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Tourists and their effects on the temperature changes inside the ali sadr cave, Hamedan

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Abstract

Caves are so vulnerable and fragile that manipulating them without careful investigation , planning and inclusive understanding of their characteristics is impossible because ignoring these facts leads to unpleasant consequences for microorganisms living in the cave and damages the dead carbonate forms. One of the ways that humans damage the caves and disturb the ecological elements inside the cave is uncontrolled presence of tourists inside the caves to visit these sites. Based on these realities of the caves, this study aims at investigating the changes in the temperature inside Ali Sadr Cave in Hamedan and daily and monthly effects of tourism in rising the temperature inside the cave. To this end, the inside part of the cave was divided into two areas: the experimental area (where tourists' accumulation is observed) and the control area (the prohibited area for the visitors and the recently discovered corridors). The temperature inside the cave has been measured using a three-functional (dimensional) carbon dioxide detector, model AZ (77535). This has been done three times a day in the morning (before the arrival of tourists) in the low, medium, and high areas inside the cave. The results showed 1 to 2°C increase in temperature inside the cave that can be attributed to the presence of the tourists. In addition, the results showed that increase in temperature and more daily fluctuations in temperature are observed during the weekends when more tourists visit the cave.

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Introduction

Using flashlights and other lightening devices significantly increases the temperature inside the caves. Increase in temperature inside the caves leads to Alga growth because light entrance into the caves is equal to emergence of life and Alga and coexistence of Fungi and Algae and Lichens. Lichens are very compatible and they do not need too much soil for their growth. When a large number of tourists simultaneously visit the caves without any pre-planning strategy, the created temperature and heat due to their presence and their physical activities increase the amount of Carbone Dioxide inside the cave several times resulting from their respiration activities. In addition, using flashlights and other lightening devices significantly increases the temperature inside the caves. Increase in temperature inside the caves leads to Alga growth because light entrance into the caves is equal to emergence of life and Alga and coexistence of Fungi and Algae and Lichens. Lichens are very compatible and they do not need too much soil for their growth. When lichens appear on the rocks they start to decompose the rocks. Therefore, a thin layer of soil and moisture results in generating them. These conditions along with enough light are favorable for Moss growth. When Mosses grow, they create a few millimeters of soil and keep the moisture. Thus, favorable conditions for the growth of more advanced species of ferns appear and this process continues until herbaceous plants appear. Initially, the species with shallow roots appear and when soil depth increases, more plants with deeper roots appear.

One-hour presence of each person in a cave leads to 60 calories of heat and 40 grams evaporation that is added to the inside of the cave. Therefore, visiting the caves by tourists and visitors increases the temperature and the moisture inside the cave (Hotzl, 1999:180). In Rim Champs Cave in Belgium, a group of tourists including 87 members increased the temperature 1.5°C within 5 minutes. This increase in temperature has largely changed the moisture inside the cave, too. Because more vapors can be accommodated in warm weather, compared to the cold weather therefore this process decreases the relative moisture and humidity of the air and the air inside the cave become dry. On average, each tourist on his own creates the amount of heat equals 82 to 119Watts (Giliesen, 1996:3). Calafora *et al.*, 2003, in a study investigated the temperature reaction inside the cave to tourists' presence and the temperature outside the cave. The visitors were divided into two groups: a 980-member group and a 2088-member group. They entered the cave in different times. It took only 150 seconds (two and a half minutes) to observe the temperature reaction inside the cave to the two-group entrance. The highest level of temperature increase was reported after 70 minutes with the 980-member group entrance and the highest level of increase in temperature with the second group (the 2088-member one) entrance appeared after 30 minutes. The most important thing to mention here is the reality that it in normal conditions it takes one week to make the temperature inside the cave and outside the cave equal after opening its entrances to the normal visitors and in a normal procedure. While at the time of the tourists' entrance, this process took only 5 to 6 hours to let the inside and outside part of the cave becomes the same. In addition, evaluations show that if only 53 visitors enter the cave daily, the temperature can be returned to the normal conditions within 4 to 5 hours. As a result, the cave has only the capacity of a few numbers of visitors daily. Tourists increase the water vapor due to their metabolic changes and therefore, the absolute moisture and humidity inside the cave will increase and these processes indirectly affect the dynamics of the shapes and the forms existing inside the caves (Pulido. 1996: 146). Sarbu and Lascu; Sanchez-moral *et al.* (1999); Fernandez- Cortez *et al.* (2006); Lario and Solar (2010) investigated in their studies the tourists and their roles in changing the ecological elements inside the caves including temperature, relative moisture and Carbone Dioxide and its consequences .They also concluded that appropriate and planned management is required to control these processes.

