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## INCREASING PEOPLE'S AWARENESS ABOUT THE IMPORTANCE OF KARST LANDSCAPES AND AQUIFERS: AN EXPERIENCE FROM SOUTHERN ITALY

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**Abstract:** A strong and sincere link with local people is, in our opinion, the best way to perform speleological and scientific activities in karst. Such a conviction is based upon the very productive relationships that can be built when actively co-operating with local inhabitants. On our side, we need to actively transfer and properly disseminate the results of our studies, beginning with the schools; which means starting from the younger generations. We need to share with local people our knowledge, and convince them of the fragility of karst, so as to create an environmental awareness that facilitates a sustainable life in karst. Last but not least, we need to be ready to cope with natural hazards and the changes they cause, and to create an adequate resilience, that is the ability of the human system to adapt itself to the negative consequences of a likely disaster.

From the above considerations, during the last years a new approach was followed in the caving and scientific research expeditions in the Alburni Mountains (Campania region, southern Italy). This new approach strongly deviates from the old approach of isolated explorations and activities. As the Alburni Exploration Team (the association joining all the cavers working in the area) we started to involve the local population in our work. A number of activities were proposed towards this aim: the organization of a 1<sup>st</sup> level course of speleology, conferences and meetings at the local municipalities, establishing contacts with the national park existing in the area, and the management of the two show caves therein present, and carrying out experimental scientific activities such as dye tracing. In this article we illustrate the motivations behind a change in the approach and describe the initial obtained results. We then look to the future with the main goal being to safeguard the beauty of the Alburni Mountains for future generations, and to continue surveying new caves and to enhance further understanding of this area.

**Key Words:** sustainability, karst, awareness, hazards, Alburni

### INTRODUCTION

To live in a sustainable way in delicate natural settings requires (i) a proper knowledge of the characters of the environment surrounding us, together with a good comprehension of its fragility and sensitivities; (ii) an awareness of the importance it has for our lives, and the lives of future generations; and (iii) for activities and actions to take into account the fragility of the system.

In vulnerable environments like karst all these issues are of great importance (Ford & Williams, 2007; De Waele et al., 2011). Too often, scientists on one side, and cavers on the other, carry out their activities, research and explorations without establishing a strong connection with the people living in the territories where such activities take place. As a result of scientists and cavers confining themselves to the ivory tower the transfer of the results of studies and explorations is typically ineffective.

In this article we illustrate the main activities recently carried out in the Alburni Mountains (southern Italy). In an attempt to create a strong link with the local populations, these activities include: sharing the body of knowledge acquired over many decades of caving explorations, preserving the remarkable karst environments for future generations, and continuing to survey new caves and to develop further knowledge of the area.

The Alburni Mountains (Fig. 1), located in the Apennine Chain of Italy (Campania region), represent the most significant karst area of Southern Italy, extremely rich in dolines, ponors, caves and swallow holes. The karst nature of the area makes it an important exploration site in which over 400 caves have been explored thus far (Del Vecchio et al., 2013 a, b). Among these, the most famous are represented by the show caves at Castel civita, the longest in Southern Italy with a total length of 5,400 km, and at Pertosa, about 3 km long (Boegan&Anelli, 1930; Parise, 2011). Covering a total area of about 280 square kilometers, the massif mostly consists of limestones and dolomitic limestones of Mesozoic age, originated in carbonate platform environments (Russo et al., 2005).

Basal springs are distributed at the SW and NE sides, with mean discharges ranging from 3 to 7 m<sup>3</sup>/sec (Celico, 1979). Location of these springs at elevation from 260 to 70 m a.s.l. shows that the overall thickness of potentially karstifiable limestones exceeds one thousand meters (Santangelo& Santo, 1997).

Karst appears to be controlled by a combination of lithological and structural features (Gueguen et al., 2012; Cafaro et al., 2013), starting from the local structural setting and the relationship between bedding and water flow direction. Progressive development of erosional processes caused in many cases the downward migration of the input sites, which resulted in the presence of both inactive (the oldest and highest) and active (the youngest and topographically lowest) ponors (Santangelo& Santo, 1997; Russo et al., 2005). The size of ponors (and the related subterranean karst systems as well) is related to the size of the feeding catchments: the dimensions of the inactive ponors are larger than those of the active ones, which should derive from wider areas collecting water and transporting it toward the input points (Del Vecchio et al., 2013 b).

