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## **Microclimatic and biological monitoring of caves as geoheritage sites**

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Caves are often regarded as valuable assets of geoparks; in many instances they are regarded as distinct geological monuments and are protected as such. Exceptional caves or cave sectors are often gated and access is restricted for the general public. However, for many valuable caves, including those located within geoparks or other protected areas, there is a considerable public and entrepreneurial pressure for their development as tourist attractions. In these instances a trade-off should normally be looked for between conservation and education/dissemination needs. Making available for tourism may be, in some cases, the best way for its preservation. Careful and considerate development will preserve the pristine environment of a cave (or cave section) while allowing millions of visitors to enjoy its beauty. Inappropriate development will almost always result in irreversible damage to the fragile cave environment. As a general rule, each cave should be treated as a particular case and pre-development monitoring should be tailored on a case-by-case basis. Moreover, monitoring shall continue indefinitely during the operation of a show cave in order to allow for immediate countermeasures.

An ongoing pilot study (CAVEMONITOR) conducted in 5 of the most famous show caves of Romania focuses on monitoring of cave microclimate changes in response to touristic traffic, as well as to changes in air and water microorganisms. In all caves we are using non-touristic cave sectors as references for caves natural regimes which allow for discrimination of the human-induced response. Here we present the monitoring protocols, discuss the various technical solutions and how these should be adapted to different caves and types of tourist traffic. We present selected results on microclimate and biological monitoring over a one-year cycle in different caves and show that the recovery time strongly depend upon cave morphology, air circulation, and other local factors. We have identified a minimal set of parameters that shall be measured before, during, and after show caves development, as well as a set of best practices. We show that microbiological monitoring of air, water and rock surfaces is an important tool that allows a better understanding of ventilation patterns, of the main impacted spots in a cave, and of the possible threats of some cave inhabitants (bats in our case) on tourists health.

