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KARST RESEARCH INSTITUTE ZRC SAZU

**Speleological Association of Slovenia
Slovenian National Commission for UNESCO
IGU Commission Karst (C08-23)
International Union of Speleology UIS
Region of Istra
Natura Histrica**



19th INTERNATIONAL KARSTOLOGICAL SCHOOL “CLASSICAL KARST”

KARST UNDERGROUND PROTECTION



GENERAL INFORMATION, PROGRAMME, FIELD TRIPS, ABSTRACTS

Postojna, 2011

Editors

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PLACES OF VENUE

- **Cultural Centre, Prešernova Ulica 1, Postojna** (No. 2 on the Map) and
- **Karst Research Institute ZRC SAZU, Titov trg 2, Postojna** (No. 1 on the Map).

LECTURES

- PowerPoint presentations should be given to organisers 15 minutes before the start of your session.
- The time slot for a regular talk can be seen from the programme. Please consider about 2-3 minutes at the end of presentation for the discussion (i.e. 12+3).

LUNCH

- Lunches are not organized during Monday, Tuesday and Wednesday, but at least 80-minute lunch breaks are in the schedule (see the places to eat on the Map).
- Simple lunch will be organised for the excursions on Thursday and Friday. These two lunches are included into the registration (no additional payment is provided). One non-alcoholic beverage is included in the price. On Wednesday, packed lunch will be prepared by the organizer.
- During sessions, at least 20 min free coffee breaks are planned.

PLACES TO EAT

- **Minutka (No. 4 on the map):** Nice restaurant with pizza, pasta, excellent Balkan food and daily menu.
- **Čuk (No. 5 on the map):** Restaurant in the Sport park with plenty of space. Although known as pizzeria, they also serve good pasta, Balkan food, traditional local and “global” food, incl. salad bar and daily menu.
- **Bar Bor (No. 6 on the map):** For those of you who will wonder where is Jadran.... They serve their food in Bar Bor, 50 m down the street from the old location.
- **Špajza (No. 7 on the map):** For those looking for fine ambient and food.
- **Proteus (No. 8 on the map):** For those who enjoyed the location of Jadran restaurant in the past.

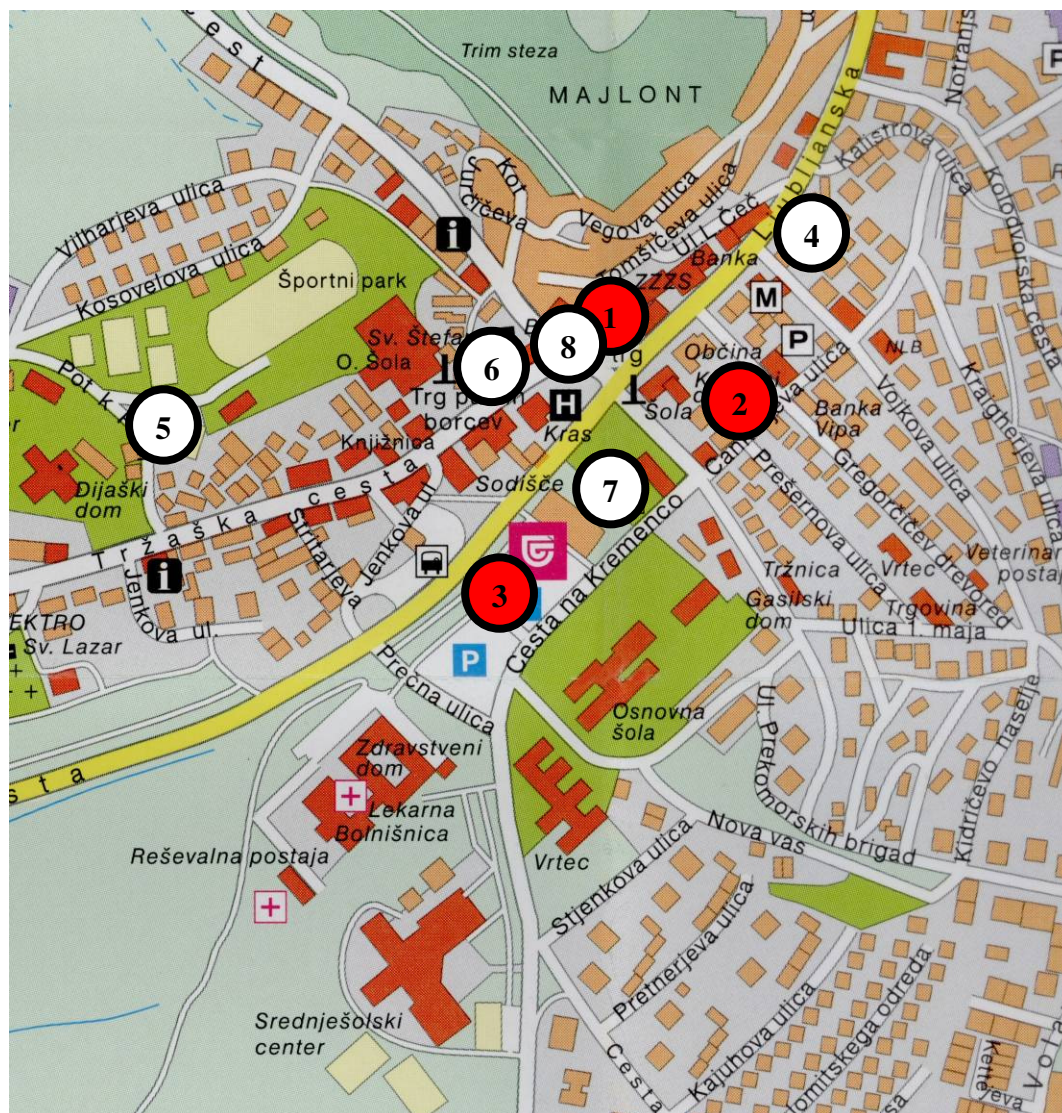
EXCURSIONS

- **Register for each excursion at registration desk on Monday morning.**
- All buses depart from the public parking in front of PTC Primorka (Novi trg 6, Postojna; No. 3 on the map) exactly on fixed time.
- Head light are strongly recommended, walking shoes and field clothes are necessary.
- Insect repellents are recommended (we will be walking in the areas populated with ticks (*Ixodes ricinus*) that transfer mainly Lyme disease and tick-borne meningitis.
- Take care for additional information and changes regarding the bus departures.
- Water will be available on all busses.
- **Participation on the excursions is at your own risk.**

POSTERS

- Leave posters at registration desk on Monday before the lunch break.
- Max. format of poster: 70 cm x 100 cm (width x height) portrait layout.
- Stand by your poster during the poster sessions.

MAP OF THE TOWN CENTRE WITH IMPORTANT PLACES



- 1 Karst Research Institute ZRC SAZU (Titov trg 2)
- 2 Cultural Centre of Postojna (Kulturni dom, Prešernova ulica 1)
- 3 Parking place in front of PTC Primorka (Novi trg 6)
- 4-8 Places to eat.

PROGRAMME

Monday, 20th June 2011

7.30-13.00	REGISTRATION		
8.30-9.00	OPENING SESSION		
9.00-13.40	SESSION 1: Protection of karst caves		
9.00-9.30	The protection of caves and their good and bad management	J.-P. Bartholeyns	
9.30-10.00	Legal protection of Slovene caves and Cave Protection Act	M. Simić	
10.00-10.30	Underground karst in France and its protection : the action of national committee for underground Heritage, 2007-2011	C. Gauchon	
10.30-10.50	Guidelines to evaluate projects in karstic areas	S. Schmassmann	
10.50-11.30	<i>Coffee Break</i>		
11.30-11.50	Karst underground protection in Croatia	D. Paar	Cultural Centre
11.50-12.10	Protection and sound management of caves of the Urals	O. Kadebskaya	
12.10-12.30	Karst underground protection in Sicily (southern Italy), some examples from speleological natural reserves	M. Vattano	
12.30-12.50	Protection and management of ice caves: a comparison of governmental, NGO and private administrations	A. Perşoiu	
12.50-13.10	The impact of visitors on the microclimates of Italian tourist caves	M. Menichetti	
13.10-13.40	Show caves and environmental protection	A. Cigna	
13.40-15.30	<i>Lunch Break</i>		
15.30-17.00	Poster Session	Karst Research Institute	
18.00-22.00	Postojnska jama – touristic use of the cave through centuries and problems of cave protection	Evening Field Trip	

Tuesday, 21th June 2011

8.00-11.40	SESSION 2: Protection of karst underground fauna and its habitat		
8.00-8.30	Protection of karst subterranean habitat and karst subterranean fauna	B. Sket	
8.30-9.00	Protection of subterranean biodiversity in the U.S.A.	D.C. Culver	
9.00-9.20	Red list of Croatian (Dinaric) subterranean fauna	R. Ozimec	
9.20-9.40	Evaluating threats to terrestrial cave fauna and its protection – differences and commonalities among two karst regions	M. Zagmajster	
9.40-10.00	<i>Coffee Break</i>		
10.00-10.20	Airborne microorganisms in organic rich caves and their relation to bat guano: case study from Romanian caves	R. M. Năstase-Bucur	Cultural Centre
10.20-10.40	Conservation of Dinaric Cave Type Localities	M. Lukić	
10.40-11.00	Proteus after flooding: should we save the animals or let them be?	G. Aljančič	
11.00-11.20	Protection of underground karst resources during logging of primary temperate forests: A comparative review of strategies in two hemispheres	K. W. Kiernan	
11.20-11.40	Protecting the karst of Lebanon: An overview	Issam Youssef Bou Jaoude	
11.40-13.00	<i>Lunch Break</i>		
13.00-20.00	Touristic use of Križna jama and threats from catchment area (Bloke plateau)	Afternoon Field Trip	
20.30-	Unresolved Mysteries of the Karst	P. Häuselmann	Karst Research Institute

Wednesday, 22th June 2011

Wednesday, 22 June 2011			
8.10-9.20	SESSION 3: Protection of karst waters and aquifers		Cultural Centre
8.10-8.40	Protection of karst aquifers	B. Andreo-Navarro	
8.40-9.00	Karst ground water protection in Iran	A. Afrasibian	
9.00-9.20	Planning railway path in the Trieste Karst (Classical Karst)	L. Visintin	
9.20-10.00	SESSION 4: Social aspects of karst protection		
9.20-9.40	Managing the Karst landscape: drafting the management plan with stakeholders and local inhabitants	R. Rodela	
9.40-10.00	Karst Underground Protection – cross-boundary EU project	L. Dravec	
10.00-11.00	<i>Preparation time for afternoon field trip</i>		
11.00-21.00	Cross-boundary issues on underground protection in Slovene and Croatian Istria (multiple-entry visa needed!)	Afternoon Field Trip	

Thursday, 23th June 2011

8.00-19.30	Management and protection of caves and karst aquifers in Dolenjska region	Whole-day Excursion
20.00-	Reception at Karst Research Institute	

Friday, 24th June 2011

8.00-17.30	Classical karst (springs of Ljubljana, Logatec polje, Planina polje, Rakov Škocjan, Škocjanske jame, Divača, Socerb)	Whole-day Excursion
20.00	The protection of caves and their good and bad management (J.-P. Bartholeyns) – lecture for cavers	Ljubljana (Novi trg 4; Prešernova dvorana)

Saturday, 25th June 2011

9.00-13.00	Optional tourist trip to the Protus Vivarium (Speleobiological Station of Postojnska jama)	
13.00	Departure of participants	

FIELD TRIPS

Postojnska jama – touristic use through centuries and problems of cave protection

Monday, 20th June 2011, 18.00-22.00

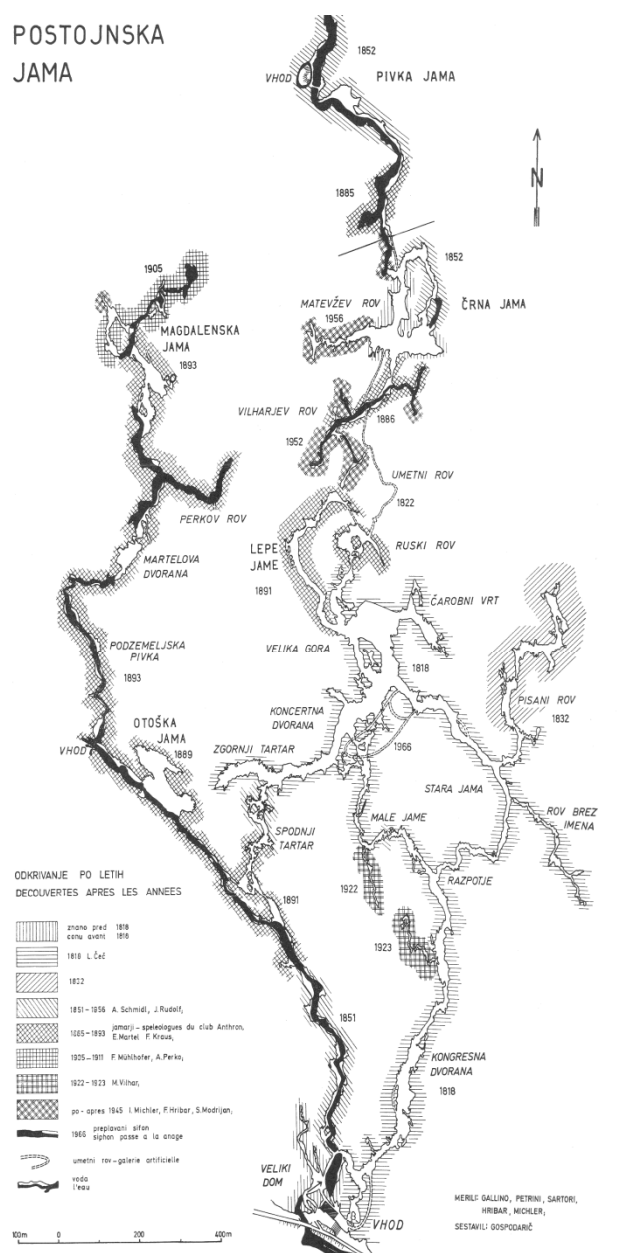
Short description

Postojna cave is the longest and most important show cave in Slovenia and one of the most famous karst caves in the world. The cave is a complex system of passages with large entrances, a river that disappears underground, subterranean chambers and a wealth of speleothems, and has been attracting large numbers of tourists for centuries. Its popularity and impressive visitor numbers are also helped by its geographical location in the so-called Postojna Gate, the easiest route over the Dinaric Alps between the Pannonian Plain and northern Italy.

On excursion more than 190-years-old history of touristic use will be presented. We will face a complex relationship between the use of the cave and the conservation of its valuable characteristics – in other words the protection of the cave and its surrounding area. Numerous traces of its use as a show cave have remained in the cave and can be still visible.

We will take the train and walk through Velika gora, Spodnji Tartarus to Pivka river, Male jame and through entrance part of Postojnska jama along railway. **Hand lamp and walking boots are strongly recommended.**

POSTOJNSKA
JAMA



Touristic use of Križna jama and threats from catchment area (Bloke plateau)

Tuesday, 21th June 2011, 13.00-20.00



Short description

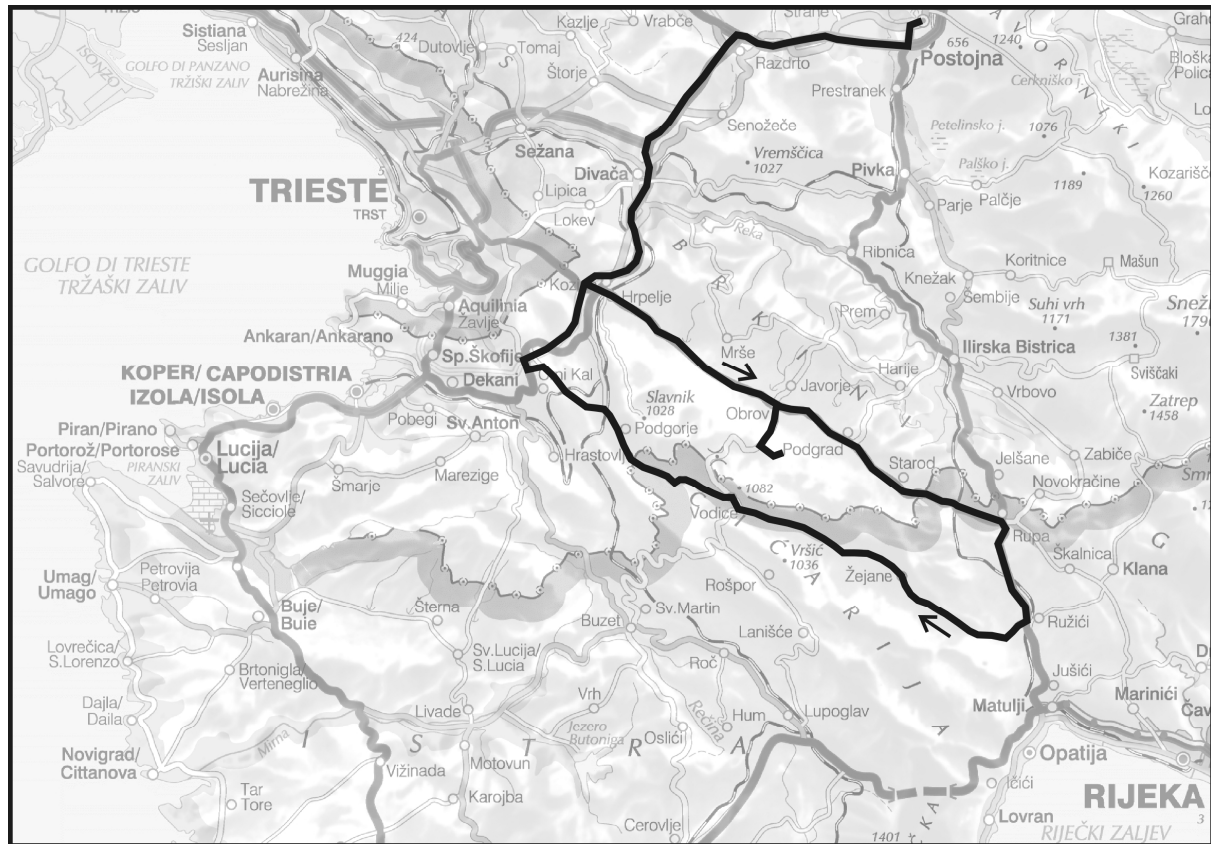
Križna jama is a more than 8 km long water table cave situated between Cerknica polje, Lož polje and Bloke plateau. Roughly one kilometre has been used for touristic purposes for the last six decades. The cave is important due to outstanding findings of cave bear bones, one of the highest subterranean biodiversity in the world and dammed underground water flow that makes more than 40 underground lakes. The latter are formed behind rimstone dams that are extremely vulnerable to breakage, abrasion, and can be influenced by climatic and anthropogenic changes of water chemistry.

On excursion, cave itself, on-going research, and sustainable touristic management of will be presented along touristic pathway. We will visit Bloke plateau from where at least high waters are flowing into the cave. Since the Bloke plateau is populated and water treatment plant insufficiently purifies waste water (although it is accordant with law), outflow from water treatment plant can cause unpredictable damages to underground biodiversity, morphology, and tourism. We will present water tracing test that was carried out from Bloke plateau in the years 2007/2008.

On the way back we will make a stop on Cerknica polje, where probably unflooded ponor zone Rešeto can be visible. **Walking shoes and head lamp are recommended!**

Cross-boundary issues on underground protection in Slovene and Croatian Istria (multiple-entry visa needed!)