The present study aims at investigate the daily and monthly temperature changing inside the Ali Sadr Cave and the role of tourists in these changes. The fact is that in recent years, we have encountered the growth in the number of mosses and lichens appearing significantly inside the Ali Sadr Cave especially beside the projectors and the light sources inside the cave. Certain experts believe that in recent years some carbonated forms have been destroyed rapidly. Considering the large number of tourists and visitors who visit the cave and the authorities' policies to increase the daily number of visitors and tourists to visit the cave as much as possible. It is necessary to conduct studies on the changing of the ecological elements inside the cave including Carbone Dioxide, temperature, and the relative moisture.

Material and methods

Sampling method

The sampling was done using a Three–Functional Temperature, Relative Humidity and Carbone Dioxide Detector Machine AZ (77535) made in Taiwan.

In order to achieve the aims of the study, the corridors inside Ali Sadr Cave have been divided into two parts: experimental area, where tourists visits daily and the control area, which is the prohibited area for the visitors and tourists and those areas which have not been equipped with the electricity and projectors yet and are far from the tourists accumulation areas. Sampling procedure was done three times a day in the morning (before tourists arrival) and at noon and at night (after tourists arrival) in different parts of the experimental and the control group areas.

Division halls and corridors

Due to the temperature change in different areas inside the cave, the halls and the corridors inside the cave have been divided into three parts: 1. Low-high corridors (the range of their ceiling height was between 0 to 3 meters above the ground surface and water level) called small corridors in this study; 2. Medium-high corridors (the range of their ceiling height was between 3 to 7 meters above the ground surface and the water level) called medium corridors in this article; 3. High corridors (the range of their ceiling height was over 7 meters) called large corridors here. Considering the vast number of halls and corridors inside the cave, the sample-taking procedure, temperature measurement, was not done exclusively from the pre-determined areas but the researchers moved inside the cave and measured the temperature at different distances and points and then they determined the average temperature and also the time. The fact is that the temperature inside the cave depends on different factors including the temperature outside the cave, the halls and corridor sizes, the number of cracks and natural conditioning, ventilation, the number of tourists and visitors and length of their presence in the cave. But the present study has tried to determine the role of the tourists in changing the temperature inside the Ali Sadr Cave measuring the temperature of the control and the experimental areas inside the cave and find the differences between these two areas and the role of other parameters in changing the temperature inside the cave has not been investigated in this study.

Measured of temperature

Since it was likely that the entered air from the entrances affects the temperature inside the cave, the temperature was measured at a distance of 200 meters from the cave entrances. The sampling was done between the dates 22.5.1393 to 20.6.1393 within 30 full days.

Results and discussions

Small corridors: Small corridors are those areas in the cave which are at most 3 meters high. Table 1 shows the average of the measured temperatures in the control and the experimental areas in different times. As table 1 shows the measured temperatures within 30 days in the experimental areas were 14.3, 15.3, and 16.6 in the morning, at noon and at night respectively. At the same time the measured temperatures in the control areas were 14, 14.2, 14.6°C respectively.

Table 1. The average of the monthly measured temperatures (°C) in the experimental and the control areas in small corridors. (Ali Sadr Cave, Hamedan).

No	Time of sample-taking procedure	Dimension of the sample-taking points → Sample-taking area ↓	`Small Corri-dors
1	Average of the morning sample taking	Experimental area	14.3
		Control area	14
2	Average of the noon sample taking	Experimental area	15.3
		Control area	14.2
3	Average of the night sample taking	Experimental area	16.6
		Control area	14.6
4	Total Average	Experimental area	15.4
		Control area	14.2
5	Average difference between experimental and control areas		1.7

The difference between the measured temperatures in the control areas and the experimental areas in the morning (before the arrival of tourists) and at night (after the departure of tourists) has been considered as the effects of the tourists on the temperature increase. In other words, ignoring the 0.3°C of the temperature difference between the morning measurements in the experimental and the control areas, the role of tourists in increasing the temperature inside the Ali Sadr Cave in the small corridors within 30 days was 1.7 6 ° C.

The daily fluctuations in the temperature in small corridors: Fluctuations of the daily temperature measurement in low-high corridors are illustrated in fig. 1. As it shows, there are no significant fluctuations and changes in temperatures measured in the morning and they show 14 and 15°C. Once the tourists entered the cave, temperature inside the small corridors increases gradually and this continues until night. The most important point in fig. (1) is that there are 4 pick points in the temperature fluctuations. These pick areas are in accordance with the weekend holidays and increase in the number of tourists. Close examination of the figure shows that these points are observed in the temperature measurements conducted in the morning. This fact indicates that the conditions inside the cave during the night continues until the next day without any significant changes.

