Lecture at
CMA4CH 2014, Mediterraneum Meeting
Employ of Multivariate Analysis and Chemometrics in Cultural Heritage and Environment Fields
5th ed., Rome, Italy, Europe, 14-17 December 2014

Multivariate Comparison of Microclimate Campaigns in the Carcer Tullianum in Absence and in Presence of Visitors

G. Visco[1], P. Fortini[2], S.H. Platter[1], M.P. Sammartino[1]
[1]Chemistry Dept, University of Roma "Sapienza"; [2]Cultural Heritage Superintendence of Rome City Council, Rome, Italy

Abstract

Microclimate conditions play one of the main roles in the conservation of Cultural Heritage (CH); here we present a comparison of 2 campaigns, run in the same days of two successive years inside Carcer Tullianum, in absence and in presence of visitors. It is well known that the fruition of CH always has a negative impact, bound to the perturbation of the environment equilibrium, due to chemical, physical and biological factors as well as the possible vandalism. The huge mole of data have been already treated by chemometry for each single campaign and the same data treatment was here adopted.

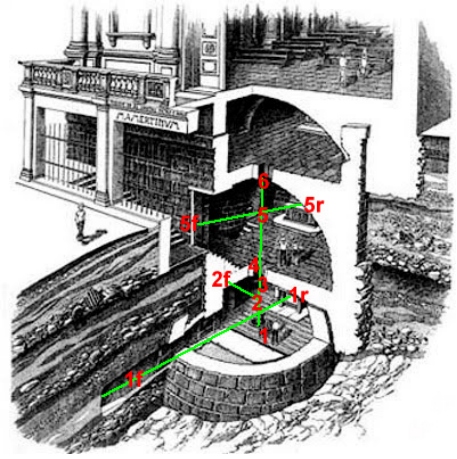

Fig. 1; Experimental Design

Introduction

Following two previous campaigns of microclimate monitoring (1 month in the same seasonal period of two successive years), inside Carcer Tullianum (Rome, Italy) in absence and in presence of visitors, a chemometrics data treatment was applied to the relative data in order to evidence the effect of the site's fruition. The monitored site consists of 3 areas, in the following called Tullianum, Carcer and Convent; the first is completely buried and communicates with Carcer through a circular grid in the center of the domed ceiling and a stairs (dating later) while Carcer also communicates with Convent even if not directly but through a closed glass window. During the first campaign the site was closed to visitors and a stratum of water, coming from the ancient original spring, continuously covered the Tullianum's; contrarily, during the second one it was open to visitors and water continuously pumped to dry the Tullianum's floor.

The comparison of the two campaigns considers only 16 days because we had not opportunity to start the second in the same day of the year so that the first two monitoring weeks not overlap; the area "Convent" is not considered because during the first campaign was yet under excavation.

Materials & Methods

In the overlapping days 10 dataloggers Hobo U12-012 (by Onset, USA) were used to measure RH, T and Illuminance and 1 certified sensor EB20-THP for RH, T, mbar (by Ebro GmbH, Germany). Free software were used: Datalab, Past, Gnumeric, WinIDAMS, Santis. The experimental design was been based on vertical and horizontal profiles covering at the best all the area (fig. 1).

Results

Fig. 2 well highlights a noticeable change of microclimate, i.e. a loss of insulation. The slope and the Pearson coefficient of the indoor-outdoor correlation graph, for T, increase; inside of Tullianum, the almost constant delay of the indoor T in following the outdoor one, assumes a rapid decreasing trend going towards the grid of connection with the Carcer, where a drop in values around zero occurs. Such change is mainly due to the fact that the big front door always remains open during the visits because is used as exit. RH shows the same trend (not shown); inside the Carcer, the increasing delay trend going toward the grid is lost and values approaching zero are evidenced in the two highest points; in the lowest point inside of Tullianum, a delay decrease from about 150 mins to about 60 highlights the effect of the drying due to the pumping of the spring water from the floor.

The gain-loss graphs in fig. 2 highlights, in both the Carcer and Tullianum, a decrease of both the values and spreads of RH, anyway the Tullianum maintains the hypogean behaviour while an evident drying of the Carcer occurs with RH values that fall from about 70-85% to about 52-78%. In