Wednesday, 22th June 2011, 11.00-21.00



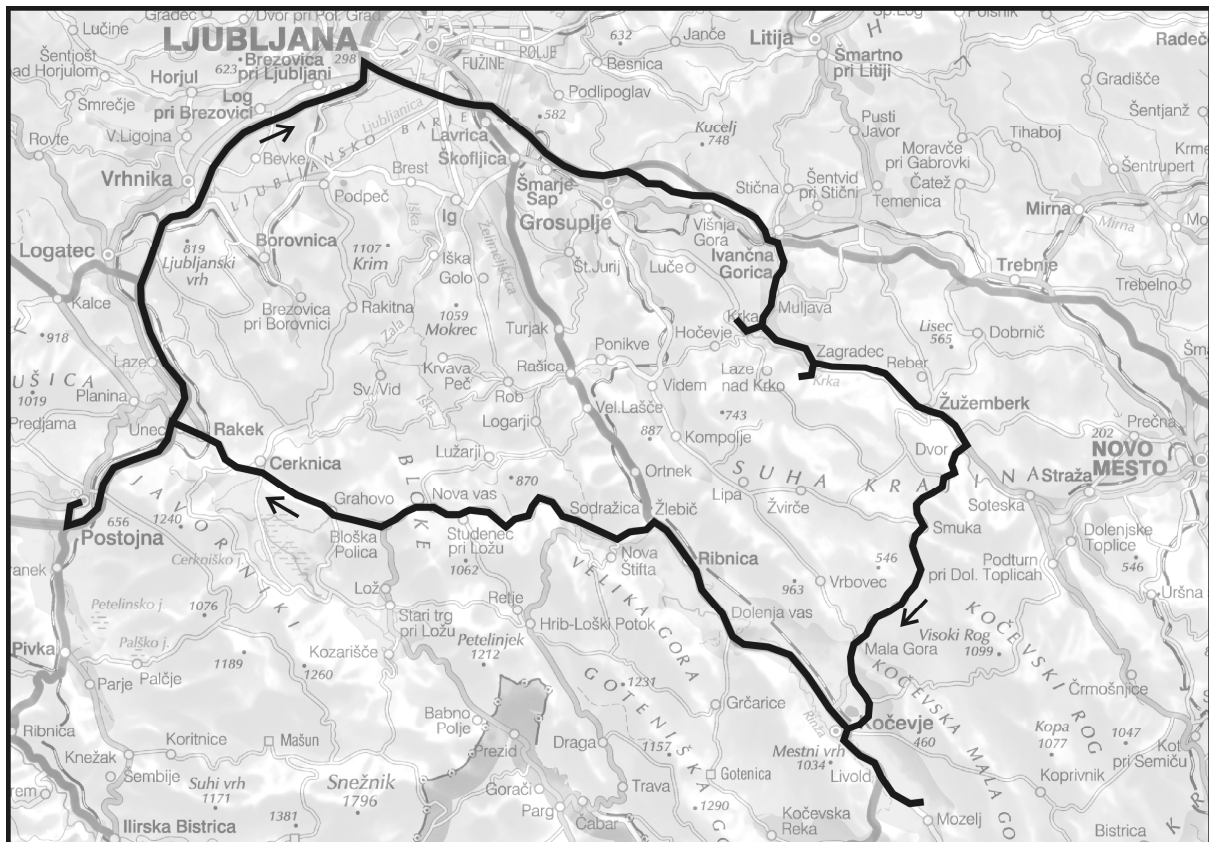
Short description

During this field trip we will visit karst phenomena of Slovenian and Croatian Istria. Istria is a peninsula between Rijeka (Croatia) and Trieste (Italy) and therefore divided between three countries (Croatia, Slovenia and Italy). It is partly karstic and partly non karstic. Combination of both types of relief results in phenomena of contact karst with hollowed underground karst rich in big horizontal caves. Underground water flow is directed generally from NE to SW where it drains into the Adriatic Sea. Since the underground water flow crosses state boundaries at several places, karst aquifer has a strong cross-boundary character. Due to lack of water in summer period, which is also a result of tourism growth in coastal area, problems with water supply appeared quite early and were only partly solved yet. Area is rich also from the biospeleological point of view since it is quite different from nearby karst areas. Due to lack of water and harsh environment area was strongly depopulated in the first part of 20th century. To make living possible in the future and to stimulate sustainable development of Istrian karst, Region of Istria applied for an EU project in 2009 together with Croatian public institution Natura Histrica and Slovene partner Karst Research Institute ZRC SAZU. The result of this project will be presented on excursion including cleanup of karst caves, biospeleological research in Slovenia and Croatia, and construction of "Speleo-house" in Vodice (Croatia).

There will be more than 150 km by bus and several short walks, also through non-touristic cave. **Hand lamp and walking boots are therefore obligatory!**

Management and protection of caves and karst aquifers in Dolenjska region

Thursday, 23th June 2011, 8.00-19.30



Short description

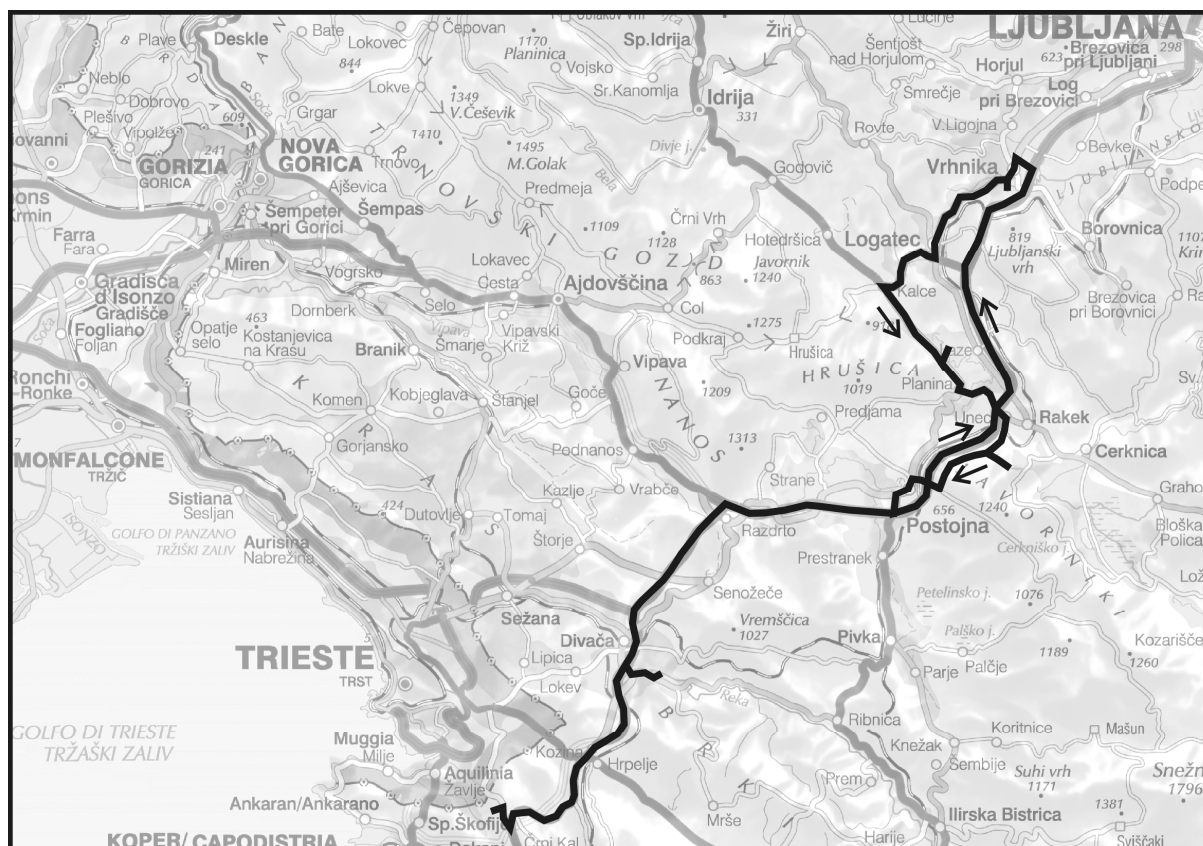
Field trip will take us along Dolenjska karst region. This is rather a shallow karst region. Upper Triassic dolomites are usually less permeable for underground water and this is the reason for fluvio-karst development of eastern part of Dolenjska – a karst with partly karstic and partly fluvial character. Big horizontal caves are very rare. Western part is similar to Notranjska karst region with deep karst and underground water flow between poljes and valleys. Finally, the water appears for the last time on the surface along Krka river.

Although the area is quite sparsely populated, several karst environmental problems appear. There is a problem of water supply since vast areas are without surface water and people depend on few water sources. In the past, some of these sources were and still are polluted and water supply was obstructed. Complex catchment areas of karst springs make difficult to locate source of pollution. In some other areas polluter was known but not stopped – as a result impact to underground karst are still visible. We will visit Mozelj landfill located on karst which will be closed in the near future due to possible negative environmental impact. We will present the proposed monitoring of karst water's quality in downstream of landfill which is based on hydrogeological investigations in recent years.

There will be more than 200 km by bus and some relatively short walks. **Walking boots and hand lamps are obligatory!**

Classical Karst

Friday, 24th June 2011, 8.00-17.30



Short description

Field trip will take place in the area of Classical Karst. In this area, the first organized scientific investigations of karst phenomena were carried out during the 19th century. On excursion, some typical morphological and hydrological karst phenomena will be visited including Ljubljana springs near Vrhnika, Logatec and Planina polje, karst valley Rakov Škocjan, Škocjanske jame, and the SW edge of Karst plateau near Socerb. Excursion is recommendable for those who are visiting Classical Karst area for the first time, those who would like to see poljes and spring at different hydrological situations or for those who would like to take photos of classical karst phenomena. Stops at specific sites will be short except the stop in Škocjanske jame. Only short walks are planned. **Walking boots are recommended but not necessary.**

Optional tourist trip to the Proteus Vivarium (Speleobiological Station of Postojnska jama)

Saturday, 25th June 2011, 9.00-13.00

Short description

Proteus Vivarium is located 100 m from the entrance to Postojnska jama. Its main purpose is to present living world of Postojnska jama that was recognized as the most diverse in the world. Postojnska jama was also a place where some of the first subterranean animals were found in the world (e.g. cave beetle *Leptodirus hochenwartii* in 1831). In Proteus Vivarium, it is possible to see live specimens of the diverse cave fauna. Entrance part to Proteus Vivarium was deepened into the sediments and this makes possible to observe several tens of thousands of years of changes in the entrance part of Postojnska jama.

No special equipment is needed to visit Proteus Vivarium since it is a touristic site. Trip through will be not guided by organizers but you can get some more recommendations about the trip and nearby places of interest.

INVITATION TO A SPECIAL SESSION: UNRESOLVED MYSTERIES IN KARST

This year's school will be as always a great opportunity as a meeting point between experienced and new researchers from different parts of the globe.

The last two years, a Special Session on Mysteries in Karst science was held, and it was quite successful, in that some answers could be found, and others are actively investigated at the moment. Since there are many more mysteries present in karst science, we decided to repeat that session again.

Usually talks in schools and congresses deal with progress of ongoing research and with their results. This session, however, has the aim to present the still-unresolved problems and to promote and stimulate research! In opposition to many other scientific branches, karstologists most often try to collaborate in order to resolve problems. This session should therefore promote further the world-wide collaboration.

Because there are no results, talks usually are short, but because questions are formulated, discussion should be longer. Therefore, talks are limited to about 5 minutes, while discussions may last 10-15 minutes.

You are all invited to contribute to the session. Please send a brief problem outline and description to Philipp Häuselmann (praezis@speleo.ch).

We will have one hour for the session. The number of topics is of course limited. We will do our best to select the most interesting and provoking.

ABSTRACTS

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PROTECTION AND DAMAGE RISK OF UNDERGROUND KARST IN PAKLENICA NATIONAL PARK, CROATIA

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National park Paklenica is a part of Velebit Mountain, which is known among mountaineers, climbers and geologists as an impressive karst area. The Paklenica National park extends on 96 km² of Southern Velebit Mt., and comprises 150 km of trails, but the first 10 km of them are visited by virtually all tourists who enter the park. The National park is visited by 100,000 people in one year, but most of them are hikers on one day field trip. Interesting geological history of the Velebit Mt. led to formation of a great number of karst relief forms such as scarps, sinkholes, crests, kamenitzas, karst wells as well as speleological objects. During past few decades speleologists explored 76 caves and pits in the National park. About 15 caves and pits are easily accessed from trails, whereas eight of them are located next to the trail. The Manita Peć cave is the only one open for organized tourist visits. Entry into other speleological objects is not authorized, but there is no adequate control which would keep inquisitive visitors away from those objects, and some smaller caves are frequently being used as overnight shelters by rock climbers and mountaineers. In this work we are presenting the Manita Peć cave (a touristic attraction and example of protected karst phenomena) and risk level of other (unprotected) speleological objects.

Keywords: Croatia, National park, protection, karst, underground, tourism

HYDROGEOLOGY OF KARST FRACTURED AQUIFER AS TOOL FOR WATER RESOCERCE IN ZAGROS RANGE (S.W. IRAN)

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Fractured Karstified rocks cover more than 90 %percent part of Zagros range. A significant presence of carbonate rocks and consequently number of well developed Karst aquifers are the main hydrogeological characteristic of Zagros range. Due to vast exposure of karst in Zagros and increasing demand for fresh water use has led to new investigation on karst water in Zagros Region. Huge discharge from springs which are feeding the alluvium aquifer, presence of surface and subsurface karst features has made Zagros range as unique for karst –hydrogeology of the region.

A cited in paper in this region tectonic has an important role in karstification process in Zagros to addition to primary porosity of limestone the tectonic activity result in the secondary porosity which include intensive fracturing which has facilitated the flow of water. Also case study show karstification decrease with depth.

It is finally stated that study of karst hydrogeology features in Zagros which will lead for better understanding of Karst aquifer will help for recognition of new fractured aquifer to overcome the problem of drinking water in the region.

It is finally stated that study of karst features in Zagros will lead to better understanding of karst in this region and so there is a great need for comparison and international scientific cooperation in recognition of karst phenomena in this area.

Keywords: karst water, water supply, Zagros, Iran

FLASH DEVELOPMENT OF GYPSUM CAVE BY MAN ACTIVITY

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Presentation of 3 large gypsum caves in French Southern Alps. They formed in a few years from the overflows of water supply reservoirs.

Keywords: gypsum cave, speleogenesis from human origin

PROTEUS AFTER FLOODING: SHOULD WE SAVE THE ANIMALS OR LET THEM BE?

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Proteus anguinus (Amphibia: Urodela: Proteidae), an endemic dweller of the subterranean waters of the Dinaric karst, is restricted to its cave habitat. However, during seasonal flooding, some specimens get washed out of their subterranean environment. While this may be considered as a highly hazardous way for *Proteus* to disperse into new habitats, it is obvious that all these individuals present a constant loss to their population.

Seasonal flooding has probably been an important selective force in the evolution of *Proteus* behaviour. We presume that *Proteus* has developed several responses to reduce the danger of being washed out of its subterranean habitat as well as to adapt its feeding and reproduction behaviour. Due to an extreme lifespan of *Proteus* (nearly 100 years in captivity) on one hand and long reproduction cycles (approx. every 8 years in captivity) on the other, loss of every individual has a considerable influence on the size of its population. Although this periodic loss has been well balanced through the evolution, a concern is raised when possible effects of climate change are considered: timing, frequency and magnitude of flood events are expected to be changed.

The Tular Cave Laboratory has extensively studied this phenomenon since 2008, and documented 14 cases in Slovenia. All animals were found by chance and reported by local people. Through this research we unexpectedly became involved in a rescue mission: six of these animals were saved and returned to their source population.

In Slovenia, *Proteus* has been protected since 1922. So far it has not been adequately discussed how to deal with specimens being washed out onto surface after floods. According to the Slovenian present nature conservation legislation and practice, these animals should be left to their natural destiny (in most cases to dry out or being eaten by birds/fish).

We suggest that all necessary actions should be taken to preserve these rare and highly endangered animals. It is the intention of this paper to present facts – for and against – saving these animals, and to raise a new discussion on this important but neglected phenomenon.

Keywords: *Proteus anguinus*, floods, conservation actions

PRELIMINARY MICROCLIMATE RESEARCH IN THE BUCO CATTIVO CAVE (FRASASSI CAVES) ITALY

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In the last years research activities in the measuring characteristics of the cave microclimate in the Buco Cattivo cave and below Fiume-Vento underground system, have been carried out with the aim to investigate both the natural and anthropogenic influence on the main microclimatic parameters within the caves system. Federazione Speleologica Marchigiana “FSM” and Gruppo Speleologico Urbinate “GSU” installed a new generation of temperature detectors since January 2006. Careful data analysis, provided by 7 sensors connected to 5 data loggers measuring air temperature (average value/hour) inside Buco Cattivo cave until 3 km from the entrance, allow us to detect transient changes into the cave micro-atmosphere. Data collected show the presence of abnormal areas which appear to be influenced by warmer air flows probably originating inside unknown areas of the underground system.

Keywords: cave microclimate, Frasassi Caves, anthropogenic influence

UNIFIED DATABASE OF SPELEOLOGICAL OBJECTS

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Unified database of speleological objects represents the integral information system of karst and pseudokarst phenomena (such as natural underground cavities – caves, swallow holes and their relative forms of relief and hydrological objects – resurgences and sinks) in the area of the Czech Republic. This database is a part of information system of nature protection that the Agency for Nature Conservation and Landscape Protection of the Czech Republic administrates. The database is used by the authorities of civil service, specialized organisations and public (urbanism planning, research, monitoring etc.). Data collection, visualization and administration of that system is providing by the web application on the URL address <http://jeso.nature.cz>. Contemporary situation of database, its progress, possibilities of data collection and the usable options of this information system are represented on the posters.

Keywords: database, GIS

PROJECT LIFE + 08NAT/IT/000369 “GYPSUM”. FIRST RESULTS ON THE CHEMICAL ANALYSES ON WATERS IN GYPSUM AREAS OF EMILIA ROMAGNA REGION (ITALY)

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A Project Life+ 08NAT/IT/000369 “Gypsum” financed by the UE has started since 2010. This project encompasses the protection and management of the main gypsum areas of the Emilia-Romagna region (Italy). Action A3 foresees the pluriannual monitoring of the main karst aquifers from a microbiological and chemical point of view. During the first year the waters of almost 50 stations have been analysed in the 6 Sites of Community Interest of the region (SCI IT4030009 Gessi Triassici (3), SCI IT4030017 Gessi di Borzano (4), SCI IT4050001 Gessi Bolognesi (16), SCI IT4050027 Gessi di Zola Predosa (2), SCI IT4070011 Vena del Gesso Romagnola (20), and SCI IT4090001 Onferno (4)). The aim was to verify the quality of the water and the possible sources of pollution (agriculture, civil, bat colonies, etc.). Sampling points were sinks, rivers in caves and springs. Three sampling campaigns have been carried out in 2010 thanks to the collaboration of cavers belonging to clubs of the regional speleological Federation. Some parameters (water temperature, pH) have been measured in situ. All chemical analyses (Na^+ , K^+ , Mg^{2+} , Ca^{2+} , NH_4^+ , HCO_3^- , CO_3^{2-} , SO_4^{2-} , Cl^- , F^- , Br^- , NO_2^- , NO_3^- , and PO_4^{3-}) have been carried out in the laboratories of the Department of Earth and Environmental Sciences of Bologna University. Ammonium (NH_4^+ , portable single ray spectrophotometer Hack DR 2010) and alkalinity (titration) have been done within 24 hours from sampling. The other analyses have been performed using a double ray Atomic Absorption Spectrometer Thermo S for cations and an Ionic Chromatograph Metrohm 881 IC Pro for the anions. In some samples of Novembre/Dicembre 2010 also metals and trace elements have been analysed (e.g. Pb, As, Cu, Zn, Cd etc.). All analysed samples can be classified as mineral waters with between 1 and 10 g/L of dissolved salts. Most are enriched in sulphates with concentrations even exceeding 2000 mg/L. These waters are thus not suitable for drinking according to Law 31/2001 (limit = 250 mg/L). The concentration in nitrates are very high with values in 12 samples largely above the drinking water limit (50 mg/L, Law 31/2001). The nitrate values appear to be independent from the total dissolved salts and are clearly seasonal, at least in the most polluted samples. Project details at www.lifegypsum.it (Coordinating institution “Parco Reg. Gessi Bolognesi e Calanchi dell’Abbadessa”; info from David Bianco: servizioambiente@parcogessibolognesi.it).