## **A BRIEF HISTORY OF SPELEOLOGY IN ALBURNI**

Great credit must be given to the first cavers that began systematically to explore Alburni, during the 50's and 60's of last century: they were able to transfer the high interests of this area to the whole Italian speleology, thus attracting cavers from many different parts of Italy. In addition to cave explorations, the first scientific research also started (Vianello, 1965). In this scenario, a crucial role was played by the local inhabitants. Initially quite sceptical and guarded about the cavers they slowly changed their attitude. Pushed by a growing curiosity over time they eventually became fully engaged in the logistics and organization of the activities.

At the same time, local populations began to look at their homeland from a different perspective. What they knew of the subterranean world was limited to the cave entrances, including the many frightening legends linked to such sites. With the cavers, they started to actively participate in the activities, sharing the outcomes of the explorations, and learning many new things about the natural resources hosted in the mountains where they lived.

Old photographs are the documents testifying to these initial contacts among cavers and Alburni inhabitants, with people helping to carry the heavy equipments, ropes and ladders,

also by means of pack animals, or providing food and materials to settle the camps near the cave entrances.

In the late 1980, the passage to new exploration techniques led to abandonment of the stairs. Nylon ropes and new, more reliable and light, tools allowed for better explorations within the the Alburni Massif. AIRES was founded, in an attempt to foster joint exploration, as an association covering different grottos and aimed at obtaining the best from joined explorations and research. In this way, the Alburni Massif became an important meeting point for all Italian cavers. The main product of this crucial period in the exploration history of the area is the book “Alburni Mountains – speleological research” (Bellucci et al., 1995). This book remains to this day the main reference for anybody interested in exploring the Alburni caves. From the middle ‘90s further cavers were attracted by the Alburni, and systematic explorations were carried out in several caves during the last 15 years.

During a national cave meeting in 2008, the idea of resuming joint efforts was raised by cavers from Apulia and Campania. Following this meeting, the Alburni Exploration Team (AET) was founded as a natural follow-up to AIRES. Key to this initiative was the will to directly involve the local populations, both to disseminate the results reached, and to establish a further value (that is, the karst caves) to this territory, very rich of natural beauties.

It clearly appears that, since the times of the first speleological activities in the Alburni Mountains, many things have changed: from the attitude of the local people, to their ability in maintaining contact with the outside world, to the way speleology is now organized. Strenuous, slow and hard work, consisting of close interaction increased mutual confidence between the actors and eventually resulted in the desired effect; the direct involvement of local population, inspired by an appreciation for the remarkable natural heritage of the surrounding area and by the need to safeguard these natural resources. Such an involvement took place in the main squares and streets of the villages, through photo and video shows which conveyed the beauty of the Alburni landscapes and caves. The strong interest by Alburni people, in particular by the youngsters, in turn encouraged cavers to organize other didactical activities and mountain tours to explain the karst morphology and hydrology. This was extremely important, since many local people were not at all aware of the peculiarities of their territories.

Even though the Alburni is a land of emigration, the few young people remaining in the area showed great interest toward the speleology events as they represented: a potential way to sustainably exploit the land, to look for work possibilities and at the same time, a means to remain in their homeland.

The aforementioned factors catalyzed the organization of the first course of speleology, and provided the foundation for the first local grotto at Sant’Angelo a Fasanella, which we are going to explain in detail in the next section. At present, we will acknowledge the continuation of this path that was initiated several decades ago by “strange foreigners with a light on their head”.

## **TEACHING**

Even though the history of explorations in the Alburni Mountains started since the 50’s, more than 60 years of studies, scientific research and caving discoveries, integrated by a number of meetings were unable to inspire the local inhabitants to take interest in the surrounding karst

phenomena in which they lived. And this notwithstanding the presence in the area of two important show caves (Pertosa and Castelcivita).

Eventually, in 2012 the main town in the area, S. Angelo a Fasanella, partly changed its attitude. This change was caused by the proposal from AET to realize a free project dedicated to the local elementary school. The main goals of the project were to transfer the knowledge and the awareness of the karst heritage to younger generations, and to stimulate a green economy by becoming aware of the natural heritage as a fundamental resource for the whole community. About thirty students from three towns of the Alburni were involved in the project: S. Angelo a Fasanella, Ottati and Roscigno.

In April 2012 the students were accompanied in a preliminary "virtual" journey, to start to become familiar with the classical themes of karst. Movies and pictures greatly helped to make the lectures more stimulating while displaying karst features and processes in a landscape familiar to the students. The first journey illustrated the path followed by water, from the surface of the mountains down into the caves: once there, the students had the opportunity to appreciate the peculiar morphologies produced by karst, the typical carbonate rocks in the area, and (a theme of great interest for the scholars) the species living in the caves, thus starting to talk about biospeleology (life in the caves). The water cycle in karst environment was further taken into account by means of movies. Also in this case, descriptions of the familiar Alburni landscape, and in particular of the Auso resurgence, was a useful tool for helping the students understand their homeland landforms. During the lectures (Fig. 1), the students had the possibility to touch and examine samples of fossils, as well as speleothems (stalactites and stalagmites), in addition to the tools used for speleological progression on rope and exploration.