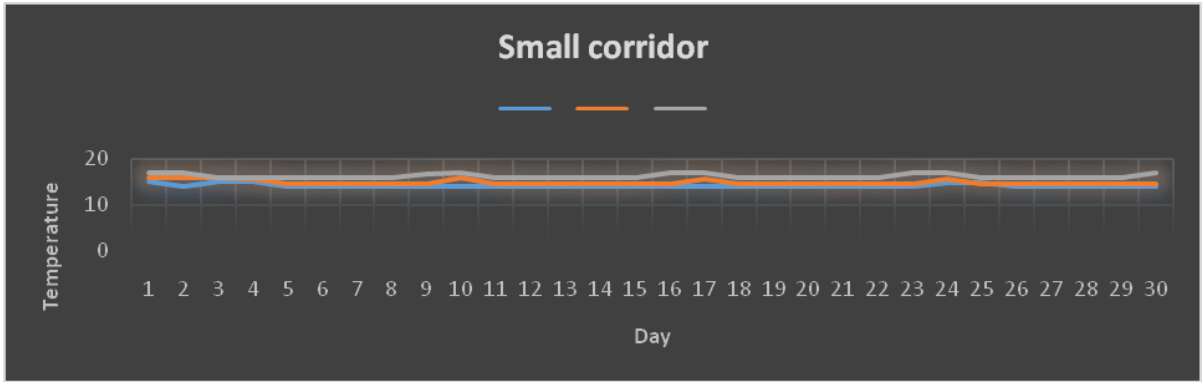

Fig. 1. The daily fluctuations in the small corridors (The Ali Sadr Cave, Hamedan).

Medium corridors

Table (2) shows the monthly measured temperatures in the experimental and the control parts of the medium-high corridors. The average of the measured temperatures in the morning, at noon and at night in experimental corridors were 14.2, 15.1 and 16.3°C respectively. In other words, the average daily fluctuations in the morning and night measured temperatures in these corridors was 2.1°C. At the same time, the measured temperatures for the control parts were 14, 14.3 and 14.5 respectively. In other words, the average of daily fluctuations in the control points of the medium high corridors was 0.5°C.

Table 2. The average of the monthly measured temperatures (°C) in the experimental and the control areas in medium corridors. (Ali Sadr Cave, Hamedan).

No.	Time of sample-taking procedure	Dimension of the sample-taking points → Sample-taking area↓	Medium Corri-dors
1	Average of the morning sample taking	Experimental area	14.2
		Control area	14
2	Average of the noon sample taking	Experimental area	15.1
		Control area	14.3
3	Average of the night sample taking	Experimental area	16.3
		Control area	14.5
4	Total Average	Experimental area	15.2
		Control area	14.2
5	Average difference between experimental and control areas		1.6

Ignoring the difference between the averages measured temperatures in the morning in both groups (1.2 °C) tourists increase the temperature1.6°C in medium high corridors.

The daily fluctuations in temperature in medium corridors: Fig. 2 illustrates the daily fluctuations in temperature in the medium high corridors. As in the small corridors, the temperature inside the medium high corridors increases when the tourists enter the cave and in certain days it reaches to 17. The pick points 6°C in this figure shows the increase in the number of visitors and tourists visiting the caves during the weekends.

Fig. 2. The daily fluctuations in the temperature in medium corridors (The Ali Sadr Cave, Hamedan).

Large corridors: Large corridors are those which are more than 7 meters high in the Alisadr Cave. As it can be seen in table 3 the average samples taken during 30 days in the experimental points during morning, noon and night were respectively 14.2, 14.9 and 16.1°C.During this period the average of the samples taken in the control areas were respectively 14, 14.1and 14.4°C.So the daily average increase in the temperature in the experimental areas were 1.9 °C and 0.4°C in the control areas. Without considering 0.2°C (the average difference in the amount of the morning measurements in the experimental and control areas which is in fact the amount of the temperature remaining from the previous days in the experimental areas).The tourists effects in increasing the average temperature of the large corridors in the Alisadr Cave during the 30-day sample-taking procedure was 1.5 °C.

Table 3. The average of the monthly measured temperatures (° C) in the experimental and the control areas in large corridors. (Ali Sadr Cave, Hamedan).

