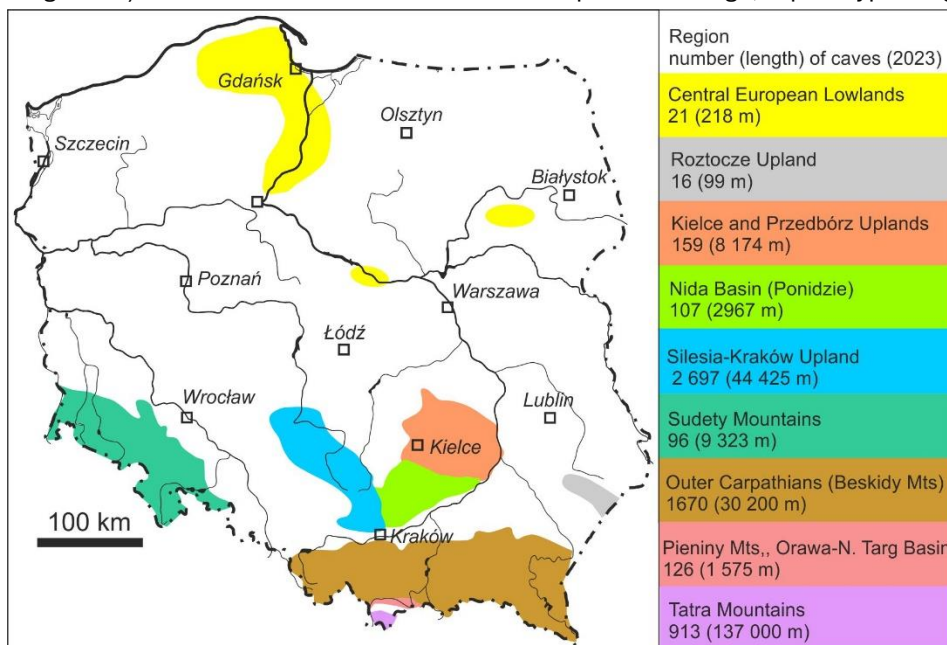


Environmental Outlook Status of Caves in Poland

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Geological Diversity and Caves

Caves in Poland occur in several regions and many rock types, not only karst rocks, therefore they can be found on the large territory of the country, from high mountains up to the sea shore. However, their frequency as well as length, shape and genesis differ in various regions (Fig. 1, Table 1). In the European Lowlands few and short caves developed in Quaternary sandstones and clays. Not frequent and small, mainly weathering caves were recorded in Neogene rocks of the Roztocze Upland, whereas in the Kielce and Przedbórz Uplands (including the Świętokrzyskie Mountains), formed of diverse Paleozoic and Mesozoic sedimentary rocks, both large karst caves and short non-karst caves occur. In the Silesian-Kraków Upland large number of mainly karst caves up to several hundred meters long have been recorded principally in Upper Jurassic limestones. In turn, the Nida Basin (Ponidzie) is famous for frequent but not very long caves in Neogene gypsum rocks. In the Sudety Mountains (=Sudetes) very diverse caves developed in carbonate and not karstified rocks (granites, metamorphic rocks and sandstones). The Outer Carpathians (=Beskidy Mountains and Foothills) formed of siliciclastic-clayey flysch rocks, are a region abounding in non-karst, mainly gravitational caves. Caves of various origin and shape are characteristic for small but geo(morpho)logically complex Pieniny Klippen Belt (in geographical term representing two Carpathian regions: Pieniny Mountains and Orawa-Nowy Targ Basin). The Tatra Mountains in the Inner Carpathians – high, Alpine type orogen, built of diverse sedimentary,



metamorphic and magmatic rocks – are abundant in caves, among which are the longest and deepest karst cave systems in Poland (the longest Jaskinia Wielka Śnieżna cave system is ca 24 km long). The total number of caves recorded in the country to date is over 5.8 thousand caves with a total length of almost 234 km (Głazek et al. 1972; Pulina 1997; Urban, Piksa 2024).

Fig. 1 Regions of caves' occurrence (after Urban, Piksa 2024).

The first scientific inventory of Polish caves was published (in several volumes) in 1953-1955. For last forty years several dozen volumes of cave inventories, covering particular regions and, subsequently, supplementing data (records) for these regions, have been published. Consequently, some regions (e.g. Outer Carpathians, Silesian-Kraków Upland) have the inventories accurately updated, while documentations of caves in a few areas (mostly Sudety Mts.) are out of date (so, the number of caves documented in the Sudety Mts., ranging 96, is not reliable). Since the first years of 21 century this work is managed by Polish Geological Institute, which manages also the internet database: <https://jaskiniepolski.pgi.gov.pl/>. Apart from this general database, several databases are dedicated to particular regions, e.g. Tatra Mts. <https://kktj.pl/Artyku%C5%82y/jaskinie-tatr-10>, Outer Carpathians: <http://jkf.m3.net.pl/index.php>.