All the activities were characterized by a highly alert audience, quite uncommon for this age. The high level of curiosity was evidenced by the quantity of questions asked which mostly sought to comprehend a familiar landscape in a new light.

Fig. 1 Two moments of the teaching activities: left, in class; right, the first experience in a cave.



In May 2012 a field trip was organized in the central sector of the Alburni Mountains, to visit the initial part of one among the most well known caves, *Grottadei Vitelli*: there, the students were captivated by the onsite lessons and excited by education props like helmets and lights.

Enthusiasm was also displayed by the school teachers as can be evidenced by similar activities in the same area. One of the activities (Fig. 2) included within the framework of the nation-wide project by *Lega Ambiente* and the Italian Speleological Society is “*Puliamoil Buio*” (literally meaning “Let’s clean the dark”). *Pozzo Raffaele Lombardi* (cadastral number CP 709) was selected as the site of the activity: the cave (total depth about 150 m) starts with an initial shaft, 22 m-deep, located nearby a picnic area, very close to one of the few roads crossing the Alburni. Easily accessible, the site is regularly frequented during the weekends and on main holidays, with the consequence of increased disposal of wastes in the cave and the surrounding area. A high quantity of wastes was therefore accumulated in the years, which was the object of the “*Puliamoil Buio*” action. About 100 kg of wastes, likely without any presence of toxic waste, was removed by cavers. The event was attended by students from the local schools that, after following the explanations and the reasons at the base of the initiative, enthusiastically contributed to its success by helping to remove the wastes and to clean the site at the surface around the cave entrance. The activity had a great effect on the students.



Fig. 2 “*Puliamoilbuio*” at *Pozzo Raffaele Lombardi*.

Following this experiences, in June 2012 the first Course of Speleology (initial level) was organized, according to the SSI standards. Four grottoes, all of them members of AET, worked to make the course possible. In the period 30 June to 22 July, seven students (4 male and 3 female) attended the course, that consisted of class lessons (Organization and history of speleology; Materials and technique of progression; Mapping and survey; Ecology and safeguard of the subterranean environment; Biospeleology; Prevention of accidents and first practice of rescue in cave), a day of practicing in a rock cliff the basics for rope progression, and three cave tours. After full completion of the course, in 2013 the first local grotto was founded, named GESMA .

## DYE TRACING

In conjunction with the teaching activities previously described, and that were specifically addressed to the Alburni population, some scientific research actions were planned and carried out, once received the due permission from the Cilento, Vallo di Diano and Monti Alburni National Park. These consisted of dye tracing tests in the municipalities of Petina and Corleto Monforte, at the northern slope of the massif, in a sector where cavers had recently performed several explorations.



The methodology followed used an artificial tracer, sodium fluorescein, with high environmental compatibility, good detection and excitation at different wave lengths. To detect the tracer along the subterranean path as well as at the final resurgences, proper fluorine captors with active carbon were used. These have been first analyzed in laboratory by means of ultraviolet light in darkroom, and then with a fluorometer in order to confirm the preliminary outcomes.

At the beginning of 2012 dye tracer tests were carried out at Petina, in locality Capostrada, in two significant swallow holes, *Grotta Milano* (CP 603) and *Inghiottitoio di Mastro Peppe* (CP 708). The likely exit point was the resurgence Niedda, in locality Molino, at the final reaches of Sant'Onofrio valley, but further possible sites were also monitored (*Grotta del Lauro* - CP 8 and the Sant'Onofrio valley).

The tests were carried out in two phases (January and March 2012). Such time lapse is justified by the need to wait for "cleaning" the system, since the two caves were supposed to have the same exit point. The first test was performed at *Grotta Milano* and at the nearby *Grava del Poeta* (Fig. 3), whilst the presumed sites down valley were the resurgence Niedda, the water course flowing in the Sant'Onofrio valley and *Grotta del Lauro*. These had been previously identified based upon geological and geo-structural observations, analysis of the discharge, and of the caves pattern and differences in elevation.

One hundred grams of tracer were put in the active branch about 100 m before the terminal sump of *Grotta Milano*. The test had a positive result, confirming the hydrogeological connection of the system *Milano-Poeta* with the resurgence Niedda.