No.	Time of sample-taking procedure	Dimension of the sample-taking points → Sample-taking area ↓	Large Corri-dors
1	Average of the morning sample taking	Experimental area	14.2
		Control area	14

No.	Time of sample-taking procedure	Dimension of the sample-taking points → / Sample-taking area ↓	Large Corri-dors
2	Average of the noon sample taking	Experimental area	14.9
		Control area	14.1
3	Average of the night sample taking	Experimental area	16.1
		Control area	14.4
4	Total Average	Experimental area	15
		Control area	14.1
5	Average difference between experimental and control areas		1.5

Fluctuation in the daily temperature in the large corridors: In fig. 3, the 30-day fluctuations in the temperature during morning, noon and night sample-taking procedures in the large corridors in the Alisadr Cave shows that like the other fluctuations existing in the corridor with low and medium height, these corridors have also faced with gradual increases in the temperature regarding the increase in the number of the tourists visiting the cave .It seems that these corridors have encountered less amount of fluctuations and changes in temperature during the morning samples-taking procedure in large corridors.

Fig. 3. The daily fluctuations in the temperature in large corridors (The Alisadr Cave, Hamedan).

Conclusion

Caves are considered as a sample of the beauties and glories of the nature. When the limestone ornamental structures of the caves encounter some damages or the natural spaces in the caves are covered with waste materials, we can conclude that the main reason of this kind of destruction and damages is related to the visitors and tourists visiting them and those who want to explore the caves. These destructive factors are doing the destruction procedure either deliberately or accidently. Although most of these destructive factors can be removed or the pollutions can be cleaned, the effects of some of these destructions and pollution are permanent and cannot be removed. Broken and destroyed stalagmites and stalactites which have been created and formed during thousands of years and may never be created or developed to its original forms or the rare kind of bats which only live in special kinds of caves may be extinct forever. Although there has been some attempts from the side of cave explorers and biologists to protect caves and remove their different kinds of pollution , most of the time the results and consequences of polluting the caves cannot be removed forever or have had their destructive effects before they are removed from the environment. It may be possible that micro-ecologies existing inside the cave are accompanied with trivial changes so the geological forms, phenomena and the existing geomorphology created inside them are adapted to the micro-ecologies and are changed based on their features. Sudden changes in the features and amounts of the ecological factors of these micro-ecologies naturally stops forming and creating different forms of stalagmites and stalactites. Some changes in the temperatures inside caves have been made by the contribution of some conditions such as photo and so on and growing and developing some kinds of algae and moss and then fern and the other kinds of plants have had its consequences. The results of growing and developing of some species of plants

in the caves that have different kinds of carbonated forms will certainly result in destroying and deforming these forms. Therefore, in managing the caves that are visited regularly by visitors and tourists, the ecosystem existing in the caves, its ecology, and the number of the daily and annual tourists must be studied carefully.

References

Calaforra JM, Fernández-Cortés A, Sánchez-Martos F, Gisbert J, Pulido-Bosch A. 2003. Environmental Control for Determining Human Impact and PermanentVisitor Capacity in Potential Show Cave before Tourist Use". *Environmental Conservation* **30**, 160-167.

Fernandez-Corte´s A, Calaforra JM, Jime´nez-Espinosa R, and Sa´nchez-Martos F. 2006. Geo, Statistical Spatiotemporal Analysis of Air Temperature as an Aid to Delineating Thermal Stability Zones in a Potential Show Cave: Implications for Environmental Management: Journal of *Environmental Management* **81**, 371–383.

Giliesen D.1996. Ecosystem at risk: Limestone cave". Available: *www.caves.org/*, 7.

Hotzl H. 1999. Industrial and Urban Produced Impacts". UNESCO project IGCP379. *Karst Processes and the Carbon Cycle,* 178-183.

Lario J, Solar V. 2010. Microclimate monitoring of Pozalagua Cave (Vizcaya, Spain)", Application to Management and Protection of Show Caves. Journal of *Cave and Karst Studies* **72(3),** 169–180.

Pulido-Bosch W, Martín-Rosales M, López-Chicano C, Rodríguez-Navarro M. 1997. Human Impact in a Tourist Karstic cave (Arecena, Spain). *Environmental Geology* **31**,142-149.

Sanchez-Moral S, Soler V, Can˜ averas JC, Sanz E, Van Grieken R, Gysells K.1999. Inorganic deterioration affecting Altamira Cave": Quantitative Approach to Wall-Corrosion (SolutionalEtching) Processes Induced by Visitors: Science of the Total Environment **243**, 67–84.

Sarbu SM, Lascu C. 1997. Condensation Corrosion in Movile Cave, Romania": Journal of Cave and Karst Studies **59(3),** 99–102.