Cave Protection Status

Caves in Poland are not protected as special national treasure, as in the case, for example, of Slovakia. The Nature Protection Act (2004) is the basic legal regulation determining caves' protection within the national parks, nature reserves, landscape parks, nature-landscape complexes, as well as protection by categories covering small areas: nature monuments, documentary sites and ecological sites. Many caves have been included in Natura 2000 areas



established in Poland since 2004. The most efficient protection status of caves is in national parks and nature reserves because all human activities are prohibited or very restricted in these categories of protection. Activity of scientists and speleologists in the caves protected in national parks and nature reserves is possible only with consent of the nature conservation authority for special scientific or exploration reasons. Several caves protected by these categories are partially accessible for people as show caves, which does not cause their degradation due to strict control of restricted visitor access.

Tab. 1. Number of caves and their protection in selected protection categories (in % of all caves and their length recorded in the region) (after Urban, Piksa 2024)

Geographical region	Cave number	Cave length [m]	Caves protected in selected protection categories [%]					
			national parks		nature reserves		n.m & d.s.	
			number	length	number	length	number	length
Central European Lowland	21	218	0	0	5	11	24	44
Kielce and Przedbórz Uplands	159	8 174	4	0*	42	76	17	3
Nida Basin (Ponidzie)	107	2 927	0	0	31	34	8	10
Roztocze Upland	16	99	25	13	0	0	6	3
Silesian-Kraków Upland	2 697	44 425	28	16	10	15	0*	4
Sudety Mountains	96	9 323	2	0*	12	46	5	1
Outer Carpathians	1 670	30 200	5	3	9	5	2	28
Pieniny Klippen Belt	126	1 575	38	53	38	24	1	0*
Tatra Mountains	913	137 000	100	100	0	0	0	0
Poland totally	5 8045	233 941	31	62	10	8	2	5

n.m. and d.s. – nature monuments and documentary sites

As is shown in the Table 1, the state of cave protection significantly differs in various regions, from the Tatra Mts – the region completely covered by the Tatra National Park providing accurate protection of caves in the whole area, up to regions reach in caves in which only about 30% of them are legally protected as the Silesian-Kraków Upland. In some regions, such as the Outer Carpathians and Kielce Upland the largest caves are protected in nature reserves or as nature monuments and documentary sites.

In Poland, there are also several nature reserves established in order to protect large or valuable caves, such as “Jaskinia Niedźwiedzia” (Sudety Mts), “Jaskinia Raj” and “Chelosiowa Jama” (Kielce Upland), “Szachownica” (Silesian-Kraków Upland) as well as “Groty Kryształowe” (Carpathian Foothills).

Underground Geological Heritage Status

Apart from the protection categories listed above, the protection of geological heritage in Poland is theoretically provided by the article no. 121 of the Nature Protection Act, which states that management of inanimate nature resources and landscapes should enable to conserve the most valuable geo(morpho)logical formations and phenomena, as well as by the article no. 122 concerning the procedure of safeguarding of fossils’ discoveries (a case frequent in caves). Practically both these articles have not been frequently taken into account in the protection practice and measures. However, a few lawsuits regarding the destruction of paleontological and archaeological sites concerned just caves. Also the article no. 161 of the Geological and Mining Act (2011) states the necessity of geodiversity protection.

Nevertheless, the awareness of geological heritage referred to karst and caves has been growing (Madeyska, Cyrek 2002; Urban 2004). It can be illustrated by the internet database “Geosites” (<http://geoportal.pgi.gov.pl/portal/page/portal/geostanowiska>) managed by the Polish Geological Institute that includes descriptions of protected or proposed for protection geosites, among which are numerous caves from every regions. Many caves and groups of caves have been also described in published catalogues of geosites protected or proposed for protection.

Over Visitation Concerns

Access to the caves not protected in national parks and nature reserves is theoretically allowed, however some of the most valuable, not only legally protected, caves are closed by gates installed in their entrances by



conservation services or forest administration. Such measures have been carried out mainly to protect bats colonies and hibernacula. Nevertheless, the unrestricted human access to caves is discerned as the factor the most destructive for cave environment (Urban, Piksa 2015). In fact, the monitoring of caves as Habitat 8310 shows that the human access and activity in caves, such as tourism and cave exploration, also vandalism, have the most common negative impact on cave environment (in 2024: 88% caves monitored in the Carpathians, and 81% caves in other regions). Similar data concerning a human impact have been obtained from monitoring works carried out in caves in several Natura 2000 areas situated in the Outer Carpathians, Sudety Mts., Silesian-Kraków Upland and Kielce Upland in last dozen years (Urban, Piksa 2024).

