking) | 6 (3) | 3,25 (5) | 6,75 (1) | 6,5 (2) | 5,25 (4) |

MANAGEMENT PROPOSALS

| Management proposal | Suitable for the reducing the following threat: |
|--|---|
| Following and respecting the categories of nature conservation in strategic documents on higher level | Urbanisation, construction; Re-opening the pit; Changes in land use; Recreation, tourism |
| Creating the buffer zones and respecting them, informing the landowners in the surroundings | Urbanisation, construction; Changes in land use; |
| Effective communication network between stakeholders and authorities | Urbanisation, construction; Re-opening the pit; Changes in land use; Recreation, tourism; Restoration; Stabilisation; Vegetation overgrowth |
| Unifying the degree of protection , enlarging existing protected areas, setting a higher degree of protection | Urbanisation, construction; Changes in land use; Confusion in legal protection; Emphasizing the living nature |
| Supporting the volunteering, local inhabitants' involvement and cooperation with NGOs | Recreation, tourism; Lack of finances; Vegetation overgrowth |
| Environmentally educative activities , e.g. information materials, guided tours | all the threats |
| Creating the ethic code | Recreation, tourism; Collecting fossils, minerals and rocks |
| Further monitoring and research | Change of mesoclimatic conditions; Natural geomorphological processes; Vegetation overgrowth |
| In specific cases, leaving the natural processes to their natural evolution | Change of mesoclimatic conditions; Natural geomorphological processes |
| Defining or establishing the Earth Sciences phenomena as a subject of protection | Restoration of pits; Confusion in legal protection; Emphasizing the living nature |
| Taking the geodiversity and geoh heritage into account when revising care plans | Confusion in legal protection; Emphasizing the living nature; Stabilisation of rock faces |
| Integrated approach to management and promotion (the promotion of the Earth Sciences value of the area together with its links to the ecological, biological and cultural features) | Recreation, tourism; Lack of finances; Confusion in legal protection; Emphasizing the living nature |
| Preparing Geodiversity Action Plan for a wider area | all the threats |