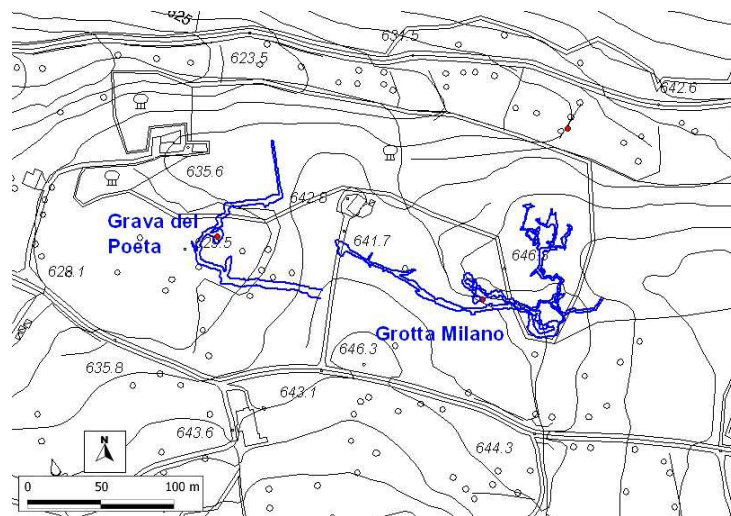


Fig. 3 Map of the two caves object of dye tracing tests in the Petina municipality.

A second test was performed at *Inghiottitoio di Mastro Peppe*, with monitoring of the resurgence Niedda and of the water course flowing in the Sant'Onofrio valley. One hundred grams of tracer were input at the bottom of the first shaft of the swallow hole; this because the hydric condition in the cave did not allow a safe progression in its deepest part. The captor at the resurgence Niedda resulted to be positive, differently than the one sampled in the valley. The results of this test confirmed the connection between *Inghiottitoio di Mastro Peppe* and the resurgence Niedda that therefore is fed by two systems of swallow holes in locality Capostrada.

During the spring-summer of 2012 the tests were carried out at Corleto Monforte, in locality *Piana di Campitelli*, where an important cave is present, *Grotta del Falco* (CP 448): at depth of some 150m this cave presents a sub-horizontal gallery with a stream showing discharge variables from a minimum value of 5-6 l/sec in summer to a maximum of about 50 l/sec in winter time. Recent cave explorations in the upper part of the karst system pointed out the presence of other rooms with water, the likely terminal points of other active swallow holes in the area. The tests were therefore focused in the attempt to identify the possible link among the active swallow holes in *Piana di Campitelli* (*Grava I* and *Grava II di Campitelli* - CP 106 and 107) and *Grotta del Falco*; in addition, the final exit point of the waters passing through this subterranean gallery was also sought by monitoring the resurgence at *Grottadell'Acqua* (CP 108), *Grotta di Pertosa* (CP 1), and some springs along the Tanagro river, west of *Grotta di Pertosa*.

The first test was carried out at the upper reach of *Grotta del Falco*, to prove the link with *Inghiottitoio II dei Campitelli* (the two caves are few hundreds of meters apart). One hundred grams of fluorescein gave positive results, thus confirming the presumed connection. A second test consisted of the input of 500 grams of tracer in the sump at the lower part of *Grotta del Falco* (Fig. 4), with the captors located at the likely springs (*Grotta del l'Acqua*, *Grotta di Pertosa*, *Tanagro river*).



Fig. 4 Input of tracer at *Grotta del Falco* (photos courtesy of Norma Damiano).

Sampling of the captors was performed during June and July. The analyses outcomes were variable, and their interpretation quite complex: the main hypothesis is that the water passing through *Grotta del Falco* reaches the water table and, after a certain time which is subject to the discharge, reaches the springs at the Tanagro river and the *Grotta di Pertosa*, near the Waterfall. On the other hand, it does not seem to reach the spring at the end of the Sump Branch at *Grotta di Pertosa* which is likely fed by other paths.

All the results from the dye tracing tests have been transferred to the technical office of the Cilento, Vallo di Diano and Monti Alburni National Park.

## CONCLUSIONS

As a conclusion, we are very proud to highlight here the general change in reciprocal attitudes between local population and cavers working in the Alburni Mountains. After several decades of explorations in the area, a new process of direct involvement of Alburni people was initiated, and the first results obtained from this, in terms of dissemination of the

speleological activities and of the will to work together to safeguard the karst land, are very encouraging.

Even if we only think to the caving results, recently, the main explorations carried out in the last years by AET at *Grava d'Inverno*, *Grava del Campo*, *Grava dei Vitelli*, and *Grotta del Vento* (Del Vecchio et al., 2013 b) demonstrated that even though the Alburni Mountains have always been highly frequented by cavers, further possibilities of explorations still exist, and hopefully will result in the future to discover and understand the functioning of the hydrologic system of this fascinating area.

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