Archaeological Heritage Status

The protection of archaeological sites is legally regulated by the Act on the Protection and Care of Historical Monuments (2003), according to which each discovering archaeological artefacts (which is frequent situation in explored caves) automatically stops work and further activity has to be supervised or even carried out by professional service. Despite this law many explorations are conducted without such control, however, good examples can be also provided e.g. from Kadzielnia (Kielce Upland) and Jaskinia Głęboka (Silesian-Kraków Upland).

In many caves situated mainly in the Silesian-Kraków Upland professional archaeological excavations have been performed recently by Polish archaeologists from the Nikolaus Copernicus University in Toruń, Jagiellonian University in Kraków and University of Warsaw, cooperating with geologists and paleontologists from the Polish Academy of Sciences (Geological Institute and Institute of Systematics and Evolution of Animals) and University of Wrocław. In the caves of this region archaeological remnants dating back the Middle Paleolithic have been identified, however, very interesting sites represent also Upper Paleolithic, Mesolithic, Neolithic and Medieval Periods (Madeyska, Cyrek 2002). Most studied archaeological sites have been legally recorded as historical monuments.

Biodiversity Conservation Status

Polish caves are used by bats as winter quarters, swarming sites, and, very rarely, as summer quarters. 20 out of 28 bat species in Poland can be found in caves—most of them during winter and the swarming period. At the national level, all bats are strictly protected. A permit from the Ministry of Climate and Environment or from the General Directorate for Environmental Protection is required for their research. The most important cave hibernacula are protected under Natura 2000, in national parks, and in nature reserves. Actions to protect bats' underground quarters are increasing in number (Sachanowicz et al. 2006).

In Poland only three invertebrate species living exclusively in subterranean habitat (but not in the caves) are protected by law (Regulation on the Protection of Animal Species, 2016). Many troglobiontic species were found in various kinds of legally protected areas mentioned above, where all biota are under protection (Dumnicka, Galas 2017; Kocot-Zalewska, Domagała 2020; Dumnicka et al. in press).

Mineral Resources Management Status

The caves were the places of mineral resources extraction: calcite and guano, up to the mid of the 20th century. However, karst areas have offered considerable mineral resources since the Middle Ages up to now. There are carbonate rocks used mainly for road and building construction. Therefore in the Kielce Upland (Świętokrzyskie Mts.) and Silesian-Kraków Upland, as well as in a few places of the Sudety Mts. development of quarries has been creating significant problem for cave preservation: some caves and paleokarst sites, even of high natural and scientific values, have been destroyed by quarrying. But on the other hand, just in these three regions, in which most caves are of relict nature, historical quarrying has opened tens of cave entrances, which enabled their exploration and research.

According to the results of general monitoring of habitat 8310 as well as monitoring works carried out in the Natura 2000 areas (described below) quarrying is the third – after human direct presence and waste – factor that threatens caves. The organization of geological inspection conducting monitoring of quarries, mines and other excavations in order to document and possibly preserve geoheritage sites in them, has been proposed, but such law finally has not been launched, yet.



Water Status

Water resources are managed and preserved according to Water Law (2017) which determines preservation of underground fresh water resources (articles 51-142), but does not refer to specificity of karst aquifers and caves. The only large agglomeration partly using karst water resources is Kielce city (Kielce Upland, Świętokrzyskie Mts., ca. 180 thousand inhabitants). The second relative large town exclusively extracting water from mountainous karst system is Zakopane, famous resort in the Tatra Mts. (with theoretically 30 thousand inhabitants, but populated by several times more tourists). Karst aquifers are used by wells in many small towns and villages in karst regions as the Silesian-Kraków Upland and Kielce Upland, but the public awareness of karst aquifers specificity is not sufficient. Therefore, these aquifers are still threatened by surface human activities such as agriculture, industry, and human settlements. However, the control measures and restrictions provided by the Water Law have been observed. The awareness of cavers in this matter should be formed by recently published and translated into Polish “Guidelines for Cave and Karst Protection”.

Environmental Contaminants Status

As is suggested by cave monitoring – carried out in national/state scale and in particular Natura 2000 areas in recent years (see below: Monitoring) – the second significant type of environmental degradation of caves situated outside the mountains is waste and other pollution (29% caves in upland and lowland regions) (Urban, Piksa 2024). The cave cleaning actions have been occasionally conducted by cavers as well as, in protected areas (nature reserves etc.), by nature protection service, however such operations are not coordinated and they have not been related to international initiatives as e.g. Clean up the Dark project.