Keywords: water, chemistry, gypsum, monitoring, pollution

UNDERWATER SPELEOLOGY AND PRESERVATION OF COASTAL CAVES (ISTRIA, CROATIA)

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Istrian coast is almost completely carved on limestones. Many coastal and submerged caves have been surveyed and represent an attractive element of the coastal landscape. These caves are well known by divers and fishermen, but no systematic studies have been carried out. We managed a systematic underwater explorations and surveying of 2 coastal caves, in order to identify factors involving the origin and development of the caves, in order to evaluate their increase in value and useful methods of protection. The studied caves are located along the Istrian coast, in different sites with different meteo-climatic conditions: the first, in the southernmost part of Istria (Premantura's bay) and the other near Brseč (eastern coast). Both are carved in Cretaceous limestones and develop at the sea level. For this reason they are partly emerged and partly submerged. Coastal caves in Istria are mainly developed along faults, fractures and joints. Considering their size and the tectonic subsidence of the area, their genesis probably started in a subaerial position, as suggested by the occurrence of speleothems and scallops. Then, when the sea reached the present level, marine factors started to rework their morphology. At Premantura, a semi-submerged cave develops on a plunging cliff, in correspondence of different systems of faults and fractures. A very well-carved abrasion notch enlarges the bottom of the cave. It extends up to -6 m in depth and 3 m in amplitude. The bottom of the cave is covered by pebbles and cobbles. Many collapsed blocks have been recognized, up to 2 m in size. Speleothems, scallops and other karst morphologies have been observed in the emerged sector of the cave. These morphologies are abruptly interrupted in correspondence of the mean sea level. The Golubere cave (Brseč) is composed by two caves, the first above and the second below mean sea level. A submarine notch have been found at -0.60 m in correspondence of the plunging cliff. A continental shell deposit have been recognised in the upper cave. A freshwater spring occurs in the submarine cave. The protection of coastal caves are closely related to the understanding of their origin, their morphometric features and morphodynamic processes. This knowledge allows to forecast their future tourist sustainable development.

Keywords: submergerd cave, Istrian coast, karst morphology

GEOHERITAGE IN THE KARST UNDERGROUND OF CROATIA AND PROBLEMS OF THEIR PROTECTION

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Heritage, to put it simply, encloses a certain area's natural and cultural values, which should be preserved for future generations. Its values include living and not living components. Unfortunately, the protection of not living natural values – geodiversity, is nowadays, as a social necessity, significantly less marked than the necessity of the living world protection – biodiversity. Caves are the forms of the underground karst geomorphology. They have developed by specific processes in certain conditions of karst geomorphology and hydrogeology. They represent different, often interesting and rare forms which preserve the traces of natural conditions in the time of their development, and make an important component of geoheritage. This paper deals with critical analysis of the protection of speleological phenomena in Croatia as a part of geoheritage in karst. At the moment, there are 42 protected speleological localities in the Republic of Croatia, among which geomorphologic monuments of nature account for the greatest part. Criteria of proclaiming caves and pits protected localities are the most disputable, because the analysis has shown that the caves and pits without necessary values are also among the protected localities, while on the other hand, the caves and pits of great value and high degree of threat are not protected at all. It was also determined that about 1800 speleological phenomena were protected in the framework of protected areas (national parks and parks of nature). It is pointed out that nowadays nature protection, especially that of caves is mainly directed to the protection of the living nature, i.e. the karst underground is being protected as a habitat, and not as a part of geoheritage. This has been confirmed by legal regulations. This paper emphasizes various aspects of cave and pit values (intrinsic, scientific, aesthetic, educative and recreative). Geosciences aspects of cave and pit values are especially emphasized (geomorphological – macro, mezzo and micro, geological-petrographical, mineralogical, sedimentological, hydrographical-hydrogeological, climatological, paleontological, georheological, etc.). Totality of all natural and cultural values of caves and necessity of their protection has been pointed to. The main types (mechanic – destruction, mechanic – construction, chemical, physical and biological) and ways (direct and indirect) of cave threats have been presented, as well as their origins. Some problems of karst and its underground protection are being pointed to, and recommendations for their more prestigious protection are given. The emphasis is on research, immediate recognition of values, inventory-making, evaluation and determination of protection priorities and levels. Cooperation among state institutions, speleologists, speleological and caving associations, scientific institutions and other experts is inevitable. In order to achieve a more prestigious protection some criteria for speleological phenomena evaluation from geoscientific point of view have been suggested: morphometrics, location and origin conditions; diversity, numerosity and rarity of speleothems and other geomorphologic and geologic indicators of geodiversity; level of potential and present threat; other geoscientific significance; geoaesthetics; educative significance.

Keywords: geoheritage, Dinaric karst, cave, cave protection, Croatia

EXPLORATIONS AND DOCUMENTATION OF THE CAVES IN FUNCTION OF THEIR PROTECTION – EXAMPLES FROM CAVE PARK GRABOVAČA AND CEROVAČKE CAVES, CROATIA

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Cave Park Grabovača is protected area near town Perušić in the Lika region. Public institution for management of the Cave Park was found in year 2006. Park includes area of 5,95 km² with nine caves (Samograd, Medina pećina, Amidžina pećina, Velika Kozarica, Mala Kozarica, Tabakuša, Slipca – Japaga, Pećina pod turskom kulom, Pećna kod Prvan sela). Some of these caves are special protected as geomorphological monuments. These caves have long exploration and tourist exploitation history but without systematic exploration and scientific documentation. Cerovačke caves are situated on the northern slope of Crnopac, the highest and the most karstified part of the south-eastern Velebit Mt. Cerovačke caves includes three speleological features: Upper Cerovačka (1290 m), Middle Cerovačka (390 m) and Lower Cerovačka cave (3200 m). They were discovered during the construction of railroad from Gračac to Knin in the year 1913. Upper and Lower Cerovačka cave are one of the known show cave site in Croatia. Cerovačke caves are important geomorphological, geological, palaeontological, archaeological and biospeleological site and they are included in the area of the Nature Park Velebit. These sites are among the most valuable speleological features in Croatian karst. Speleological clubs from Karlovac and Samobor, together with protected areas administrations were establish systematic exploration, monitoring and documentation projects with unitary data basis. The main goal of these projects is to improve the knowledge of these sites towards to their better protection. Also, it is very important to continue with speleological researches in order to discover new, so far unknown caves and channels. It is also necessary to continue with systematic scientific researches.

Keywords: cave protection, exploration, cave documentation, Grabovača, Cerovačke caves, Croatia

PROTECTING THE KARST OF LEBANON: AN OVERVIEW

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Karst in Lebanon is widespread. It is developed to different degrees in diverse areas within varied rock ages. More than 65 % of the surface of Lebanon is covered with karstic rocks. Some are spectacular and important and some are less significant in terms of beauty and biodiversity, however all are important in terms of groundwater. There are three main categories of karst present in Lebanon. These are surface karst, subsurface karst and underwater karst. Each one of these has different and varied landforms as well as unique elements. The exposed surface karstic features of Lebanon are of different types and extent. Cockpit karst, sinkholes, natural bridges, pinnacle and broad tower karst are typical features. Small features, such as karren and lapiaz, and even smaller features, such as scallops, ripples pans, flutes and rills are abundant. Dolines of different forms are scattered all over the landscape. The doline fields of the North Mount Lebanon range is a typical example. Large dolines, such as the poljes of Qammouaa are rare. In Lebanon example of surface karst areas that need protection and care are: North Mount Lebanon areas, the Tarshish area, Boualiaa area, Tanourine el Fouka area, Jaj area. Subsurface karst includes vertical and horizontal caves of all shape and sizes. Lebanon holds more than 700 documented caves. Many more are being discovered each year. Subsurface karst is also under threat from soluble and solid waste. Examples of caves being used as solid dumps and drains for sewage are widespread. Caves are under threat from vandalism. Graffiti and writings by people who decide to sign their names are also polluting many caves all over Lebanon. In the Harissa area the owner of a house decided that he wanted to place stalagmites, he had bought from China, as a center piece to the outdoor décor of his house. Jiita cave the longest and most beautiful cave in Lebanon is under threat from sewage and soluble waste that trickles into the cave and contaminates the underground river it holds. Humans also tend to destroy surface and subsurface karst by quarrying activities, road construction. The deepest sinkhole in Lebanon, Fouar Dara, is under threat from quarrying and currently the quarry lies 200 m away from the ponor. After extensive complaints to the MoE, MoI and MoEW some progress has been made in highlighting the issue although the quarry is still working. Spectacular features such as caves, bridges, and pinnacles are all present under the shallow shores of Lebanon. They are the habitat for many sea flora and fauna. Those sites are under threat from waste which is both in soluble and insoluble form. Typical underwater karstic areas are in Chekka, Jounieh and Nakoura areas. There are 9 show caves in Lebanon. The Ministry of Environment has proposed to protect 18 horizontal caves and 9 vertical caves. Out of the eight natural reserves present in Lebanon and protected by a Law, seven are located in karstic terrains. The Tyre Coast Nature Reserve in the south is the only one which might not be related directly to a karstic environment. In terms of its water resources more than 80 % of the groundwater in Lebanon comes from karstic aquifers. The two main towers of our groundwater resources are the Cretaceous and Jurassic karstic aquifers covering 42 % and 12 % of the land surface respectively. A large amount of Lebanon's biodiversity can be found on/in karstic rocks. The surface karst of Lebanon holds the ceders trees the underground karst is the hub of more than 30 species of bats. Those karstic features act as hubs and protection zones for endangered species. Lebanese people have lived with karst since early ages and they will have to protect and live with this fragile

environment if they want to survive. It seems the only way to protect the karst heritage in Lebanon is by personal and single actions by concerned citizens. The government has yet to realize that apart from water resources this is the only other resource that Lebanon possesses.

Keywords: karst, Lebanon, protection

THE WATER PRESERVATION PROJECT „SPRINGS OF LIFE“ AT BORDER KARSTIC AREA OF BELA KRAJINA, SLOVENIA AND ŽUMBERAK - SAMOBORSKO GORJE NATURE PARK, CROATIA

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The cross-border project "Springs of life" is partially funded by the European Union from the Instrument for Pre-Accession Assistance within the IPA Operational Programme Slovenia – Croatia 2007–2013. The project aims to preserve and restore small springs, which would serve as important alternative sources of drinking water, and certain village ponds, which would contribute to the preservation of ecological balance, biodiversity and provide a favorable status of endangered species and habitat types in the protected areas, with emphasis on the species which are under the directive of priority habitat in protected areas, Natura 2000, and have already been declared in Slovenia, and are in the process of creating in Croatia. Through the reconstruction and rehabilitation of certain major springs and larger ponds (45 all together) there will be ensured a favorable conservation status of species and, indirectly, project will increase awareness and encourage people about the importance of nature conservation. It will stimulate oriented economic use of water resources in accordance with the interests of protection of nature and its conservation. The results of a census carried out will be restored water bodies and their suitable presentation at selected locations in the border karstic area in the Bela Krajina in Slovenia and in the area Žumberak and Samoborsko gorje in Croatia. They will contribute to greater care about the behavior of the environment in the border area, recognition of the importance of water resources on karstic area and their proper use, connection isolated animal and plant species. Restored water bodies will represent a migration corridor between the Slovenia and Croatia.

Keywords: springs, ponds, restoration, cross-border project, Bela Krajina, Slovenia, Žumberak, Samoborsko gorje, Croatia

DONG VAN PLATEAU NORTHERN VIET NAM: CAVE EXPLORATIONS AND HYDROGEOLOGICAL RESEARCHES IN ORDER TO PREVENT ANY ADVERSE IMPACTS ON THE ENVIRONMENT AND THE WATER RESOURCES QUALITY

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In Dong Van Plateau, karst is one of the control factors of surface and groundwater resources. The protection of drinking water has become the most crucial question for human survival. Therefore it is necessary to strengthen specific environmental investigations and attain a reliable water resources assessment for a sustainable social-economic development of this area. Villages are located close to springs, rivers or caves with ferly good deposits of water, but other villages built at the top of hills and mountains have not any available water resource close to their leaving place. Discovering a cave with water occurrences inside even of limited discharge it is a very important water supply for the local people particularly during the dry season when surface water is poor or non-existent. The exploration of hypogean cavities and the collection of data through the inventory of water occurrences as well as fauna and rocks, allows to upgrade the hydrogeological setting of the area in order to prevent any adverse impacts on the environment and the water resources quality. The speleological exploration is focused also on improving the hydrogeological framework with the aim to establish a satisfactory water supply to the local communities and upgrade the knowledge and experience in several aspects of karst research as well as promoting the development of the first “Geopark” in Vietnam. The use of stable isotopes, in particular the isotope ratios of oxygen and hydrogen as conservative tracer, has improved the understanding of problems related to catchment and groundwater studies. The water for stable isotope analysis was collected from cave dripping, hypogean streams, lakes and springs, mostly. According to the hydrostructure setting, a karst system generally shows at the base a thick and large saturated zone which supplies the discharge of relevant perennial springs and rivers. Due to the development of surface and hypogean karst features as well as to climate factors, flow dynamics in carbonate aquifers involve usually strong variation in response to precipitation events. As a matter of fact rains over bare karst terrains seep easily underground recharging rapidly through a network of joints and fissures perched as well as the basal aquifer of the hydrostructure.

Keywords: hydrogeological researches, isotope geochemical applications, geopark

FLORISTIC DIVERSITY AND ECOLOGICAL FEATURES OF SELECTED CAVE ENTRANCES ON MEDVEDNICA MT. (CROATIA)

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Medvednica Mt. is located in NW Croatia. Although there non-karst morphogenetic relief categories predominate, in the Mesozoic and Neogene carbonate beds isolated karst relief is developed. It is divided into several smaller areas in the SW, central and NE part of the mountain. The most numerous surface karst landforms are dolines. Caves are smaller in size and of simple morphology, with the exception of the Veternica cave which is 7100 m long. Within the research project of the flora and ecological factors at the cave entrances in Croatia, researches in Medvednica were made in two shafts and one cave: Kosićev ponor, Tisin ponor and Velika peć cave. These are caves with large entrances where there are good conditions for the development of plants and their representation is greater than in other caves of the area. In all three caves geomorphological, botanical and microclimate research were carried out. There were collected and listed the plants that grow near the entrance and at different distances from the entrance to the passage interior and some of them were mapped. The change of air temperature and relative humidity outside the cave and at the lower limit of the plant growth in a cave for 24 hours in different seasons were measured together with momentary ambient light outside caves and at different distances from entrances. Recorded plants were subject to taxonomic and phytogeographic analysis and analysis of ecological indicatory values and life forms. A total of more than 50 species were recorded. From floral elements represented the largest share has the European floral element, and the life forms hemicryptophytes prevail. Prevalent species are those that grow in shaded and humid habitats and those that are widespread and can grow in subalpine and hilly areas. Measurements of ecological abiotic factors showed changes depending on the distance from the entrance, the climate in which caves are located and the morphology of their entrance parts. The factors controlling the development and abundance of plants are the morphology and dimensions of the entrance and its illumination conditions, soil characteristics and ecological features of habitats.

Keywords: Medvednica, karst, cave entrance, flora, ecological features, ecological indicatory values

PROTEKARST: A NEW APPROACH TO KARST PROTECTION. PRELIMINARY RESULTS.

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Karst is a complex three-dimensional system, composed of rocks, water, air, soil, animals and vegetation. We can see two different areas about karst: external (exokarst) and underground (endokarst). It's not about two blocked compartment, quite the contrary, they are relationated and what happens in one has effects in the other.

Karst has important scientific values (geological, hydrologic and hydrogeological, biological, landscapes), patrimonial and cultural values (archaeological, cave painting, recreational and educational values) and economic values (agriculture, forestry and mining, extraction of gravel in quarries, tourism and other uses of stored water in the aquifers).

This paper proposes the development of a methodology based on the obtaining of a karst protection map from the thematic cartography of each value integrated through GIS. It exposes the different criteria to quantify geological, hydrogeological, botanical, archaeological and landscape values and the obtained results in a outcrop of calcareous rocks (alpujarride marbles, Betic range) in the Sierra of Mijas situated in the west of Malaga.

Keywords: karst, valuation, protection, GIS, Betic range, south of Spain

KARST UNDERGROUND PROTECTION IN SICILY (SOUTHERN ITALY), SOME EXAMPLES FROM SPELEOLOGICAL NATURAL RESERVES

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In Sicily (southern Italy) large karst areas in evaporite and carbonate rocks occur, affecting about 20 % of the island territory. Very varied surface landforms, from karren to polje, and hundreds caves of different origin characterize these areas which represent extraordinary environments for the

variety and originality of the landscapes and for the observation and study of the solution forms. Even though a specific law for the protection of karst areas is lacking, the Sicilian Region Government has set up twenty-two natural reserves to preserve and exploit both evaporite and carbonate karst areas characterized by peculiar surface landforms and caves. Among these twelve protected areas have been founded specifically to preserve caves due to their speleological, paleontological, anthropological and archaeological interest. The management of the speleological reserves is assigned to environmental associations, university and to the Regional Forest Department that advance the scientific research, popularize their environmental features, promote their safeguard, undertake environmental restoration measures, encourage the development of sustainable tourism through several activities also in collaboration with scholars, local authorities and communities, universities and schools of any level. This paper describes the management of some speleological natural reserves, also taking into account the operating results obtained and the difficulties encountered.

Keywords: Sicily, karst, speleological natural reserves

THE IMPACTS OF VISITORS ON CAVES' PHYSICAL ENVIRONMENT

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Studies of impacts on caves usually cover the topics of water pollution, changes in temperature and CO₂, lampenflora and impacts on cave biota. Herewith the impacts of visitors on physical environment in caves are presented. They accumulate in caves through the centuries, are long lasting and are one of the most visible impacts in caves. These impacts also reduce the scientific value of caves (as they “erase” important information of the evolution of caves and surface) and the aesthetical value of caves.

The caves of the Classical Karst have been in use since Prehistoric times and the use of the caves variegated. They were used as shelters, hiding places or in cult manner; as places for deposition (weapons, explosive, as refuse dumps and waste water) and for exploitation of natural sources (karst springs, ice). The most known use since the 17th century has been for tourism and speleology. Due to speleological explorations, development of karstology as a science and the development of tourism, the region and its phenomena have become world known. But long and intense use of caves particularly in the last two centuries, have caused significant impacts also on caves' physical environment.

Speleothems breaking is one of the most evident impacts. But it seems that it has been over now and there are also no new breakings evident. The off trail footprints affect mainly fine sediments and are very frequent in all caves. Show caves have undergone to the most intense impacts due to infrastructure works and visitors. Lampenflora is one of the most visible effects in the most visited

caves (Postojnska jama, Škocjanske jame and Grotta Gigante). In caves there can be found trash and waste material. The most evident trash, left in caves by cavers, is the carbide. There are almost no new carbide dumps, due to raised awareness of cavers and due to the use of led lamps in the last 10 years. Graffiti appear in almost all caves, only the newly explored caves are “clean”. The big graffiti, made by colours, carbide smoke or cut began to appear after 1920. It is only after the year 1990 that graffiti are not so frequent anymore. Evident and significant impacts have been done also by scientists by taking samples of flowstone formations, archaeological excavations, etc. In the caves which have been recently explored and have controlled access, the impacts are minor, also due to cave explorers who put trail markers through caves.

Although most of the damage has been accumulating, there have already been some actions by cavers and staff of the show caves to reduce the impacts, such as cleaning the trash from caves, placing trail markers, gating caves, cleaning graffiti, re-wearing the suits and shoes in “clean” parts, etc. An important issue is also equipping caves that are frequently visited.

Classical Karst has been one of the most important karst regions for speleological explorations, scientific research and tourism in the history and today. It needs and it deserves that we repair the damage that was done in caves, as well as we try to explore the underground passages with the minimal impacts. Indeed it is necessary that protection of karst caves is discussed within complex ecosystem.