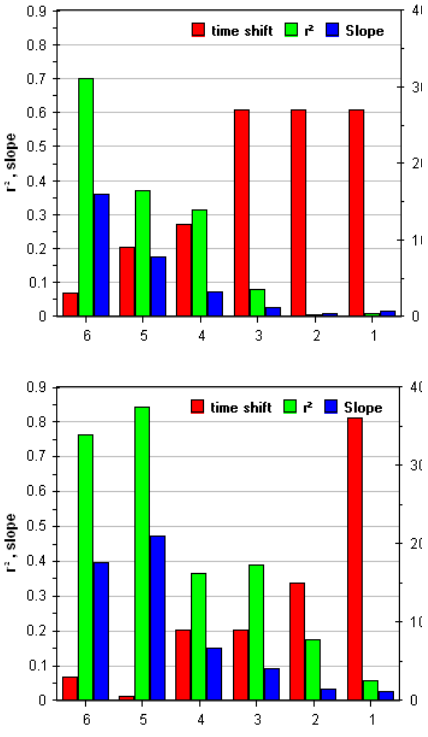

Fig. 2; Comparison of six temperature sensors on vertical profile, from the 1st (top) and 2nd campaigns: slope and r^2 of the indoor-outdoor correlation, time shift

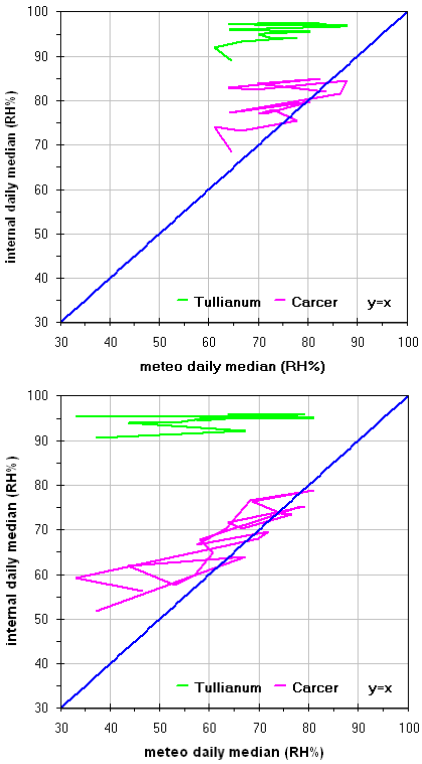

Fig. 3; Gain-loss graphs of relative humidity obtained in absence (top) and in presence (bottom) of visitors

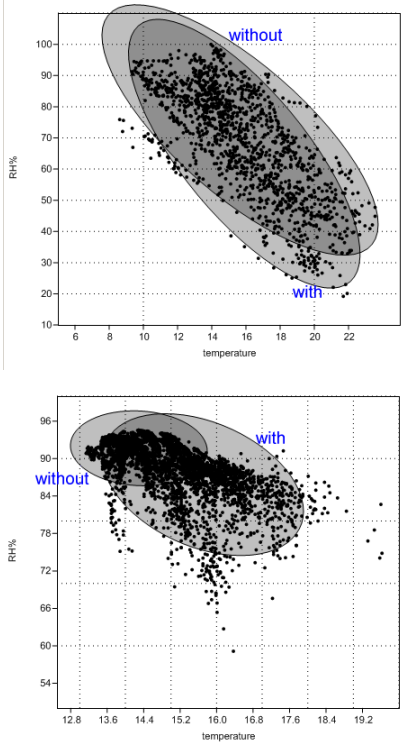

Fig. 4; Macroclimate (top) and microclimate (bottom) scatterplot, during the 1st (no visitors) and 2nd (with visitors) monitoring campaign

the analogous graph for Temperature (not shown), the trend (opposed) is much more evident with some values inside of the Tullianum and almost all those inside of the Carcer that increase up to overcome the external ones. Lastly, fig. 3, multivariate, also shows that, even if in similar macroclimate conditions, as expected, a noticeable variation of microclimate occurred, i.e. a big widening of the range for both T and RH, an increase of T and a decrease of RH.

Conclusions

The adopted data treatments resulted suitable to easily highlight the noticeable expected loss of insulation that occurred on opening the site to visitors; further, they follow the rule "simple is better" loved by some chemometrician because the calculation on which they base can be easily understood by restorers, museum's chiefs and superintendents that can so obtain a lot of information, Others kinds of graphs, not shown for lack of space, were also drawn, each one highlighting a particular information.

From the conservation point of view, the loss of balance achieved in many centuries of burial is a risk factor for the building that, unfortunately, is inevitable if it is to be enjoyable; however, some precautions can be taken to decrease the risk.

References

1) G. Visco, S.H. Plattner, P. Fortini, S. Di Giovanni, M.P. Sammartino,. Microclimate monitoring in the Carcer Tullianum: temporal and spatial correlation and gradients evidenced by multivariate analysis;first campaign, *Chem Cent J*, 6(2), (2012) 1-17.

2) G. Visco, S.H. Plattner, P. Fortini, M.P. Sammartino, Second Campaign of Microclimate Monitoring in the Carcer Tullianum: Temporal and Spatial Correlation and Gradients Evidenced by Multivariate Analysis, *Chem Cent J*, 6(104), (2012) 1-17.