Monitoring and Research Status

Polish caves have been monitored as the Habitat 8310 – Caves not Open to the Public, in a frame of the Monitoring of Natural Habitats listed in the Annex 1 to the European Habitats Directive in a state (national) scale, as well as on a scale of Natura 2000 areas abundant in caves. The national monitoring was performed in two stages: the first carried out in 2013-2014 and the second – in 2024 (63 selected caves from every regions). These stages of monitoring prove that general environmental state of the monitored caves has not changed distinctly in recent years. In the Carpathians their status has changed from 59% caves of accurate state in 2013-14 to 54% caves of such state in 2024, and in the other regions: from 41% caves of accurate state in 2013-14 to 47% caves of such state in 2024) (Urban 2025). Similar monitoring works have been conducted in caves of several Natura 2000 areas situated in the Outer Carpathians (6 areas), Pieniny Klippen Belt (1 area), Sudety Mts. (2 areas), Silesian-Kraków Upland (1 area) and Kielce Upland (1 area) in last dozen years. These works have indicated similar, mainly anthropogenic impact as well as similar state of cave environment (Urban, Piksa 2024).

Polish caves have been obviously a subjects of various scientific studies: geological, geomorphological, archaeological, biological, microclimatic, etc. The results of the research have been published in scientific journals of local and global significance. Scientists that have carried out this research are usually members or cooperators of the Speleological Section of the Copernicus Society of Naturalists (CSN) which has organized the yearly national speleological symposia since 1963. Consequently, these meetings have been perfect fora for presentations of study results and exchange of ideas. The materials presented during these symposia (since the seventies of the 20th century) have been printed and published in internet (<http://www.speleo.ptpk.org/symposium.html>).

Public Awareness and Education Status

In the Natura 2000 areas and areas abundant in caves various activities propagating caves, cave environment and fauna (mainly bats), as well as necessity of their protection have been recently held. These events are organized by nature protection agencies, especially by landscape park administrations (e.g. Group of Małopolska Landscape Parks), Speleological Section CSN, Polish Geological Institute as well as some universities (AGH Univ. in Kraków, NC Univ. in Toruń, Univ. of Wrocław). One of the most effective initiative in the promotion and popularization of caves and karst is webinarium managed by the Speleological Section CSN organized each month or two months since 2021. Most these activities were initiated in the frame of the International Year of Caves and Karst 2021-2022, started in Poland from the publication of adequate posters, leaflets and guidelines, that proves the significance of this action.



Conclusion

The description of the 8310 Habitat – Caves not Open to the Public in the “IUCN Red List of Natura 2000 Habitats of Poland” (Piksa, Urban, in press) documents, that the general state of this ecosystem is relatively good and stable in Polish territory. The cave state assessed under criteria A (reduction of geographic distribution), B (restricted geographic distribution), C (environmental degradation) and D (disruption of biotic processes and interactions) is described by the following features: A1 LC – of the least concern regarding the cave number change for the last 50 years; B1 LC – of the least concern as sites commonly occurring in the study area; C1 NT – near threatened environments for the last 50 years; D2b NT – habitats near threatened by biotic disruption in a 50-year period. However, it does not mean that these ecosystems (sites=caves) should not be subject of adequate protection and care, since they are endangered by physical destruction by quarrying and other excavation works, threatened by direct anthropogenic impact as well as waste and pollution. Therefore, continued efforts are required to propagate the knowledge on natural and scientific significance of caves and karst systems, and to promote the protection of this natural heritage and important economic resource (as karst aquifers). This activity should be realized by cooperation between government agencies, nature protection services, scientific institutions, local communities, as well as non-governmental organizations, among which caver and speleological groups should play crucial role.

Basic Data

- Total number of caves: 5.8 thousand, total length of caves: 234 km.
- Karst area coverage: approximately 20% of total land area (2.5-3.0% area of karstified rocks' outcrops)
- Stygobiotic fauna: more than 80 species, about 80% found outside the caves (in wells, interstitial waters and springs)
- Troglobiotic fauna: about 30 species or subspecies found mainly in caves
- Main zoological groups: Chiroptera, Diptera, Lepidoptera, Acari, Araneae, Amphipoda, Copepoda, Collembola, Annelida, Coleoptera
- Number of speleologists: approximately 1,500
- Number of speleological groups and organizations: 32 clubs, 28 of them affiliated with the Polish Mountaineering Association
- National caving organization: Polski Związek Alpinistyczny (Polish Mountaineering Association, since 1963)
- Main Speleological Publications: Jaskinie (Caves, quarterly)

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