Keywords: Classical Karst, cave use, impacts on physical environment in caves, types of visitors

WATER TEMPERATURES IN CAVE STREAMS AND KARST SPRINGS

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Stream temperature is an important water quality parameter and can have strong influences on aquatic biota. A variety of models have been proposed to simulate water temperatures in karst conduits; however, many of the assumptions of these models have not been validated using field data or examined in detail using heat transport theory. We examine the conditions necessary for the validity of each of these assumptions, and determine the mechanisms that control heat exchange under a variety of conditions. To explore these questions we employ analytical solutions, record stream temperatures in multiple locations along cave streams in Tyson Spring Cave, Minnesota, USA and Postojna Cave, Slovenia, and simulate the observed temperatures with a numerical model using realistic geometrical parameters for the conduits. We conclude that, in most cases, conductive heat transport limits overall heat exchange rates, and therefore cannot be neglected. However, radiative exchange and convective exchange through the air can also play a role in conduits with open

channels. Additionally, we discuss the types of temperature patterns that are typically observed in caves and karst springs and explain these patterns using the theoretical framework developed above.

Keywords: temperature, modeling, water quality

GEOTECHNICAL AND ENVIRONMENTAL MONITORING OF THE FARNETO CAVE (BO, ITALY)

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Farneto is the most famous cave of the Natural Regional Park of Gypsum of Bologna. The cave was discovered in 1871 and explored in the early XXth century. After several decennia of abandonment, the entrance to the cave was closed by a rockfall in the early 90s. Following important stabilisation works the cave was re-opened to the public in October 2008. A monitoring system, composed of 6 strain gauges and 2 clinometers, has been set up to control possible movements in the most critical areas of the cave. In order to have a correlation with the changing climatic situations, three sensors of temperature/relative humidity have been added, while rainfall data have been taken in a nearby raingauge. From three years of monitoring data it is clear that the registered movements are independent of both rainfall and relative humidity in the cave, while the deformations are influenced by air temperature, with cycles of thermal dilation and contraction of the rock. These rather small cyclic deformations, however, appear to give rise to an irreversible long-term deformation. This study is part of the activities carried out by the Natural Park of the “Gessi Bolognesi e Calanchi dell’Abbadessa” with the aim of guaranteeing the safety of the visitors.

Keywords: gypsum, stability, show cave, geotechnics, monitoring

PROTECTING MOČILJSKA CAVE AND SUBTERRANEAN BIODIVERSITY (DUBROVNIK, CROATIA) THROUGH ACTIVE CONSERVATION

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Karst phenomena and subterranean biodiversity of the Dubrovnik region are of the exceptional value as natural heritage. This is evidenced by Legislation and Red Data Books of the Republic of Croatia according to IUCN categories of threat. Močiljska Cave (Dubrovnik, Croatia) was proclaimed a protected geo-morphological monument of nature in 1963 with the view to conserve its natural value. The main goal of this paper is to investigate different possibilities of design, restoration and construction of the door at the entrance in Močiljska Cave in order to close the entrance and ensure active conservation of cave and subterranean life, especially endangered and endemic species and their habitats. Data on the existing biospeleological and karstological cave investigations, concerning all criteria regarding nature and landscape protection with special attention to conservation of natural entrance, passage and vegetation at the entrance to the cave are used as basis for concept design and design for construction. For this purpose interdisciplinary approach and close cooperation among speleologists, architects and experts in the field of nature protection is needed. Results of this paper are to be used as basis for conducting conservation measures and efficient management of karst phenomena of the Dubrovnik region.

Keywords: speleological objects, subterranean biodiversity, conservation, management

PROTECTION OF SUBTERRANEAN BIODIVERSITY IN THE USA

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Approximately 1400 obligate subterranean dwelling species (stygobionts and troglobionts) have been described from the U.S., the vast majority from caves. In general, species richness is lower than in Europe, although there are several hotspots of subterranean biodiversity, especially the terrestrial invertebrate fauna of northeast Alabama and the aquatic invertebrate fauna of the Edwards Aquifer in Texas. The U.S. is a global hotspot for subterranean salamanders, and the fish fauna is well known and studied, but only of moderate diversity compared to subtropical regions. Within the U.S., the major regions of subterranean biodiversity are the Appalachians, the Interior Low Plateau, and the Edwards Aquifer/Balcones Escarpment (Texas). Subterranean habitats aside from caves have been

little studied but the lower Potomac River basin in the vicinity of Washington, D.C. is a hotspot of species richness for seepage springs (hypotelminorheos). Strategies for protection of the subterranean fauna include protection of habitat and protection of species. Parks and nature reserves have been established by the federal government, state and local governments, and private individuals and organizations. In some cases, places are protected because of the caves, such as Wind Cave National Park. In others, caves are “inadvertently” protected because the primary interest in the area is not caves. Hawaii Volcanoes National Park is an example of such collateral protection. In addition, many caves that are directly protected are not particularly rich in species. Site protection by various government agencies is supplemented in a major way by private conservation organizations such as The Nature Conservancy, cave conservation organizations such as the Cave Conservancy of the Virginias, and even private individuals. The Endangered Species Act is the major legal tool used in species, rather than habitat protection. It has been used as an important means of species protection for the cave faunas of Texas and the Ozarks, but overall it has been used very little. Less than 30 stygobionts and troglobionts are on the threatened and endangered species list. The Endangered Species Act may play an important role in the protection of bats in the face of the White Nose Syndrome epidemic. Several factors create unique challenges for the protection of subterranean biodiversity in the U.S. One is the strength of private property rights relative to either the state or federal government. This is reinforced by custom, especially in the western U.S. Another is the relative weakness of the federal government compared to state governments in the area of land use, making for a complex regulatory environment. Future progress with protection of subterranean biodiversity would be accelerated by better central planning and data acquisition, better education about cave fauna, and a stronger cooperation between recreational cavers and conservationists.

Keywords: stygobionts, troglobionts, biodiversity

EOGENETIC CAVES IN CONGLOMERATE: AN EXAMPLE FROM UDIN BORŠT, SLOVENIA

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Udin Boršt is a karstified terrace of carbonate rock, which is of fluvioglacial origin, and is situated in the north-western part of Slovenia. There are 15 registered caves, which have been interpreted as caves in conglomerate, while karst of Udin Boršt itself was interpreted as conglomerate karst, shallow karst or isolated karst. In this article, caves in Udin Boršt have been interpreted as eogenetic caves. Based on porosity and bedding material, different types of caves and cave passages have developed. Four general types of eogenetic caves found in Udin Boršt are: linear stream caves, shelter caves, breakdown caves and vadose shafts.

Keywords: eogenetic, caves, conglomerate, Slovenia, Udin Boršt

AND WHAT ABOUT KARST UNDERGROUND PROTECTION IN FRANCE? FOUR YEARS OF ACTIVITY FOR THE NATIONAL COMMITTEE FOR UNDERGROUND HERITAGE

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In April 2007 the French Ministry for Ecology and Sustainable Development established the National Committee for Underground Heritage (CNPS). When the Committee was raised, the minister, Nelly Olin, claimed that “every question about underground heritage, every kind of situation could be hold by the Committee”. This is an important stage in the awareness of specific problems and measures to be adopted for the protection of underground karst in France.

Indeed, karst underground protection has been very efficient in France for a long time: about 300 caves are scheduled as ancient monuments (mainly due to prehistoric cave art) or picturesque natural sites. A commission for the protection of caves and karst was created by the French Federation of Speleology in 1969, but since there is no specific law for the protection of caves and karsts, there is no legal basis for protection of karst phenomena. In recent years, some old mine entrances have been blown up for motives of security, even when they were of high historical or mineralogical interest! Caves discovered in building or works sites are often destroyed or blocked up again before being explored or surveyed...

The main aim of founding the CNPS was the official acknowledgement of the specific characteristics of underground karst heritage, in a general stream of interest for geomorphosites and geologic heritage. Of course, it was very important for karst scientists and for cavers. During these first five years, several issues have been opened: the problem of the inscription of a karst site on the UNESCO list, application of the karst to the politics for creation of new protected areas, using and ownership of caves data basis...

Many questions have been addressed by the works of the Committee: is it possible to manage underground karst without any regard for the karst surface? Is it pertinent that geologic heritage is managed by another committee? As the Committee is made up of geomorphologists, biologists, geographers, archaeologists and cavers, is their understanding of karst protection the same? And what could be the understanding of the Ministry on such a subject?

Keywords: protection of caves, France, National Committee for Underground Heritage

POSSIBLE POLLUTANTS ON THE UNDERGROUND WATER IN THE CAVE SLATINSKI IZVOR, REPUBLIC OF MACEDONIA

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The cave Slatinski Izvor is the longest cave in Republic of Macedonia (around 4 km). Because of its length, the morphological and hydrographic elements, the cave has placed on the temporary list of the world natural heritage, since 2004. The cave is built in calcite-dolomite marble with precambrium age. Through the main cave network flows underground watercourse, whose water the local people have used for drinking. The origin of the underground watercourse, in the biggest part, is from the groundwater rivers Slatinska, Krusevska and Markovska River. Despite the fact that the water is used, in the last period, there were recorded several impacts on karst waters. Thus in 2007 the wider area was covered with forest fire, because of that there is still soil erosion. During the cultivation local people used inorganic fertilizers, as well as different pesticides and herbicides. In the wide area there are not landfills, and the solid waste is disposed in the natural hollows and ground waters. In the few villages, around the cave, there isn't sewerage, so thus through the septic tanks liquid pollution is possible. The local asphalted road runs along the Slatinska and Krusevska River, and nearly the stream hole. The road could also have direct influence on the pollution of the underground waters. Unfortunately, there are no institutional measurements of the level of pollution of Slatinski Izvor. Thus, the appointed material has only theoretical basis.

Keywords: pollutants, underground water, cave

GEOMORPHOLOGICAL CHARACTERISTICS OF DOLOMITE – LIMESTONE CONTACT KARST ON KOČEVSKI ROG AND KOČEVSKA MALA GORA (SE SLOVENIA)

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In Slovenia the most common type of contact karst appears where allogenic waters from a non-karstic catchment flow onto the karst surface. Contact karst on lithological contact between non-carbonate and carbonate rocks (mostly flysch) has been relatively well-studied, however, a complex study of contact between different carbonate rocks (e.g. dolomite – limestone) has not been conducted yet.

Kočevski Rog and Kočevska Mala gora are high Dinaric karst plateaus (SE Slovenia) which are mainly built of Mesozoic carbonate rocks. There are some areas where fluvial processes take place and contact karst landforms are developed. It was discovered that these areas appear on contact

between different carbonate rocks (mostly dolomite and limestone). In the research six case study areas where were geomorphologically studied in detail. The results of analysis of the case study areas have shown that this type of contact is strongly influenced by the position of fractured zones which have an effect on rock's hydrological function. The landforms which appear on this type of contact karst are similar but less evident comparing to those on contact between non-carbonate and carbonate rocks. The most common landforms are: erosion gullies and dells, ponors and ponor steepheads, alluvial fans, karst depression or a small-scale karst poljes, absence of horizontal cave passages. The results are presented in a form of geomorphological maps.

Keywords: Slovenia, hight Dinaric karst plateau, geomorphology, contact karst

ANALYSIS OF HYDROLOGICAL DROUGHT IN KARSTS AREAS

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Assessment of hydrological drought is one of the basic methods in the hydrological research. This study can be solved for the whole catchment areas, as well as for the individual springs. In this work, the hydrological drought was analyzed for the individual karst springs in evaluated area of the Upper Nitra catchment (Slovakia). For this purpose, the threshold level method (sequent peak algorithm) was used. The time-series of daily deficit values were calculated from daily spring-yield measurements and these data were used for further analysis and assessment in the next steps. The data processing was solved in the software package HydroOffice 2010, specifically in the modules FDC and TLM. The results of this study were consequently compared and analyzed from the several aspects, namely the impact of geological conditions on the occurrence and character of the drought events in different hydrogeological structures and areal extension, duration and intensity of drought events in the assessed area. The paper presents the preliminarily results and was financed by WATCH FP6 project (contract No. 036946).

Keywords: hydrology drought, karst water, karst springs, HydroOffice software, Slovakia

THE IMPORTANCE OF CAVES IN EGYPT

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Egypt is one of these mysterious places on the earth, with one of the first human civilizations. The rich history of Ancient Egyptian on the one hand and poor knowledge about its geological heritage on the other hand makes this part of the World even more interesting. Caves all across Egypt gave answers to many opened questions and helped scientists to understand history and prehistory of Egypt. Therefore, the purpose of this study is to show all aspects of importance of cave preservation. One of the best examples is the Wadi Sanour Cave protectorate in Beni Swaif Governorate, which represents the geological heritage as a geosite. Beside geological importance the Cave of Swimmers (southwest Egypt, near Uweinat and Gilf Kebir region) hides drawings more than 8,000 years old. Those drawings are evidences of climate change since the last Ice Age and are considered to be one of the most important cave drawings in the World. Some of the caves played important during the history. For example Rommel cave at Marsa Matruh, that Rommel used during the World War II to plan the offensive against the Allied forces. Also some caves are religiously important (e.g. Church Cave in Cairo). All these caves turned to be a geotouristic places by the time, and every one of them represents a famous story which can be attractive for a lot of people.

Keywords: cave, paleoclimatology, geology, history, Egypt

CAVE AND KARST CONSERVATION AND MANAGEMENT IN SWITZERLAND

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Cave and karst protection has to be initiated by the cavers, because they are specialists for that topic. Therefore in 1997 the Swiss Speleological Society (SSS) has approved a program for the conservation and protection of the Swiss caves and karst areas. This program focuses on four different parts:

1. Prevention: The commission for cave and karst protection of the SSS promotes awareness and has an active relationship with the cavers and the caving clubs. The main goal is to use the media, teach lessons in schools, present public talks to inform the population as a whole, and also to contact

directly politicians and the government on all levels. Further, the SSS tries to influence the legislation process by participating in consultations and official hearings.

2. Classification of caves and supervision: Not all caves and karst areas need protection in a similar way. If schemes for classification are based on objective arguments (Geotopes), they are also accepted by the government and other NGO's. Supervision includes e.g. controlling endangered sites, following information about potentially problematic projects in the media and a continuous inspection of construction building applications in the official publication.

3. Intervention: If problems were to be noticed during the supervisions or due to a construction project, the Swiss legislation would allow several possibilities for NGOs to interfere (e.g. demanding authorities to interfere, right to appeal of environmental protection associations).

4. Restoration: the communities and the cantons are obliged by the federation to restore contaminated sites. The government subsidized the last few years several projects for restoring and cleaning caves. Actions for cleaning caves have also been done by cavers for free and benevolently.

The application of this program is a major task of the commission for cave conservation of the Swiss Speleological Society. In order to prioritize real improvements of the situation in the field, 13 regional groups have been created in Switzerland. Each group is composed of active cavers and has to establish contacts with the local authorities, has to advertise on this topic, has to supervise and classify caves and karst in its region, and finally has to organize cleaning or restoration actions for specific caves (or dolines). Regional groups are encouraged and supported by a committee and by the Swiss Institute of Speleology and Karstology. This structure is financially supported by the Swiss Government and cantonal authorities. An important lesson learned with this experience is that it took about 1 year to set up a concept accepted by all Swiss cavers. It took another year to define a strategy to decide how this concept could be realized. Then it takes 5 to 10 years to establish the necessary contacts and information to obtain real results in the field. The presentation will be hold by Silvia Schmassmann.

Keywords: national program, prevention, supervision, intervention, restoration, contaminated sites, implementation of a conservation program

GEOMORPHOLOGICAL MAPPING OF THE MONJOLOS KARST REGION, MINAS GERAIS, BRAZIL

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The present study is intended to map the major karst features in the region of Monjolos, located at 230 km north of Belo Horizonte limited by parallels 18°12'37" and 18°19'49" south latitude and 44°06'36" and 43°59'51" west longitude. Geologically, the region lies significantly on the carbonates of the Bambuí Group. The region presents typical exokarst features with limestone outcrops, karren fields (mostly rillenkarrén), sinkholes, poljes and ponors. The endokarst is represented by 24 known and registered caves according to the Brazilian Speleological Society (SBE). The surveys in the endokarst were initially conducted by the spelogroup Sociedade Excursionista Espeleológica (SEE) from Ouro Preto Federal University (UFOP) and the speleogroup Grupo Bambuí de Pesquisas Espeleológicas (GBPE). Currently the speleogroup Mocó have been developing important prospection work in the region. Regarding the region cultural importance it is worthy to mention that some caves present prehistoric cave-paintings and pictographs. In addition, the caves Lapa Olho D'água and Lapa de Santo Antônio (at Monjolos) and Lapa de Santo Hipólito and Lapa da Vargem D'anta (at Santo Hipólito) were visited by the Danish naturalist Peter W. Lund in 1835. For the reasons mentioned, the region was selected due to the need of continuing work in an expressive karst region. Mapping regional karst phenomena is essential to improve land management, especially in this region where recently karst suffered with road constructions. For regional geomorphological mapping, the authors will adopt the broadly know symbology established by the Commission of Karst Phenomena of the French National Geography Committee (1965) adapted and used in Brazil by Kohler (1989) and Travassos (2007). Remote Sensing techniques are also combined with field work.

Keywords: map of karst phenomena, karst, Monjolos, Minas Gerais, Brazil

KARST SEDIMENTARY FILLING: MARKERS OF THE PROVENCE GEODYNAMICAL EVOLUTION

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Karst protection implies to know their repartition, structuration and conditional formation and development. This abstract presents informations which could be obtained by karst filling, karst playing the role of a geological recorder of the phenomenons which have been affecting our planet. Indeed, karsts bear paleogeographic and climatic informations, pointed out through their geometry and fillings. The study of such objects allows the paleo-reconstruction of their host rock history far from any anthropic influence. These facts may be illustrated by the study of the Provence area (S.E. France) where, structural and tectonic evolution, during Meso-Cenozoic, is the result of an interference between Pyrenean and Alps orogenies (Campanian to present day), in addition to Liguro-Provençal rifting (Oligocene) and Messinian crisis. Moreover, in Provence, the lack of Cenozoic major overlap and tectonic markers could underline eventual large-wavelength uplifts without such markers. In order to constrain Provence geodynamical evolution, and more precisely the relation between eustatism and tectonic during the Cenozoic, we propose a petrographic, structural and biostratigraphic analysis of karst sedimentary filling. This analysis will be coupled with the analysis of speleogenesis, i.e. the different stages of karstification and infilling. These results will lead us to limit the genesis steps, 3D structuration and layering systems in correlation with base level fluctuations. Then, it will be possible to understand fluids circulation and repartition in order to preserve these karstic aquifers in a sustainable way.

Keywords: karst, geological recorder, Provence, geodynamic, speleogenesis

GEOLOGY AND KARST OF KUNGUR REGION

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Karst and processes, connected with it, are widely developed in Perm kray, and territory of Kungur and its vicinities among experts is considered territory of classical development and a combination sulphatic, sulphat-karbonat and karbonat karst types.

Presence and occurrence of numerous failures of a surface, presence of the underground cavities opened as a result of chisel works, constrained development of an infrastructure of a city - building

of new constructions of industrial or civil appointment in the conditions of obligatory preservation of a historical lay-out of a city and separate monuments of architecture.

In the given work authors have spent generalisation of results of all investigation phases of a karst within the city territory.

Now we are developing GIS project for karst areas of Perm district, which includes semantic databases joined with electronic maps of different scale. There was made catalog of spreading of karst forms at these territories. Data for one were collecting more than 60 years yet. At territories with the most active karst processes we are making addition works (creating web of points of hydrogeological monitoring). Also we have created set of karstologic maps of different karst areas of region for estimating of level of potential karst hazard.

The importance of new methods of researches of karst processes is not only accumulation and collecting of different data about geological structure of territory. The important aspect is also approbation and using of modern technologies of researching of karst processes and forecasting of development of ones.

PROTECTION AND SOUND MANAGEMENT OF CAVES OF THE URALS

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In the Ural region a variety of surface and underground karst features can be found on gypsum, anhydrite, limestone and dolomite bedrock. Over 3200 caves of total length of about 244 km have been found. Despite the fact that flora and fauna as well as paleontological and archaeological sites of the karst landscape and caves are of great importance, no cave has been given a status of the federal heritage object, excluding the caves located at the conservation areas.

A presented subdivision into districts of karst territories is proposed and an improved list of the caves in the Urals has been made. The estimation of the main sights of karstic landscapes and problems of their protection is presented. Specificity of usage of underground spaces and features and functioning of protected speleo-objects was considered.

Thorough several years the author has been developing a model of functioning of protected karstic landscapes at their complex usage. The basic legal positions for realization of protection of natural karst landscape in a form of show caves were formulated. A number of methodical-theoretic positions and practical recommendations about establishment and the equipment of show caves were developed.

Keywords: cave, protection of caves, management, Russia, Ural

PROTECTION OF UNDERGROUND KARST RESOURCES DURING LOGGING OF PRIMARY TEMPERATE FORESTS: A COMPARATIVE REVIEW OF STRATEGIES IN TWO HEMISPHERES

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In contrast to the situation typical in much of Europe where forest cutting has a long history and forestry typically involves recurrent operations on land that has already been subject to previous cycles of logging, commercial logging in Tasmania, New Zealand, Canada and Alaska commonly involves initial roading and cutting of previously undisturbed primary natural forest. Where karst underlies these latter undisturbed primary forests the karst values present still remain undamaged by modern human impacts, in contrast to settings that have already undergone at least one cycle of logging where any karst values have generally already been degraded to some degree. This confers upon these primary forest karsts a particular global conservation significance because they offer the rare potential to protect sensitive karst values of kinds that elsewhere may already have been compromised. This in turn places particular responsibilities on the managers of these primary forests to identify key karst values and the processes that sustain them at particular sites; to make informed and responsible judgements as to whether particularly important sites should indeed be logged or should instead be left undisturbed for nature conservation; and, where logging is chosen, to develop management protocols that will minimise the harm to karst values that the forest operations cause. In New Zealand the difficulties of adequately protecting natural forest and karst values when logging occurs has now resulted in effective curtailment of all primary forest logging on government-owned karstlands and their formal protection in national parks and nature reserves. In Alaska, while formal reserves to protect undisturbed karst values are less widespread than in New Zealand, high standards of protection also apply to federally-owned karstland forests, presently aided by diminished demand for access to their forest resources, but there are effectively no provisions to protect karst on lands controlled by the Alaskan state government. In Tasmania, Australia, some karst forests have been protected in national parks but those karst areas with the most commercially enticing forest resources remain largely unprotected. Here a formalised Forest Practices Code has been developed with the aim of reducing the environmental harm caused by logging. Similarly, a Forest Practices Code has been developed in British Columbia, Canada, but in practical terms forest managers there often seem concerned primarily to safeguard caves of recreational significance rather than the wider natural heritage values that many caves contain and the ecological processes of karst. This paper will review some of the strengths and weaknesses of these various approaches for the retention of nature conservation values, potential for long-term environmentally sustainable economic development, and maintenance of the ecosystem services karst typically provides.

Keywords: forestry, logging, temperate rainforests, management, karst ecosystems

NEW LOCALITIES AND THE FIRST POPULATION SIZE ESTIMATE OF HIGHLY ENDANGERED DINARIC CAVE CLAM, *CONGERIA KUSCERI*, BOLE 1962

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The Dinarides are home to the only stygobitic bivalve in the world, *Congeria kusceri* Bole 1962, an endemic Tertiary relic. Although the genus *Congeria* had a widespread distribution during the Tertiary, the extant species is now restricted to Slovenia, Croatia and Bosnia and Hercegovina. During the research partly funded in 2010 by the State Institute for Nature Protection and Ministry of Culture, the search for new localities and investigation of known populations continued. Six new localities of living populations were found, increasing the number of known *C. kusceri* populations to 14. Altogether 32 localities in all three states are known but only empty shells are recorded in most of them. All new populations live in the vicinity of previously known ones and in the same hydrological basin except the population in the spring cave Izvir jamske školjke u kanjonu Krupe. The latter is the first living population found in Slovenia in an area where only shells have been previously recorded. In Croatia, two new living populations were discovered in the cave Jasena ponor and at - 1392 m in the sump at the bottom of Jamski sustav Lukina jama – Trojama. The population size in Jama u Predolcu was estimated as a part of this study, and this is the first analysis of population size in this species. The number of living *C. kusceri* in the cave is about 70.000, which is likely to be far below the actual numbers. The locality is threatened by construction of a bypass for a nearby city, and could be completely destroyed. The northern populations in Croatia in the caves Markov ponor and Jamski sustav Lukina jama – Trojama are threatened by construction of the Kosiinj Hydroelectric Powerplant, which would completely change the hydrodynamics of groundwater in the entire area. In addition to being strictly protected by the Croatian law, the species is listed in the Annexes II and IV of the Habitats Directive and in the Red list of Croatian cave fauna in the IUCN category CR. Continued research on this under-investigated species will focus on obtaining new information that will help in conservation efforts of this Dinaric and world resource.

Keywords: *Congeria*, Dinarides, cave, biogeography, population size, conservation

IMPACT OF PRECIPITATION ON ICE CAVES TEMPERATURE FLUCTUATION

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In 2009 a project of systematic temperature measurements in Slovene ice and cold caves was launched. The aim of the project is to determine the general temperature characteristics of the caves. Approach of our work consist of temperature measurements in 15 caves, all below 1500 meters above sea level, with cold thermal anomaly and ice occurrence long into the worm part of the year. In reviewing the first results temperature fluctuations, during the summer months when the ice caves climate is under a closed system with constant low temperatures, were observed. Sudden increases of temperatures can be associated with precipitation and are governed by the volume of rainfall, time of the year, cave morphology and by the thickness of the calling. In the poster temperatures and precipitation interaction along with other monitoring results are going to be presented.

Keywords: temperature monitoring, ice cave, ice stalagmites, Slovenia

QUARTZ SAND MINES ON VIS ISLAND, DALMATIA, CROATIA – DINARIC AND MEDITERRANEAN GEOHERITAGE

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As part of continuous sequence of Cretaceous limestones and dolomites, in the central part of Vis Island, quartz sand deposits are found. "Quartz sands" locally called vora, represent a solid or a friable material composed dominantly of quartz and some chalcedony. These sand deposits, developed as two separate beds, 1–6 meters thick, have been mined since the beginning of the 19th century because of the characteristic white color and were used for glass production by the famous glass factory in Murano. Numerous evidences of mining activities can be found north of Kostrina village (Veliki rudnik mine, Mali rudnik mine, Špilja od Vore cave, Tor rudnik mine). These mines represent combination of underground constructions, mines and natural karst caves (e.g. Veliki rudnik mine, Špilja od Vore Cave). During speleological and biospeleological investigations of these objects interesting endemic fauna was found, same as bat colonies. This further emphasized their uniqueness, and, in addition, Špilja od Vore cave represents cave type locality of Croatian fauna. Vora mines are an exceptionally interesting part of Croatian, Dinaric, but also Mediterranean geoheritage and they should be properly preserved. With proper and viable care, in the future they can be

represented as a cave/mine park and thus can be used for the natural and cultural promotion, educational purposes and tourism activities.

Keywords: mining, quartz sand, cave, biospeleology, Dinarides, Mediterranean region

CONTAMINATION OF KARST UNDERGROUND IN MILJEVCI PLATEAU (CROATIA)

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Miljevci plateau is located in central Dalmatia (Croatia), between the rivers Krka and Čikola and mountain Promina. It is located approximately 110 km from Split. It is a part of the North Dalmatian karst plain, and belongs to the Outer Dinarides. The oldest strata of Miljevci plateau are Senonian limestones with rudists, which occur sporadically and mostly in groups. The lower Paleocene-Eocene "Liburnian deposits" with fossil brackish environment lie transgressively on Senonian limestones. They are followed by the middle eocene foraminiferal limestones. Middle Eocene flysch lies the foraminiferal limestones, consisting mainly of marls. The youngest strata in the field date back to Quaternary.

A speleological research has been conducted in this area with aim to complete the speleological database and locate types of anthropogenic contamination in the caves. Different kinds of surface contamination (for example, illegal waste dumps) have also been located. On the basis of research data, speleological objects (caves and pits) have been marked on maps and classified according to their genetic type and forms of contamination. A brief overview of geology, hydrogeology and geomorphology of the area has also been presented. Speleological objects in the immediate vicinity of the villages are especially endangered. Thus, the waste removal and protection of the studied area have been suggested in accordance with Croatian laws concerning protection of the karst underground.

Keywords: Miljevci plateau, speleological objects (cave and pits), contamination

THREE OUTSTANDING UNDERGROUND SYSTEMS ENDANGERED IN THE SOUTHERN PART OF THE DINARIC KARST

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The paper deals with the threat and the protection of three outstanding underground sites in the end part of the Trebišnjica basin, in the south of the Dinaric karst. The studied area is a fully developed karst with numerous and highly developed forms, which is bounded on one side with Popovo Polje, and on the other side with erosion basis of it polje, which is partly made by the Neretva valley, almost at sea level, but a major part is made by the Adriatic coast. Popovo Polje is a terrace on which in the natural state vast amounts of water used to be accumulated, which has been discharged by at least 500 known ponors and estavelas. Within erosion basis occurs at least 10 springs, and in the western part of it at least 40 submarine springs (vruljas), which forms amazing diverse environment: from the underground habitats, through swamps and running waters, to the brackish water. This is one of two areas of the Dinaric karst where subterranean fauna are the richest in the world. Our attention is directed to the management and protection of three underground systems. The first is the well-explored cave Vjetrenica, which has its entrance on the edge of the central part of Popovo Polje and still unknown contact to Adriatic Sea, which is in a tourist use. Another one is Ombla spring, about 20 km southeast of Vjetrenica cave. From its immediate catchment size of 600 square kilometers, is known only a very small final part of it, which is preparing for construction of an underground power plant. The third is a system of underground connection between the final part of Popovo Polje and submarine springs around the Slano and Ston on the Adriatic Sea, approximately twenty kilometers to the northwest from the Vjetrenica cave. On the topographic surface of these connections, named Lučino razdolje, which is with density of 70 dolinas per square kilometers very karstified, is planned to be build the central landfill of Dubrovnik-Neretva County. All three sites have transboundary basins. Croatia has adopted EU legislation, but often seeks to avoid public interest and nature protection, in favor of the interests of investors. B&H is in the post-war transition, in which the political system works badly and lawlessness is visibly dominated. So, these three sites are under severe threats.

Keywords: Dinaric karst, Vjetrenica, Ombla, Mali Ston zaljev, protection

CONSERVATION OF DINARIC CAVE TYPE LOCALITIES

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Cave type localities are caves where animal specimens were collected for scientific species description for the first time. In these caves type material is preserved, and they represent important storage of cave animals for scientists interested in biodiversity, taxonomy, systematic and molecular analyses etc. In 2000 the Croatian Biospeleological Society, in cooperation with the Ministry of Environmental Protection and Physical Planning of Croatia, initiated a two-year project entitled "Production of a biospeleology survey, education and popularization leading to protection of the biosphere of the underground of Croatia". In 2003 the project was followed up by a three-year programme with the support of the same Ministry and was subsequently financed by the State Institute for Nature Protection in Croatia. One of its important results was the publication of the Catalogue of Cave Type Localities of Croatian Fauna as a supplement of the scientific journal *Natura Croatica* in 2006. The Catalogue features a first integrated list of 206 cave type localities in the territory of Croatia, including 338 taxa described from them. The Volume 1 of Cave Type Localities Atlas of Croatian Fauna published in 2010 by the Croatian Biospeleological Society and State Institute for Nature Protection gives additional data on cave type localities published in the Catalogue. For every cave position, picture of entrance and described animals and map of the cave is given together with reference of the most important speleological literature where cave is described. The list of taxa and type localities was amended and provides an integrated outline of taxa described from the Croatian caves to date. The total number of type localities was thus considerably extended and currently features 254 type localities (with a total of 399 described taxa), including 102 objects (with a total of 133 type taxa), which were selected and thoroughly profiled in Volume 1 of the Atlas. The subsequent volumes will analyze the remaining type localities, and the list will be regularly updated as a result of discoveries of new animal taxa in the Croatian underground. Another important result of the project was the proposal that was made in cooperation with State institute of Nature Protection that all known cave type localities in Croatia are included in CRO-NEN (National Ecological Network) and will be proposed for Natura 2000 status. On the basis and experience of the work in Croatia in 2011 Croatian Biospeleological Society initiated a long term project of conservation and exploration of cave type localities on entire Dinaric area. The first one year stage of the project is funded by the Whitley Fund for Nature with Whitley Award 2011. The main objectives of the project are: development of scientific and expert network, database creation for data collection and distribution, development of cross-sector cooperation and raising public awareness. Numerous activities like networking of scientist from all Dinaric countries, symposium, round table, workshops across Dinaric area, project web site, leaflet, open access database will contribute to the main goal – conservation of cave type localities in Dinaric area. The transfer of knowledge and experience among organizations and experts from different Dinaric countries is of the utmost importance for the commencement of long term protection of cave type localities.

Keywords: biospeleology, Croatia, Dinarides, Natura 2000, CRO-NEN

ENVIRONMENTAL MONITORING OF A HIGH ENERGY COASTAL SHOW CAVE (BUE MARINO CAVE, SARDINIA) AND ANTHROPOGENIC IMPACT ON SUBTERRANEAN ANIMAL SPECIES

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High energy caves open to public often do not seem to require intense and detailed environmental monitoring programs. The impact of microclimatic variations and visitors sometimes appears to be insignificant at first sight. Bue Marino cave (Dorgali, Central-East Sardinia), a more than 16 km long karst system in direct connection with the sea, is visited between Easter and October by approximately 80,000 tourists. It can be classified as a high energy cave, with two underground rivers, annual floods, many accesses to the sea and a considerable air flow throughout the year. A preliminary monitoring of temperature, carried out between September 2006 and September 2007, has shown sensible both annual and hourly variations in air temperature in three stations placed along the tourist trail and a fourth in the innermost part of the cave, away from the section open to visitors. The influence of groups of visitors is visible in all stations, although of an order of magnitude less in the innermost station, away from tourist flow. Since the start of 2011 new monitoring instruments have been put in place. Chemical analyses of water from the underground river and cave sediments (sands) at the end of the part open to public and deeper inside the cave, several km away from the tourist trail, clearly show signs of organic pollution. A detailed monitoring of cave fauna, carried out during biospeleological researches since the early 70s, has shown variations in biota, with a general depletion in number and faunal diversity in the tourist parts, and a confinement of the richest communities in the inner part of the cave not open to tourism. These preliminary investigations, that will be implemented in the future, clearly show that the massive exploitation of this exceptional karst site, open to public since the early 60s, has had and still has its impact on this delicate environment. The visiting protocol would probably need to be reconsidered, in order to minimise the negative impacts due to visits, but more detailed investigations (e.g. condensation phenomena, carbon dioxide in air, microbiology, etc.) would be required.

Keywords: coastal cave, environmental monitoring, biospeleology, tourism

KARSTIFIED CLASTS IN SOUTH VELEBIT MT. MORAINES, CROATIA – EVIDENCE OF GLACIATION OF KARSTIFIED MOUNTAIN RANGE

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Middle Pleistocene moraines of Southern Velebit Mt. comprise karstified clasts which range from 0,5 m up to more than 10 m in diameter. These are represented by lithologies which are common on the Velebit Mt.; Upper Cretaceous limestones and Jelar-breccia of Paleogene-Neogene age. The moraines are several meters to several tens of meters thick and are composed of debris in grain contact, with interspaces locally filled with fine-grained matrix, and locally cemented by sparry calcite. The calcite cement is secondary infill of openwork moraine and was dated by U-Th series providing minimal age of 159.8 ka. The karstified clasts in these moraines are usually rotated and karren are abraded. Sometimes there are younger karren developed over the older forms, but both systems are today in a rotated position. Karstification of these clasts pre-dates formation of moraines which are attributed to the Riss glacial. These rillenkarren and rinnenkarren were possibly formed during the Mindel-Riss interglacial on nearby mountain tops, and were eroded and transported by glacial ice. Thus, recognition of karstified debris in moraines provides evidence of pre-middle Pleistocene karstification of the Dinaric Mountain range.

Keywords: karst, karren, moraines, Pleistocene glaciation, Velebit Mt., Dinarides

THE IMPACT OF VISITORS ON THE MICROCLIMATES OF ITALIAN TOURIST CAVES

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Recently, several important Italian caves have seen the installation of facilities for tourist exploitation, raising questions about the sustainable use of a karst environment. The cave microclimate is one of the elements of a karst ecosystem that can be taken into account when monitoring the spatial and temporal evolution of an underground atmosphere and hydrosphere. The currently available microcomputer technology allows for the gathering of various microclimate data useful for the characterization of the evolution and, eventually, the prevention and management of possible modification of cave microclimates. Microclimate data gathered in the last ten years from Antro del Corchia in the Apuane Alps are compared to those of Grotta di Monte Cucco and Grotta Grande del Vento-Frasassi in Central Italy. These caves extend for many kilometers and present a complex morphological pattern with several entrances located at different altitudes. All these karstic systems contain underground voids of over a million cubic meters in size with only a small portion affected by tourist trails. Thermal variations in the underground atmosphere induced by the visitors generally reach a maximum of a few °C and are observable up to a distance of several tens of meters from the tourist trail. They are of short duration and do not succeed in modifying the long term temperature trends. They follow daily cycles that are compatible with the recovery capacity of the hypogean systems. The air flow across the entrances of the karst systems is mainly controlled by outside temperature that is linked to seasonal variations and day/night cycles. In the underground systems as a whole, the air flow is quite complex, however, it is only slightly influenced by the presence of the visitors expressed mainly in the opening of the artificial tunnel doors, where present. In all cases the flows can reach many cubic meters/sec. The CO₂ concentrations in the part of the karst systems open to tourists varies by a few hundred ppm due to the presence of the visitors. The natural variations these systems can be as much as one order of magnitude higher. The opening of the artificial tunnel doors and the flow of the outside air tend to dilute the CO₂ concentrations both during the day as well as over longer time periods. However, the karst system as a whole seems to be able to absorb the thermal and CO₂ perturbations and, particularly, to restore and maintain the pre-existent environmental conditions to a reasonable degree. The recovery time is controlled by the inertia of the system, where the air flow and the hydrogeological conditions play an important role. About 80% of the input into the energetic budget in the underground systems seems to be due to electric power and body heat, of which 70 % is dissipated by air circulation and 20 % at the air/water/rock interface.

Keywords: cave microclimate, showcave, CO₂, Corchia, Frasassi, M.Cucco

FLOODING OF THE CAVES BY HYDRO-ACCUMULATION “LEŠĆE” IN CROATIA – A YEAR LATER

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The second Hydroelectric Power Plant “Lešće” on the river Dobra in Croatia has begun to work in August 2010. The dam on the Dobra River has raised water level by 30 meters at most when the reservoir is full and created 13 kilometres long hydro-accumulation inside the canyon. As expected, such water level rise has flooded caves inside the canyon, where the artificial lake was created. Croatian Biospeleological Society has surveyed the region before opening of the power plant in 2008 and 2009 in order to establish mitigation and compensation measures to the cave fauna, financed by Hrvatska elektroprivreda d.d. (Croatian Electricity Company). The conclusion was that 10 caves will be completely flooded, 6 will be partially submerged, while 6 may be under hydrological influence of the risen water level. Survey of the Croatian Biospeleological Society after filling of the hydro-accumulation has revealed some unexpected effect. 1,6 kilometres distanced cave - Ledenica u Špeharima was also flooded. The wider influence to aquatic habitats is unknown, especially important to downstream subterranean watercourses, because there is no habitat monitoring, although it was proposed within measures. Recent conditions of the caves are discussed in this work. In such a case as building a hydroelectric power plant, when questionable “higher goal” overwhelmed nature conservation, there is not much to be done. Monitoring of these changed habitats, among other important issues, could reveal how adoptive is aquatic cave fauna and how quick can it spread.

Keywords: devastated caves, hydro-accumulation, Dobra River, Croatia

GROUNDWATER PROTECTION OF BJELANAC SPRING ON ZLATAR MOUNTAIN (WESTERN SERBIA)

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The Bjelanac spring is situated on Zlatar Mountain in Western Serbia and belongs to the region of the Inner Dinarides. Groundwater from this spring is used for the water supply of the village of Akmačići (Nova Varoš). During the year 2002 both chemical and bacteriological pollution was recorded in this spring. Firstly, it was organoleptic, and then chemical and bacteriological pollution in the Bjelanac spring. It could be seen, primarily, in the occurrence of foam and white scum of highly unpleasant odour, with periodically completely dark cloudy colour. Conducted chemical analyses have pointed to increased iron, manganese, ammonia, and hydrogen-sulphide content in the water from the Bjelanac spring, which was followed by the existence of fecal coliform bacteria of the *E. Colli* type. Since then this water has been used only for technical purposes. In the area of the village of Akmačići neither significant industrial nor intensive agricultural activities have been recorded. Nevertheless, the existence of some saw mills, with accompanying sawdust dumps, the “Zlatarka” dairy plant, stables and manure dumps have pointed to possible causes of pollution, namely potential polluters. Hydrogeological explorations carried out on this spring aimed at the analysis of causes of the Bjelanac spring pollution and defining of measures for its revitalization. In order to form and realize the set concept and applied research methodology we have taken into account common hydrogeological principles and postulates, primarily the principle of uniformity in exploration, and the postulate of maximal hydrogeological information. Therefore the exploration was divided from the aspect of gradation into the following phases: First exploration phase: Collection, selection, and reinterpretation of past published fund and literary materials. The data on geographical, climatological, and hydrogeological characteristics of broader surroundings of the study area as well as basic geological characteristics of the Akmačići area were presented as the result of this exploration phase. Second exploration phase: The completion of digital, elevation and geological model of the broader surroundings of the study area, i.e. the village of Akmačići by using Autocad 2010 and Surfer 9 software. On the basis of these models, and by respecting the principles of contact following, recording of all occurrences and facilities, as well as the principle of diagonal profile following, detailed routes for field explorations were determined. Third exploration phase: Hydrogeological reconnaissance and hydrogeological mapping. Detailed survey of all hydrogeological occurrences and facilities in the study area and sampling for conducting “shortened” chemical analyses. In addition to hydrogeological mapping of the terrain, petrologic, geological and basic structural examinations of the terrain were carried out. Fourth exploration phase Geophysical survey. Geoelectrical sounding, geoelectrical mapping (scanning), as well as the application of the “mise a la masse” method was carried out in this phase. The mentioned explorations were conducted for the sake of spatial delineation, namely delimiting of the water-bearing horizon and determination of possible paths of groundwater movement through the karst aquifer of Bukovača. Fifth exploration

phase Conducting of chemical analyses of taken groundwater samples, being basic indicators of chemical composition of principal cations Na^+ , K^+ , Mg^+ , Ca^{2+} , Fe^{2+} , Mn^{2+} , anions Cl^- , SO_4^{2-} , HCO_3^- , NO_3^- , the content of organic matters in water (via the consumption of KMnO_4), general, permanent and temporary hardness, electrical conductivity, namely dry residue, pH value, dissolved O_2 and CO_2 in water, and organoleptic properties of water (colour, odour, taste, clearness). Sixth exploration phase. The analysis of obtained results, their interpretation and final study completion. On the basis of carried out explorations the following conclusions have been drawn:

1. The groundwater from the Bjelanac spring is polluted and currently cannot be used for drinking. It can be used only for technical purposes.
2. Groundwater movement path towards Bjelanac goes in two directions: south-southeast and southeast.
3. A manure dump being, probably, one of the main sources of bacteriological pollution of the groundwater was recorded on the groundwater movement path, about 30 metres from the water-catchment. Additionally, stables and septic tanks, that pollute groundwater readily, are also recorded close to a stream running from the sawmills eastward (and that flow corresponds with probable groundwater flow to the point where the stream turns southeast).
4. All obtained results point also to the waste water of the dairy plant as one of polluters, primarily as the source of the increased concentration of NH_3 and H_2S . A relatively compact clay layer of about ten metres at the place of the past waste water discharge has saved the source from higher pollution from this place.
5. Filtered sawdust water from the dump among sawmills also pollutes the Bjelanac spring, first of all by the increased concentration of iron and manganese. Although there is no direct (shortest) topographical connection with the Bjelanac, proved paths of groundwater movement point to the connection between the sawdust dump and the Bjelanac spring (groundwater movement towards the stream and then turning left towards Bukovača and Bjelanac in the south-southeast strike).

Keywords: pollution, karst, groundwater protection, Zlatar, Western Serbia

PROTECTION OF LANDSCAPE DIVERSITY OF NATIONAL PARK KRKA THROUGH CAVE EXPLORATIONS (EXAMPLE: CAVE MILJACKA II)

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National park Krka expressed interest in further explorations of caves on their territory for purpose of protection of their underground landscape diversity and education of tourists and local population in 2010. Caving section Željezničar and Croatian biospeleological society in collaboration with National park Krka conducted extensive caving, cave-diving and geomorphological research of cave Miljacka II. Miljacka II is the biggest cave in National park Krka and represents important hydrogeological underground connection between river Zrmanja and river Krka. As a karst aquifer that conducts drinking water, cave Miljacka II needed additional attention. Exploration of cave Miljacka II now has a length of 2357 m that is researched and mapped. Further research require increased funding, better equipment and are physically considerably more demanding.

It has been discovered that big amount of karst water flows through vast underground passage that morphologically represents interesting phreatic loop with phreatic lifts at the entrance of the cave and continues along a fault direction NE-SW. Cave morphology gave important answers about hydrogeological changes that happened in this area. Photo and video material is going to be a part of education material of National park Krka, in which underground lakes, streams and vast spaces of cave Miljacka II will be represented to general public. This is one of rare examples of good cooperation between cavers and public institutions of Croatia.

Keywords: cave diving, karst aquifer, protection, drinking water

INVESTIGATIONS ON THE CHANGES OF KARST LANDSCAPE AND BIOGENE AND ABIOTIC FACTORS OF THE EPIKARST SYSTEM DUE TO HUMAN IMPACT ON THE SURFACE PROTECTION AREA OF THE TAPOLCA CAVES, BALATON UPLAND N. P., HUNGARY

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All regions are endangered by anthropogeneous effects, but the treat of karsts is outstanding. The karsts are specially sensitive areas due to the system's 3D impact surface. Men always influenced the development of karst in a larger or lesser extend: they utilized it in many ways, which caused changes in the landscape. The growing activity of local population and agriculture effected the karstic ecosystem: changes occurred in the woodland and it degraded the rock grassland too. The quality of karst waters slowly declined due to the contamination at swallow holes, soiling of infiltrating waters and the contamination of karst springs. The mining left behind pits and quarries on the surface, the karst water level sank down due to growing water usage. The intensive landuse degraded the soil, changing its consistency through growing amount of acidity and the burden of heavy metals and the erosion rate increased. Karst systems can be summed up of different aboveground and underground processes. The analysis of karst ecological system and its subsystems is a task of priority on the karst area in Hungary as well – because of the preservation of natural values, sustainable farming, the protection of undersurface waterbasis and the sustainable demonstration at National Parks. The damages and pollution of karsts and caves take place through the karst's epikarstic systems which are in connection with the surface. This gives a special significance to the cognition of natural processes taking place in epikarstic systems and the analysis of changes due to human impacts. Our researcher team was made up to analyze the complex processes and system connections in karst ecological system. We are planning to investigate interdisciplinary the large system's segment near the surface (epikarst). These researches will cover the elements of the abiotic system (soil and karstic cover-deposit, water, interaction between soil gas and rock). Our planned researches will include the study of surface's and epikarst's biogenic factors (vegetation on surface, changes of soil's microbe communities) impacts on processes of karst corrosion. To emphasize interdisciplinary character of our planned study and to pronounce the system's connections and coherence even on the level of study, our research plan was divided according to specialties to make the tasks better understood. In our study we provide a picture on the karstological research conducted at the Tapolcai karst (Hungary), gathering the traces of environmental changes due to hundreds of years of land usage on one side, and the effect of anthropogenic processes on the alterations in the epikarst system, in the hidro-, bio-, and pedosphere on the other. In the scope of our research on the Tapolcai karst our aim was to map in a broad sense all the anthropogenic processes effecting the study area. The qualification of surface waters happened with the help of biological water labeling, as well as by water sampling and labor survey. The sample collection was accomplished by soil drilling in karst soils (cover deposits), and through the collection of large blocks of soil (soil-monoliths) we conducted rain

simulation experiments as well. We compared the physical-chemical composition of the soil dissolution infiltrating through the monoliths (grain size, humus and carbonate content, pH etc.) as well as the microbiological parameters. We studied the karstic landscape changes through fieldwork and GIS methods following the changes of coverage in different time layers. In our work we also examined the resource vulnerability of this confined karstic area. For this, we had to evaluate and combine the lithological, pedological, meteorological, hidrological and geomorphological characteristics and data of the studied area. After adopting to the local precipitation conditions, we applied the Slovene Approach for intrinsic vulnerability mapping. The obtained map can have great practical importance, since a lot of illegal waste disposal sites are located on the studied area. This presentation gives an account on the preliminary results of the study started in 2009. by our researcher team (OTKA Grant: K 79135) of the changes of biogenic and abiogenic factors of the epikarst system on the surface protection area of the Tapolca cave system, Balaton Upland N. P. Hungary.

Keywords: biogenic and abiogenic factors of the epikarst, human impact, vulnerability, surface protection area of caves

STATE AND PERSPECTIVES OF PROTECTION OF CAVE PAINTINGS IN BOSNIA AND HERZEGOVINA

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Cave drawings (i.e. drawings inside caves, at the entrances and on rock walls) in Bosnia and Herzegovina are known since the end of the 19th century. Today we know several such sites: Badanj near Stolac, Pećina in Podlipa near Sokolac, Ledenjača near Miljevina, Djevojačka cave near Kladanj, Vjetrenica in Popovo polje, Kozlogradske rocks near Foča, Stijena pod pismom near Višegrad, and since recently sites Potpis (rock engraving) in Trnovo municipality and cave Dahna (paintings) near Tomislavgrad. Until 1980s archeologists and art historians hadn't paid attention to them, thus their protection had not been given importance either. There is no documentary basis for most of them (photographs, drawings). Due to their cultural-historical and artistic value, their protection is of primary importance, especially in the period of transition with the nonexistence of clear (at least in B&H) institutional regulations on protection.

Underdevelopment of social conscience about the value of the drawings or nonexistence of civic capacity in Bosnia and Herzegovina does not exempt general public (regional public included) from the responsibilities of protection of these valuable monuments of European cultural heritage.

One of the possible ways of protection is inclusion of these sites into tourist routes through presentation, exploitation and education of the local community.

The local community should treat these resources as potential economic resources necessary for local economic development, which is completely up-to-date with the new approaches to local economic development in the 21st century.

Keywords: cave, cave paintings, archaeology, protection

AIRBORNE MICROORGANISMS IN ORGANIC RICH CAVES AND THEIR RELATION TO BAT GUANO: CASE STUDY FROM ROMANIAN CAVES

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Although the underground environment seems at a first sight inhospitable for microbial colonization, often this is not the case. Different niches in caves are preferentially colonized by micro-organisms, however many times their role is not satisfactory explained yet. From all micro-niches in caves, air is the hardest to delimit. From other indoor and outdoor environments we know that air represents not only a vehicle for microbial transport, but some microbes are also successfully reproducing in the air, showing that even air can be a suitable habitat. In three selected eutrophic Romanian caves which all host bat colonies (Meziad Cave, Rastoci Cave, Topolnița Cave) we studied the viability and potential for formation of microbial gradients in the air depending upon quantity of organic matter of guano heaps, distances from cave entrances and atmospheric parameters (temperature, relative humidity, air pressure, carbon dioxide). In the study Ridacount (R-Biopharm, Germany) test plates were used to enumerate total aerobic heterotrophic bacteria, total coliforms and differentially *Escherichia coli*, and total counts of yeast and moulds. Microbial counts were expressed as colony-forming units CFU/100 cm²/20 min and were up to 520 total bacterial CFU/100 cm²/20 min, 55 total coliform CFU/100 cm²/20 min, 10 *E. coli* CFU/100 cm²/20 min, and 315 yeast and moulds CFU/100 cm²/20 min. In some cases we observed statistically significant correlations ($p < 0.05$) between microbial groups and some abiotic parameters (distance from the entrance, temperature and CO₂ concentrations). In addition, in air samples *Micrococcus* spp. and *Chryseomonas luteola* were identified. Bat guano in these caves is the biggest source of organic material, but no statistical significant impact was observed of this organic load on the distribution of bioaerosols. Guano contained up to 3.11×10⁹ bacterial CFU/g, 4.61×10⁷ total coliform CFU/g, 8.29×10⁴ *E. coli* CFU/g and up to 3.55×10⁶ yeast and moulds CFU/g. Among bacteria, *Burkholderia cepacia* and *Chryseomonas*

luteola were identified to the species level. Interestingly, physical properties of guano heaps (surface, volume, pH) had no impact on yeast and moulds counts, but these parameters notably influenced bacterial indicator groups. Total bacterial counts and total coliform numbers were positively correlated with the volume of guano heaps and pH, but counts of *E. coli* were positively correlated only with guano surface ($p < 0.05$). These results indicated that the properties in different guano samples were similar, and that they had impact on distribution of certain groups of micro-organisms. In conclusion, our study showed that in eutrophic caves with low or no human interference, viable microbial propagules are present in the cave air, and their distribution in the underground is further influenced by the atmospheric and space characteristics inside a particular cave. Although the studied caves have high organic load and a certain level of airborne micro-organisms, the integrity of such environment should be respected and preserved as other organisms in caves benefit from their presence and contribute to total cave diversity.

Keywords: airborne microorganisms, *Burkholderia cepacia*, *Chryseomonas luteola*, guano, abiotic parameters, cave, Romania

RECENT BIOSPELEOLOGICAL RESEARCH OF RESANOVAČKA LEDENICA CAVE, TYPE LOCALITY OF HADZINIA KARAMANI (HADŽI, 1940) (OPILIONES: NEMASTOMATIDAE)

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Resanovačke Pećine Caves belong to Vijenac tectonic unit, extended in Northwest–Southeast direction, north of Dinara Mt. in Bosnia and Herzegovina. Ledenica or Resanovačka Ledenica Cave is located on NW part of Resanovac polje (field) on the slopes of Stražbenica Mt. The cave was named “Ledenica” (Ice Cave) due to the ice in entrance chamber, which usually remains till the summer. The Cave contains one big fossil channel abt. 700 m long, till 40 meters wide and 25 meters high, particularly rich of sinters. Recent biospeleological research of Ledenica Cave, conducted in June 2010 and May 2011, has been organized in collaboration of Biospeleological Society in Bosnia and Herzegovina (BIOSPELD), Croatian Biospeleological Society (CBSS) and representatives of Municipality of Bosansko Grahovo. Main intention of research was to find specimens of *Hadzinia karamani* (Hadži, 1940) (Opiliones: Nemastomatidae), described from Resanovačka Ledenica Cave. During the second research in May 2011 we found one adult and two juvenile specimens of *Hadzinia karamani*. This is the first finding of this species after August 8th, 1935 when famous biologist Stanko Karaman found one adult male of new genus and species. Our research included physical prospecting of cave channels, microclimate measurements, cave fauna collecting and photo-documentation with cave animal’s macro photography. Terrestrial habitats are dominant with average temperature of

8 °C, while aquatic habitats are presented with small and enhanced water pools. Around 25 taxa of cave fauna were detected: Gastropoda (*Zospeum* sp.), Isopoda (*Alpioniscus* sp.), Acari (*Eschatocephalus* sp.), Araneae (*Parastalita* sp., *Troglohyphantes* sp., *Meta* sp.), Pseudoscorpiones (*Chthonius* sp., *Neobisium* sp.), Opiliones (*Hadzinia karamani*, *Nelima troglodytes*), Diplopoda (*Brachydesmus* sp.), Collembola (*Pseudosinella* sp. and other), Coleoptera (*Parapropus* sp., *Duvalius* sp., *Laemostenus* sp.), Orthoptera (*Troglophilus* sp.), Diptera (*Speolepta* sp.), Lepidoptera (*Triphosa dubitata*) and representatives of bat fauna Chiroptera (*Rhinolophus* sp.). Also representatives of cave fungi have been found, as parasites on moth *Triphosa*, most probable belong to genus *Cordiceps*. During preliminary analyses, in collected material some taxa, new for science, were detected. Plentiful photo documentation, including photographs in situ was realized. Investigations of Ledenica Cave, but also the other caves in Resanovac region will be continued as cabinet expert work and further speleological and biospeleological research.

Keywords: Resanovačke Pećine Caves, Resanovačka Ledenica Cave, Nemastomatidae, *Hadzinia karamani*

KARST UNDERGROUND PROTECTION IN CROATIA

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We discuss the present day state and the most critical issues of karst underground protection in Croatia. The main problems are insufficient information about caves, inefficiency of cave protection acts and lack of communication between interested parties. We present examples of various impacts on karst system in Croatia. The most important examples are destructive actions in karst and pollution of groundwater and caves. There is a need for a national database of caves supported by cave inventory projects that have to record various data about cave geology, speleogenesis, hydrology, biology, paleontology, physics, chemistry and other scientific fields. Caves are important sources of those information. The cave mapping is a prerequisite for cave protection.

Keywords: karst, cave, protection, Dinaric karst, Croatia

THE IMPORTANCE OF THE STATE NATURAL MONUMENT GRUTA REI DO MATO, SETE LAGOAS (MG), BRAZIL

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According to Brazilian Constitution (1988) all citizens have the right to access an ecologically balanced environment of common use, essential to the quality of life. Still according to the document, the Union and all society must protect and preserve the environment for future generations. Under these principles Conservation Units arise as important tools for protecting unique natural areas. The State Natural Monument Gruta Rei do Mato, located at Sete Lagoas, Minas Gerais was created by the State to protect the karst scenario against quarrying activities and to promote tourism. The cave Gruta Rei do Mato is the main karst feature, although many other significant exokarst features exists. The cave was protected in 1984 due to a State Law (n° 8.670) and until its opening for tourism in October 22nd 1988, many interventions to make this Protected Area suitable for tourism were made (e.g.: catwalks, gates, reception, etc.). Nowadays, after some development of Brazilian karstology, this Conservation Unit is being improved to serve as a place of knowledge about karst and caves for local schools and general public moving towards environmental education.

Keywords: conservation unit, karst, natural monument, environmental education

MONITORING OF SPELEOLOGICAL OBJECTS IN NATURE PARK BIOKOVO

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Endogenous karst phenomena, caves and pits, belong to most important natural values of Nature Park Biokovo and represented important elements of geological and geomorphological heritage, but also unique underground habitats with rare and endemic, frequently still undescribed cave fauna, same as paleontological, archeological and cultural localities. Due to systematically implementation of biospeleological researches of Nature Park Biokovo (2002–2006) beside findings of many cave taxa, new for Biokovo, but also for science, many new, till than not explored caves, with interesting findings (new paleontological and archaeological localities, bats colonies). After synthesis of results, published in final Elaborate in 2008, necessary needs for monitoring of most valuable caves occurred. Selection for monitoring is based on several criteria: geomorphological values exist of paleontological and archaeological findings, expressed biodiversity, caves from which cave taxa have been described (locus typicus), important bats habitats, but also touristic potential caves are included. After criteria of endangerment, ten caves have been selected for monitoring in 2009 and 2010 Year, and will continue in 2011. In frame of systematically monitoring, has been performed as follow: preview of general status of caves, status of cave findings and habitats, analyses of ecology and microclimate factors, same as analyses of populations of cave fauna selected taxa. On the basis of monitoring, expert Elaborate have been work out including: expert suggestions for activities necessary for caves protection, same as necessary of further researches, recommendations for microclimate measurement instruments placement, same as sampling for water analyses. Further, measures for conservation and protection of cave habitats, same as cave taxa are recommended and finally, possibility of using caves for educative and touristic purposes together with elements for caves promotion. Without systematically monitoring of caves it is impossible to perform quality management, protection and promotion of endogenous Karst phenomena in Nature Park Biokovo, same as other protected areas in Croatian Karst.

Keywords: karst, speleology, biospeleology, cave, survey

MANAGING THE KARST LANDSCAPE: DRAFTING THE MANAGEMENT PLAN WITH STAKEHOLDERS AND LOCAL INHABITANTS

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It is the aim of this paper to report on a research which investigates the detail of an empirical case where the management plan of a protected area, a karst landscape, was drafted in a participatory way. The karst landscape, located the East of the Friuli Venezia Giulia region (Italy), was designated in 2007 as a Natura2000 site with total of 12.189,57 ha. This area has priority habitats types, flora and fauna species as indicated in the Annexes of the Habitat Directive and Birds Directive, but also it includes agricultural land (113 ha), forest (8822 ha) and part of the Timav water basin. It is of a recreational interest (e.g. hiking, climbing, biking, wild-mushroom picking, hunting and fishing) to the nearby urban areas and home to about 1.500 inhabitants. The presence of many and diverse interests, and awareness of the European-wide negative experience with earlier top-down site designations led the local authorities to choose for a participative approach to the management plan of the Karst-Natura 2000site (Karst - SIC IT3340006 and ZPS IT3341002). In the research presented here we focus on the participatory process and consider the how this has influenced decision-making and the potential it has for the achievement of nature protection objectives.

This research commenced in November 2009 and currently is still in progress. It involved the analysis of quantitative and qualitative data collected at different points of time. In 2009 a first entry into the field involved a contact with local stakeholders. Then, in 2010 observation of four participatory workshops was undertaken and a questionnaire administrated to the participants of participatory forums (N=60) and of the participatory workshops (N=37). In 2011 further interviews were undertaken with the participants, local inhabitants and other stakeholders.

Here we report on the interviews conducted with local inhabitants and other stakeholders. Respondents reported that the topics discussed at the workshop became a topic of discussion in their community. The designation of a Natura 2000 sites has implications for the management of agricultural land forest but also brings new opportunities for tourism and small-scale activities were set up so to build upon this. Most of our respondents reported to have an interest into some of these activities and that such protected areas, as Natura 2000 is, could offer some opportunities for their community. Respondents reported about their personal experience during the activities which in most of its part was a learning experience. They come to know new aspects about this area and started to understand some of these naturalistic features. Results indicate that participatory processes can facilitate learning among those attending the workshop but also that such an approach can offer the opportunity for collaboration that goes beyond the immediate participatory experience. Findings of this research are useful for participatory processes which besides decision-making also aim to facilitate learning processes.

Keywords: Natura 2000, Karst landscape, participatory approaches, nature protection, stakeholder collaboration

IDENTIFICATION OF SEASONAL DRY FORESTS ASSOCIATED WITH CARBONATES USING SATELITE IMAGES AND FIELD CONTROL: KARST REGION OF SANTO HIPÓLITO AND MONJOLOS, MINAS GERAIS, BRAZIL

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This study is planned to identify and map the occurrence of dry forests (Seasonal Dry Forests or Florestas Estacionais Deciduais) associated with carbonates of the Bambuí Group in the karst region of Santo Hipólito and Monjolos. The study area is located at the São Francisco depression, near the western edge of the Serra do Espinhaço ridge. It is located 230 km north of Belo Horizonte, capital city of Minas Gerais. It has an approximate area of 350 km² and is bordered on the west by the regional base level (the Velhas river), north to its direct tributary (Pardo Grande river) to the south by the Pardo Pequeno river and east by the Espinhaço ridge. The dry forests in carbonates are typically found at interfluvial landscapes presenting an expressive importance in the ecosystem especially for being associated with karst recharge areas, as well as supplying biomass to the endokarst environment. Therefore, seasonal dry forests are crucial for karst systems and caves. The historical significance of the mentioned region is confirmed by the visits of the Danish naturalist Peter W. Lund in the nineteenth century. In biogeographical terms, the area is located in the contact zone between the dry forests and mountainous fields (rupestral fields or campos rupestres) of the Espinhaço ridge. The preservation of such biomes is necessary to reduce impacts on natural and man-made environments. For the identification of carbonate dry forests, the authors used Landsat 5 images with field control. The methodology was adapted to be used in the tropical karst and is based on the proposal by Kokalj and Oštir (2007) who identified through remote sensing techniques different land uses (including deciduous forests) in the Slovene “classical karst”. After fieldwork, mapping was conducted in combination with the Brazilian freeware SPRING/INPE (for remote sensing) and ArcGIS 9.3 for mapping. The result of the work will be a map capable of serving as the basis for environmental analysis, future monitoring and management.

Keywords: dry forests, remote sensing, karst, Santo Hipólito, Monjolos, Brazil

MINING IMPACT ON GYPSUM KARST AREA: A STUDY APPROACH IN SORBAS (SE SPAIN)

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The massif of Sorbas (Almeria, SE Spain) is one of most karstified gypsiferous area of the world, with hundreds of dolines and different endo- and exo-karst features. In this massif more than 1000 caves have been discovered in an area of about 12 km². Its Messinian gypsum, deposited into a Neogene intramontane basin, is composed of continuous strata of very pure selenite, which since about 40 years ago is extracted from three large quarries, producing more than 200,000 tonnes/years of high quality gypsum. Although situated at the boundary of the Protected Natural Space of Gypsum Karst of Sorbas, the exploitation of gypsum has intensively affected the caves and their ecosystem, especially the landscape and the surface and underground water drainage. Before the complete impoverishment of such natural treasure, the harmonization between protection of the karst environment and mining activity is necessary. To achieve this goal, a karst index for detecting the most vulnerable areas has been implemented through measures designed as part of a new adaptive management in the southern part area of Sorbas. The study took several steps with multiple field-work for data collection, in each one proceeding with the measurement of the direction and dip of fractures and the inventory of different karst forms. All of them are inventoried with corresponding spatial position (UTM) and compared with the previously existing information (supplied by the Caving Club of Almeria, ECA). Subsequently, an exhaustive analysis of the data collected led to the definition of the karst features of the area: geomorphology, main fracture direction, major lineations, surface watersheds and vadose drainage, cave density. To assess the extent of karstification, the spatial analysis of the distribution of the different cave entrances have been studied. The cave entrances, as a gateway to the karst, are an expression of discontinuous karst phenomenon and are based on geoestructurales conditions, vegetation cover and degree of knowledge of a territory. For these reasons, it is difficult to draw a detailed map of the regional variable. The high density of sinkholes, and especially its structural alignment, can sense through a geostatistical analysis of spatial variation of the network of underground tunnels, i.e. is more likely found karst cavities. To discern a possible indicator of the effects of gypsum mining, the geospeleology index, developed previously in another study in the north of the Sorbas massif, has been applied. It uses assessment criteria on the base of location within or outside of the protected area (geographical basis), the position in the evaporitic basin, stratification and fracture (geological criteria), new and previously known caves, horizontal or vertical development of large caves (karst criterion), the presence of nearby springs, water table depth and infiltration recharge areas (hydrogeological criteria). With these conditions of exploitation, it is estimated the conservation of most of the cavities, the preservation of the recharge basin of the karst system and springs, the minimum affection to the vadose groundwater flow, the protection of nearby springs and minimizing the visual impact.

Keywords: gypsum karst, quarry, environmental impact

GEOMORPHOLOGICAL MAPPING OF KARST PHENOMENA AT THE LAPA GRANDE STATE PARK, MONTES CLAROS (MG), BRAZIL

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The main objective of this project is to elaborate a geomorphological map of the main and major karst features in the region where the State Park of Lapa Grande is inserted. Created in January 2006 by a State Decree (n° 44,204) it comprises an area of 76 km² protecting a total of 47 caves. Within the area, the largest cave is the Lapa Grande which gives the name to the Park. The Speleological Complex of Lapa Grande is located west of the city of Montes Claros at about 420 km from the Capital city, Belo Horizonte. It is limited by the parallels 16°38'55" / 16°43'35" south latitude and 43°54'61" / 43°58'39" west longitude. The Park is basically formed by a set of caves and rock shelters developed over the carbonates of the Bambuí Group, Lagoa do Jacaré Formation. The altitude in the region varies from 650 to 1,009 meters in a karst relief characterized by limestone outcrops, sinkholes, ponors, rock bridges and towers. The main river is the Lapa Grande (also known as the Bois creek and the Pai João creek). The area of the Park has long been recognized as having a great potential for cave exploration, archaeological and historical studies. Several of these caves are recognized for having significant historical values such as the Lapa Grande. This cave was used for saltpeter exploitation, and today is known for presenting the largest regional horizontal development and some rare speleothems. Other caves are known by its archaeological value and they are the Lapa Pintada and the Lapa Pequena which present rock paintings and pictographs. The cave Lapa D'água, one of the most ornamented has rare speleothems such as the "giant pearls" described by Teixeira da Silva (2003). The research in the endokarst were made by the Sociedade Excursionista e Espeológica (from Ouro Preto University) and by the Speleo Group Peter Lund (EPL) from Montes Claros. Other Spelo Groups from the region (GRUCAV, GEO, EVP, EBM, MOCÓ and GEPEL) also made significant contributions. Nowadays, the State Park has infrastructure to receive researchers and tourists. Thus, the region was chosen for this project due to the need of maintaining the work started at this important karst province with the geomorphological mapping, a fundamental tool for a more efficient land management. The guidelines adopted by the Commission of Karst Phenomena of the National Geography Committee from France (1965) which were used and adapted by Kohler (1989) and Travassos (2007) to the tropical karst will be used together with remote sense techniques and field work.

Keywords: map of karst phenomena, karst, Lapa Grande, Montes Claros, Brazil

SPLUGA DELLA PRETA: TWENTY YEARS OF STUDIES AND RESEARCHES AFTER THE “OPERATION CORNO D’AQUILIO”

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Started in 1988, the Operation Corno d’Aquilio (O.C.A.) has been one of the first and most difficult cleaning operations carried out in an Italian cave. In sixty years of epic explorations (the first descend in this famous abyss is dated 1925) various tons of rubbish were abandoned inside the cave, in underground camps and along the more difficult meanders, as far as 800 meters of depth. During this project more than three years of descends and the work of hundreds of cavers were needed to give back to the abyss its original look, carrying out almost 5 tons of litter of previous expeditions.

However the O.C.A was not only a reclamation project, but also an ambitious multidisciplinary research project that has involved many Italian universities, developing geological, geomorphological, biospeleological, hydrological and physical studies in the cave. During the operation a one year multi-parametric monitoring experiment, one of the first in Italy, with various stations at different depths was carried out. Despite the out-of-date instruments used compared to what is used today, the data obtained in the early 90s are of considerable interest for understanding the physical dynamics that characterize this abyss. With the aim of validating this twenty year old research, a new environmental temperature monitoring, coordinated by the University of Urbino was started in 2010.

GUIDELINES TO EVALUATE PROJECTS IN KARSTIC AREAS

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Guidelines to evaluate projects in karstic areas Although about 20 % of Switzerland is covered by karstic areas, its particularities – especially the underground ones – are rarely considered accurately when planning and executing construction projects. With the “Guidelines to evaluate projects in karstic areas”, the Swiss Speleological Society SSS/SGH provides the authorities, persons willing to develop construction project and other interested persons with a tool synthesising the required background information and providing criteria to evaluate the impact of a project onto caves and the

karst and to optimize the project. The general approach corresponds to a (simplified) environmental impact assessment (EIA) and is suitable for small projects, too. It consists of the following steps:

- 1) Describe the environmental context of the planned project;
- 2) Describe the project;
- 3) Identify the concerned environmental issues (water (including ground water); flora, fauna, habitat; landscape; archaeological sites, Geotopes & scientific relevance; vibrations; soil; air & climate; prevention of major accidents);
- 4) Identify the perimeters to consider;
- 5) Describe the present-day conditions (within the perimeters);
- 6) Define parameters to fix protection targets and evaluate possible impacts;
- 7) Define protection targets;
- 8) Evaluate expected impacts;
- 9) Identify possible problems by confronting fixed protection targets with expected impacts;
- 10) Reduce expected impact with project adjustments and/or protection measurements;
- 11) Evaluate remaining impact (steps 8 & 9).

This approach provides an assessment of the project compatibility with cave and karst protection concerns. These guidelines explain the karst-specific characteristics of each environmental issue and propose appropriate parameters (step 6) and examples for protection targets (step 7). A checklist for scientific sampling of cave sediments (especially speleothems) and some explanations about the sediment database of the SSS/SGH are furnished in an appendix. The complete Guidelines can be downloaded in German and French on www.speleo.ch.

Keywords: guidelines, environmental impact assessment, project evaluation, project optimisation, impact on caves and karst areas

ALL THE NUMEROUS THREATS TO THE PRECIOUS SUBTERRANEAN ENVIRONMENT AND ITS INHABITANTS

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As subterranean are considered dark habitats in solutional voids (fissures and caves) in the karstified rock, the voids in lava fields, and the narrow interstitial channels in the non-solidified granular sediments. Beside darkness, one of the main primary characteristics of underground habitats is the relative lack and poor quality of food. The consequence is the poverty and a high specialization of inhabitant fauna. Nevertheless, as much as 8 % of aquatic species in Europe are obligatory subterranean troglobionts, while subterranean fauna in other regions and in terrestrial subterranean habitats is relatively much poorer. Very characteristic for subterranean species is their high endemism which makes them highly endangered – the extinction of one population can often mean

the extinction of the species. Threats by hydrotechnical works (HW). HW may cause changing of living space, either drying out of some fissure systems or inundation of dry ones. The physical conditions underground are not enabling the biota to simply follow their needs in the space. HW may also change hydrographic relations and so bring in contact either competing species which would cause the extinction of the weaker ones. Changed hydrographic relations may also bring in contact different races of one species resulting in a potentially detrimental mixing up of their gene pools. Threats by inorganic or organic pollution (OP). Even a slight OP may enable surface animals to penetrate and successfully compete underground (if the access is possible), which can mean either the retreat or even extinction of troglobionts. A strong OP may have the same killing effect as any other kind of strong pollution. Autopurification in subterranean waters may progress only to the level of nitrates, which accumulate. Any pollution can endanger all subterranean habitats, the narrowness of the interstitial or of fissures does not prevent it; it may also be achieved directly from the surface through extensive fissure systems. Collecting of subterranean animals. Due to a certain commercial interest, to an excessive collecting may be exposed vertebrates (fish, amphibians, birds) and beetles. The beetles may be even attracted from fissures by baits, which is probably not the case with other animals. Collecting-sampling for research purposes can hardly affect subterranean populations to any degree. Administrative pollution. The knowledge is essential in planning effective protection measures for either the subterranean (or any other) environment or for its inhabitants. Therefore serious investigations (faunistic, biogeographical, ecological, molecular-phylogenetic, etc) are badly needed. Administrative obstacles hidden under the make-up of (unnecessary) protection acts make investigations extremely difficult. In the time of a rapid disappearance of natural conditions, such obstacles may mean that a lot of fauna will disappear before we may study or even detect – and consequently really protect it.

Keywords: nature protection, biodiversity endangerment, threats, subterranean habitats

MODEL FOR COMPLEX MONITORING OF PROTECTED KARST TERRITORIES

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In 2009 the Department of Geography of the National Institute of Geophysics, Geodesy and Geography at the Bulgarian Academy of Sciences started an international interdisciplinary project entitled "Working out an experimental model for complex monitoring of protected karst territories

(PKT) aiming at their sustainable management and development" (Project 02.260/18.12.2008, funded by the Bulgarian National Science fund). This project is based on the concept of karst geosystems, which can be studied using karst kadastre (specialized information system based on GIS) and complex monitoring. The project targets involvement of all aspects of karst geosystems monitoring, experimentally applied at protected karst territories, such as climatic, microclimatic, hydrometric, hydro-chemical, soil, lysimetric and radiometric monitoring. Development of original socio-economic monitoring at protected karst territories makes a special part of this research. Elements of the National biological monitoring have also been tested. In the course of this project development other topical methods of monitoring have been applied, adaptable to karst environments. Experimental research is being carried out in real conditions at 4 protected karst territories in Bulgaria. Expertise from monitoring of karst territories in other countries has also been utilized (namely the Czech Republic – Moravian Karst Protected Landscape Area and Japan – Quasi-national park of Akioshi-dai karst area, Western Japan). Legal and normative basis concerning protected karst territories make a special accent in this project, as well as how much they are relevant to the respective karst territories specifics. This project realization will create conditions for direct application of the research results in various educational programs, as well as protected karst territories management. It is expected that this project will result into a unified system for karst geosystems monitoring, experimentally tested at protected karst territories. The project long term strategic target is realization of international collaboration of coordinated monitoring attempts concerning karst genesis. This will allow comparative Geographic analysis and forecasting through 4D modeling. Special server has been set up to store and analyze project data, entitled "proKARSTerra" (Protected karst territories: Science-Management-Education). A series of additional initiatives have also been planned, among which an international scientific forum and student competition, concerning karst knowledge (2012).

Keywords: karst, karst geosystems, complex monitoring, karst genesis, protected karst territories, 4D modeling, specialized educational programs, scientific networks

THE INFLUENCE OF TOURIST VISITS ON MICROCLIMATE IN THE POSTOJNSKA JAMA CAVE SYSTEM

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The Karst Research Institute ZRC SAZU has undertaken regular climatic and part of biological monitoring of the Postojna cave system since 2009 at selected locations, as well as performing the tasks of karstology consultant or cave custodian in the implementation of the concession contract, meaning that we professionally monitor the state of the cave with an emphasis on the impact of the use of cave as natural asset.

One of the numerous tasks of cave custodian is to prepare professional directives for sustainable use of the cave. With such intention the air temperature in the cave and CO₂ concentration in the air were monitored at several locations during extreme tourist visits related to feast days from the end of December 2009 to the middle of February 2011 (Christmas 2009, Easter 2010, First May 2010, The Feast of the Assumption 2010, Christmas 2011 and Slovene cultural feast day 2011). Water temperature in the rimstone pool was monitored as well. The aim of the study was to find relation between number of tourists and increased air temperature and CO₂ values and possible influence of the extreme visits to the cave microclimate.

Postojna cave system (20,570 m) is the longest and most visited karst cave in Slovenia. In 2010 the cave was visited by nearly 500,000 visitors. There were 15,198 visitors in the cave in December 2009, and 9,524 visitors in November 2009. The Christmas crib performance 2009/2010 was visited by 10,530 visitors in six days. The increase of air temperature for 0.3 °C in the passage Lepe jame can be attributed to enlarged number of visitors. During the same period CO₂ concentrations in Lepe Jame increased from 600 to 1,600 ppm and returned back as the temperature did to the values before Christmas crib performance, but not always if one massive tourist visit is followed by another one next day. Water temperature in the rimstone pool was very stable, only during Christmas crib performance 2010/2011 there was observable increase for 0.1 °C. The highest rise of the air temperature for 0.4 °C was detected during the Christmas crib performance 2010/2011 in hall Koncertna dvorana.

After all tourist visits temperature and CO₂ concentration drops back to the values of natural background in one or two days since the cave is composed of huge passages and it is well ventilated. Consequently, the CO₂ concentration and air temperature stabilize to regular values quite rapidly.

Keywords: climatic monitoring, CO₂ concentration, show cave, Postojnska jama, Slovenia

RAMSAR LOCALITY "PUNKVA SUBTERRANEAN STREAM"

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The only one subterranean Ramsar locality "Punkva subterranean stream" in the Czech republic was declared in 2004 with the area of 1571 hectares. The subterranean locality belongs to the "Amateur Cave" complex with approximately 40 km length of corridors and also represents the most valuable karst area in the Czech Republic. The area includes springs, several swallow holes, sinkholes, resurgences, permanent and intermittent subterranean tributaries of Punkva stream connected with caves. The locality hosts several species of fauna such as the bats, endemic species and also new species to science have been found there. The protection of this Ramsar locality resides in regrass arable land, in the construction of several sewage power plants and in monitoring of living and non-living nature.

Keywords: Ramsar, Punkva, subterranean stream

GEORADAR MEASUREMENTS OF PERMANENT ICE THICKNESS IN CAVES

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In 2010, we carried out GPR studies in a remote cave Medeo. The cave is located in the territory of Srednevisherski area of West Ural folded zone carbon-bearing karst. The aim of the study was to examine the power and homogeneity of perennial ice formations. According to the results of the first defined power multi-year ice and built a three-dimensional model of sediment.

Keywords: ice cave, GPR, 3D model

CORRIDOR VC HIGHWAY PROJECT IN BOSNIA AND HERZEGOVINA – ENVIRONMENTAL STUDY FOR SARAJEVO SOUTH (TARČIN)–CROATIAN BORDER HIGHWAY SECTION, WITH A PARTICULAR OVERVIEW OF WATERS AND PROTECTED NATURAL AREAS

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This paper presents a short, basic Environmental Study (in particular the influence on waters and protected natural areas) for Corridor Vc Highway, on Sarajevo South (Tarčin)–Croatian Border section. Corridor Vc alignment through Bosnia and Herzegovina is approximately 330 km long, while the alignment in the investigated area is about 126 km long. This investigated section of the Vc Corridor comprises the karst region of Bosnia and Herzegovina, and this is why it is very important to properly and thoroughly estimate the impact of the construction of the highway on the complex system of water movement in karst. The areas of Neretva River confluence, with all the specific hydrological characteristics of karst, and the area of Hutovo Blato Nature Park, placed on the Ramsar List of wetlands of international importance, are particularly vulnerable.

Keywords: Bosnia and Herzegovina, Hutovo Blato, Vc Corridor, karst regions, Neretva River, water in karst

CAVE PROVALATA: FIRST EXAMPLE OF HYPOGENE CAVE IN MACEDONIA

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First results are presented from Cave Provalata, the first documented example of a hypogene speleogenesis in Macedonia. Located on the top of the superimposed valley of Buturica River, the cave is formed in Cambrian marbles, covered by coal-bearing lacustrine sediments and pyroclastic sediments with Pliocene to Pleistocene age. The overall pattern of the cave is strongly controlled by fractures with cupolas as most abundant morphological feature, at some places clearly connected to half tubes and feeders. Cave deposits include abundant white saccharoid gypsum crusts, grey clays, calcite crusts and yellow sands in which alunite and jarosite minerals have been confirmed by X-ray analysis. First results suggest speleogenesis by sulfuric acid, with nearby coal deposits as possible source of H₂S.

Keywords: hypogene cave, sulfuric acid speleogenesis, gypsum, Cave Provalata, Macedonia

CONTRIBUTION OF FLUORESCENT ORGANIC MATTER TO CHARACTERIZE THE IMPACT OF FORESTRY ON KARST WATER QUALITY

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In the French northern Subalps, where limestone outcrops are very developed, management and protection of karst water resources is an essential stake. In such a mountain context, karst systems are generally lowly size. The catchment areas are mainly covered by forest and pasture with urbanization and human activities that are not intensive. Among these activities, the forestry can raise quality problems concerning karstic waters got for the human consumption. This forestry can increase runoff and transport of suspended and dissolved sediment. These phenomena are translated, in particular, by peaks of turbidity in karst spring, making the water unfit for consumption. For solving this problem the Swiss-French Interreg project ALPEAU was established to study the role of forests and forestry impact on the quality of karst water. One purpose of this project is to define strategies for the protection and preservation of the karst water resources based on a control of forestries and the search of practices favorising or saving the groundwater quality. This implies a work on water indicators of forestry activity. On the catchment area, the mobilization of soil is the only vector of pollution. Turbidity and total organic carbon (TOC), being too general, we search to find a new indicator more pertinent and we focused on the natural fluorescent organic

matter. The karst system of La Combe in Saint Cassin (Chartreuse mountain) is one of the three experimental sites selected for this study. It is indeed representative of small karst system of middle altitude with a catchment area of about 2.5 km², where only forestry is present as human activity. To characterize the dissolved fluorescent organic matters in waters of the karst system, weekly monitoring by sampling point at the outlet was made. This monitoring was used to characterize the type of organic matter by spectrophotometric analysis. These permit the construction of fluorescence excitation-emission matrix assisting in the identification of dissolved organic matter in ground water. In addition to this characterization, analysis of TOC and total nitrogen were made on these samples. In parallel, a monitoring of the conductivity and the turbidity was established at a hourly time step. Initial observations show the systematic presence of three types of organic matter: humic type, protein type and a type characterizing microbial activity. These different types of organic matter present variability depending on the period of hydrological cycle. Turbidity, meanwhile, presents levels and frequencies of occurrence more important after the beginning of the forestry works. The arrival of an organic matter type coupled to a peak of total nitrogen revealed the specific forest practice (cutting) programmed into the catchment area. These results should allow to combine forest management and protection of the water resources.

Keywords: karst, fluorescent organic matter, forestry activity

CIVIL AND INDUSTRIAL ENGINEERING PRACTICE IN RUSSIA AND KARST UNDERGROUND PROTECTION

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According to the latest studies results, karst areas occupy about two thirds of the whole territory of Russia. Predominant types of karst are covered carbonate and sulphate ones. The most common types of karst manifestation on the ground surface are sinkholes and subsidences. They are the only types of karst deformations which are taken into account when karst hazard is estimated in case there exists a probability of damage to construction. Unfortunately, issues pollution of the geological environment caused by building and operation of constructions in karst regions are usually ignored, though such practice contradicts the UNO principle of sustainable development of terrains which has been declared in a number of corresponding laws of the Russian Federation. Basing on these principles, the author has made a number of recommendations on protection of karst cavities and karst water from negative impacts of building on karst. The recommendations have been included into the Standard on economic and engineering development of karst regions and some other normative documentation. For covered karst a classification of karst hazard has been developed according to conditions of potential negative impacts on karst rock. The main criterion for the categories within the classification is the value of existing and predicted sinkholes on a 1 ha area per service life of the construction.

Keywords: karst hazard, sinkholes, subsidence, Russia

A WORKING MODEL OF KARST AS AN EDUCATIONAL TOOL

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In 2008 members of the Dubrava Cultural Centre Eco Club in Zagreb, mostly third-grade pupils of the Antun Mihanović elementary school, participated at the Science Week with the presentation "Where does the water in karst flow?". With the help of their teacher, a professional geologist and several graduate students of geology, the pupils used clay, styrofoam and plaster of Paris to make two hydrogeologically active models of karst terrain and the underground. The models represented two geomorphologically different parts of the Velebit Mt. range in Croatia, milder Northern Velebit Mt. and rougher Southern Velebit Mt., respectively. Both models had underground hydrological network of tunnels and caverns made in clay with plastic tubes and bags, accompanied by karst springs, swallow-holes, estavelas, lakes and streams. These were designed in the very process of building the model, and the pupils designed the style of water percolation. After the hydrological network was designed, it was carefully covered by gypsum-impregnated canvas and "limestone" superstructure was built of styrofoam. The surface was modelled again in gypsum. During demonstration the pupils sprayed the model with water, mimicking the rain, which eventually surfaced in karst springs, estavelas, or sank in sinkholes to reappear in lower springs and fill the lakes. The idea was threefold: * to motivate children to explore and learn about karst through their own (interdisciplinary) research, * to do a hands-on activity using various materials, tools and techniques in order to produce a working (re)usable model/educational tool * to prepare material for the upcoming Science Week (an experiment, live and slideshow presentations). The results were more than satisfactory! Children successfully demonstrated their karst models before the public dozens of times, and explained to the audience everything they learned. The models themselves are very robust, and are still occasionally being used for in-school demonstrations.

Keywords: karst, relief, hydrogeology, education

PULSATING SPRINGS SVETINJA ON RADANOVO POLJE

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Radanovo Polje is a karst Polje with complex karst relations noticeable through the pulsating springs phenomena. Radanovo Polje is located at the higher level and about 5 km northwest from

Jelašinovačko Polje. The spring is on the northwest foothills of 487 m elevation. Shown on the picture in numbers are 1, 2, 3 and 4. From these springs, water flow in short streams into the Japra brook. Shown on the picture (a) is the Svetinja spring and (b) a small dent. During a single day, different conditions of water were recorded on the marked locations.

Keywords: pulsating springs, Radanovo Polje, Japra brook

TEMPERATURE DIFFERENCES OF 38 KARSTIC SPRING WATER OF JELAŠINOVAČKO POLJE

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By observing the 38 springs, criteria such as: sea level, flow, temperature and constant flow. The only thing in common is that they are all karst springs. Important differences were noticed when compared using each and every parameter. Each and every one of these springs is unique. One of the key things is constant or temporary appearance. Water temperature can be affected by underground flows. The time of contact with the storm water or the ground configuration which the water drains through can seriously affect the temperature.

Shown in the table is the relation of these parameters for 38 karst springs of Jelašinovačko Polje.

Keywords: karst springs, water temperature, constant springs, temporary springs, through flow

OVERGROWN AND EROSION KARST AND MOVEMENT OF WATER

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The most important anthropogeographical features of karst are; whether the erosion area is karst or covered with loam (Terra Rosa), or black soil and that the coverage is tough, or more or less tough by filling its small dents. We can find all the possible covered steps on karsts.

Even where we cannot see limestone rocks, but just the green, lack of above-ground streams, presence of sinkholes, occasional rock sticking out of the edge of the hill, all these signs are telling us that it is karst.

Keywords: covered karsts, erosion karsts, limestone

POSSIBLE UNDERGROUND FLOW OF KARSTS SPRINGS OF ZDENA AND DABAR

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Earlier research showed connection of sinkholes in Jelašinovci Polje the Zdena and Dabar springs. The time and the concentration of the first appearance and length and concentration presence of the fluorescent solution let us assume the length of the underground flow. Temperature differences of the two rivers could have also been caused by the time underground flow. By analyzing available data as well as the position of tectonic faults we can only assume possible routes of Zdena and Dabar.

Keywords: underground flow, fluorescent solution, temperature, tectonic fault

EDUARD DOLEŽAL ON IDEAL UNDERGROUND FLOW WATER IN BOSNIA

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Eduard Doležal based on the observation, is attempting to solve underground flow water of Pontus and Adrija. Here we come across the definition of watershed by Boussinesq i Dr. Alfred Philippson.

Underground ideal flow has a length of 23,105 km and in between the entrance and the exit there is 650 m of height difference, so the mid angle of descent is 1° 36'. It is even possible that Mrtvica brook which has a higher level after the snow melts and intense rains joins storm waters from the Vitorog mountain and increases the tributary of Pliva (Janj).

As is well known, the ground water entering at right angles from the sides or bottom of the river bed with that to an observer can not discern, or the waters of Mrtvica join downhill from Vitorog at the Hrbaljina with its underground waters flow right underneath Glamočko Polje towards Livanjsko, which would fit Baliff's idea on waters that flow towards Livanjsko Polje.

Keywords: observation, watershed, ideal underground flow, stream, tributary, river bed

IVAN TURINA ON A 100TH ANNIVERSARY OF STUDYING KARSTS AND HYDROGRAPHICAL CONDITIONS IN BOSNIA

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A significant contribution came from Ivan Turina by studying karst of Bosnia in his work "Hydrographic, geological and tectonic relationships of a karst landscape of northwestern Bosnia" which was published in the official Glasnik of the National Museum of Bosnia and Herzegovina, April - June 1913. In the research in 1911 and 1912, there are 52 pages of processed karsts and 2 tables; Bihać – Krupa, Kulen Vakuf - Donji Lapac, Ermain - Gračac. As a result of the research these areas can be broken down into 6 mountain ranges. Through subjects: the karst phenomena, hydrographical and geological relationships and tectonic properties described in detailed hydrographical phenomena in northwestern Bosnia. In addition, "Hydrographic condition of the Lušci Polje" explains in detail the development of groundwater resources, finding water in the karst cracks and flooding of this Polje.

Keywords: karst area, karst phenomena, permanent springs, occurrence of water, karst cracks, floods, mountain ranges

RESULTS OF COMPARISON OF SOME PARAMETERS OF BIOCENOLOGICAL ANALYSIS OF THE STREAMS THAT CHASM IN JELAŠINOVAČKO POLJE

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Karst Polje functions as a complex karst system with numerous springs, short streams and gullies. A biocenological sample analysis were conducted on the streams that flow into and Ponor in

Jelašinovačko Polje. The water samples show that the Čardašnica and Jezernica waters are of similar biocenological properties in the quality aspect, and that they belong to the similar streams. Analyzed samples indicate significant quality deterioration due to anthropogenic influences. The same parameters results were compared here and relations were graphically shown. Different values can easily be noticed on the graphical display of parameters.

Keywords: biocenological analysis, ponor, deterioration

WEALTH OF THE FAUNA IN THE WATERS OF KARSTS CAVES OF JELAŠINOVAČKO POLJE

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On the outskirts of Dinara in Sanski Most municipality, there are numerous springs of fresh water flowing in short streams to karst gullies of Jelašinovačko Polje. Here, in couple of estavels, the water remains present through the entire year. Characteristic of this water is constant minimum level and the temperature even in the driest time of year. Due to the constant presence of water also present is the *Proteus anguinus* as spring as other species such as: *Monolistra spinosa*, *Speleocaris pretnei*, *Troglocaris anophtalmus*, *Congerius kuscieri*.

Keywords: water fauna, karst caves, Dinara, Jelašinovačko Polje

PLANNING RAILWAY PATH IN THE TRIESTE KARST (CLASSICAL KARST)

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The Friuli-Venezia Giulia Region is interested by the design of an important high velocity/high capacity railway link (that belongs to the Pan-European Corridor 5) which should connect the city of Venice (Italy) to Ljubljana (the Slovenian capital) by crossing the village of Divača (Slovenia). During the feasibility studies, many solutions were examined regarding three main part of the project; the Monfalcone-Trieste link, the Trieste-Divača one and the Aurisina-Divača connection. The Monfalcone-Trieste link is characterized by a required planimetric path and must be optimized in a

vertical meaning in order to avoid an interaction with the important underground water resource stored in the karst massif. On the other side, even if the Trieste-Divača railway project is freer in the term of development directions, it must cross an highly karstified territory leading to the risk of technical problems and underground environment damage. Solutions with similar development directions could be compared with each other by a statistical analysis on the karst occurrences along the paths; however, a cost-benefit analysis is absolutely necessary to confront solutions which have very different length, which develop in not similar territories and which cross otherwise protected areas. During the feasibility studies the best Monfalcone-Trieste path has been chosen by comparing the water table height during different regimes with the project altitude and the impact with the superficial and underground karst features has been minimized by a detailed study around the plan. The research of the optimal solution to link the city of Trieste to Divača has allowed to reject the Trieste-Divača direct connection through the Val Rosandra Natural Park (interested by an important cave system and a vulnerable hydrology) and to choose the Aurisina-Divača option through a very karstified area that, however, could host the railway project although with particular attention for the karst environment.

Keywords: Classical Karst, railway path, karstified territory, geostatistical analysis

THE FRAMEWORK OF ENVIRONMENTAL SPELEOLOGY IN PRACTISE

OR WHY NOT DISCOVER THE CAVE?

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The Cave, cavity formed by natural processes in the earth's crust, is a natural phenomenon, which from the point of view of its specificity because of speleogenesis inorganic fill bio-components deserves the attention of science and research. Because the geo-ecotope of cave originated by long-running processes and is characterized by high vulnerability, the reconditioning of caves to their original condition after damage is a severalfold longer lasting process than the period of human generation. In terms of scientific studies, it is important to study the caves and their components in original condition. However, this is possible only to a certain extent. Discovery of the cave is the beginning of history of its destruction. Discoverers' and cave explorers' movement in the newly-discovered caves means the anthropogenic destruction of cave forms, sediments and bio-components. While the cave exploration requires the physical presence of speleologists, this process

can't be prevented, it can be only limited. Cavers world-wide are organized in speleological societies, which represent the guarantee for their professionalism and positive attitude towards the nature. The positive relationship of discoverer to the cave is the main assumption that cavers inside caves leave the negative marks to the least extent. The knowledgeable cavers and speleologists never destroy the cave more than it is strictly necessary because discovery and exploration of underground space survey and documentation of caves scientific research. There exist many of cases of negative anthropogenic influence to the caves, closely connected with the utilization of karst areas, which are case by case different one from the other. A special type of direct anthropogenic impact on the cave is opening it for the public. In case of show caves, which usually become to the most important caves in region, the negative interventions in the natural environment by building sidewalks, lighting, drainage etc. is later compensated by the protection of the cave components in surrounding of show path after opening the cave for public. However, show caves construction management, must apply the clear rules, the compliance with which will guarantee the maximum limited and only necessary degree of negative interference on the natural environment. In ideal case, there are national nature protection organizations, as experts who affect and regulate the cave exploration, environmental-friendly economic utilization of karst areas and construction activities associated with opening the caves for public. The important thing for application of the environmental speleology in real practise is the existence of a legislative framework, which includes protection of caves in the state nature conservancy law. Nevertheless, in many cases, there do exist lots of unforgivable sins against nature, which destroy not only the natural phenomena, but also the useful information for humans. Nowadays, the environmentally sophisticated society of speleologists in the early 21st century, co-operating with state nature conservancy organizations is trying to avoid the cave damages by the concept of national/world-wide methodology for: speleological activity / opening the caves for public / environmental-friendly utilization of karst lands systematic education of cavers community and the public to percept the cave environment control the compliance and penalizing the non-compliance with nature protection law. Notwithstanding, the best condition for the cave itself means, continuance in remain undiscovered. In any other state, the cave sustainability is based on compromises.

Keywords: environmental speleology, cave vulnerability, cave sustainability, cave protection, environmental-friendly utilization of karst areas

APPLICATION OF THE SPELEOLOGICAL RESEARCH IN NATURE PROTECTION, EXAMPLE OF THE ŽUMBERAK-SAMOBORSKO GORJE NATURE PARK, CROATIA

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This paper presents the application and importance of speleological research in management of the Žumberak – Samoborsko gorje Nature Park. This research was conducted from the year 2001 to

2005. by the Caving club Samobor, and financially supported by the Nature Park. The results are of great importance to proper management of this protected karstic area.

Keywords: cave, Žumberak, Samoborsko gorje, Nature Park

EVALUATING THREATS TO TERRESTRIAL CAVE FAUNA AND ITS PROTECTION – DIFFERENCES AND COMMONALITIES AMONG TWO KARST REGIONS

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Subterranean animals present a special case in conservation and protection activities. It is especially so for terrestrial cave animals that present the larger portion of subterranean biodiversity, but understanding of the threats and efficiency of protection policies is relatively poor. It is the example of highly endemic fauna, with species having narrow geographic ranges, yet the fauna as a whole is spread throughout the karstic landscape. Potential regional threats to terrestrial subterranean fauna were identified, such as destruction of habitat and alteration of organic and nutrient inputs in the caves. We focused on evaluating and understanding the large scale threats to terrestrial fauna in two karstic regions: caves in Virginia and West Virginia in US and caves in Slovenia. We investigated geographic pattern of threats and how they are related to caves harboring terrestrial fauna. Secondly, we checked what and how adequate is the existing pattern of cave protection, including direct and indirect protection, meaning landscape protection for some other features. In both regions, we used data on obligate subterranean beetles as a model group for terrestrial subterranean fauna: larger datasets for analyses were available, they are well studied and have relatively well resolved taxonomy. There are many commonalities, but also differences among the two regions in threats and protection. The average proportion of agricultural land use around caves is almost twice as much in Virginias than in Slovenia, while in the latter caves on average are closer to the four lane roads and towns with over 5000 inhabitants. In both regions, caves are protected individually, though mechanisms for protection differ. A larger proportion of caves in Slovenia are part of surface conservation areas.

Keywords: terrestrial cave fauna, threats, protection, West Virginia, Virginia, Slovenia