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Preventive conservation plan for library buildings in La Plata, Argentina

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Abstract

This summary shows the advances of a project called "Development of building environmental management and continuous monitoring for preventive conservation in UNLP libraries" which is now taking place in the libraries of the National University of La Plata. It is essential to know the hygrothermal condition inside the book deposits, as one of the first preventive measures to become aware of the state of conservation of the books. The aim of the study is to propose a systematic environmental monitoring method to verify compatibility between measured parameters and optimal preservation conditions. Annual monitoring campaign was performed in twelve libraries with diverse results according to the characteristics of the envelope and HVAC systems. It is the first time that a formal monitoring campaign has taken place in these library buildings. We met staff well disposed and eager to achieve better results. We provide a standard report model suitable for the institutions as a decision-making tool, with simultaneous analysis of temperature and relative humidity, according to the local climate.

Keywords: preventive conservation; microclimate; environmental monitoring; performance index; deviation index.

1. Introduction

Libraries are — by definition— sustainable institutions. They lend books (use and reuse) as well as functioning as meeting, study, work and discussion places for students and researchers. Preventive conservation acquires another meaning in these kind of buildings: extending the life cycle of books makes libraries economically sustainable.

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According to IPCC 5th report, human activity has been the main cause for global warming, which has been observed since the middle of the 20th century. CO_2 concentrations have increased 40% since pre-industrial times mainly due to emissions from fossil fuel combustion and, at a lesser degree, land intensive exploitation [1]. As habitat designers, we must be aware of the impact that buildings have on the environment. As libraries perform a social role in educating citizens, it is desirable for those institutions and their management to be examples of sustainability for the community [2].

Following this premise, we research passive conditioning for the conservation of cultural heritage.

In 2014, the National University of La Plata (UNLP) began to finance a R&D promotional project called "Development of building environmental management and continuous monitoring for preventive conservation in UNLP libraries". The project is carried out by a multi disciplinary team and one of its objectives is the establishment of a systematic environmental monitoring method in these libraries to verify compatibility between measured parameters and conservative state of the goods. Also to transferee this experience to each institution so they can make their own environmental evaluation. We also study building envelope, spatial functional distribution, hygrothermal characteristics of indoor and outdoor environment and performance of existing air-conditioning equipment.

We take the work developed during "museum accreditation process" as a reference. In it, the Confidential Facility Report (CFR) is orientated to lay out the particular situation of each museum [3]. The objective of CFR is to make a report of the environmental state, as a starting point, to determine needs and priorities to guide improvement interventions and the value enhancement of the institutions. CFR appeared in the museum accreditation process to achieve Museum Standard, launched by Piedmont Region [4] as a response to National Decree D.M. 10/5/2001 about scientific and technical criteria and performance and development standards for Museums [5]. Monitoring utilizes procedures recommended by UNI 10586 Standards "*Condizioni climatiche per ambienti di conservazione di document grafici e caratteristiche degli alloggiamenti*" and UNI 10829 "*Condizioni ambientali di conservazione, misurazione ed analisi*".

Environmental monitoring is not a frequent practice in the region, despite being the first tool of environment conservation diagnosis and examination. Many authors realized this [3,6,7]. The reasons why this procedure is not carried out are, among others, unawareness, lack of instruments and trained personnel, as it is usual in developing countries [8]. After monitoring, the next step is to establish measurements of passive design to mitigate adverse climatic effects, detected in the first step. Previous experiences show that it is possible to reduce temperature variation and average relative humidity even lower than outside, with simple, very low energy consumption systems with low maintenance [9] [10]. It is also possible to achieve this goal by adapting building operation and maintenance, as the ones implemented in a series of historical buildings in USA by Henry, 2007 [11]

The goals of this work are to explain the execution process of R&D project, to show its main results, and to propose a model of report adapted to our organizations, as a counterpart for the tasks that libraries carry out and a tool for decision-making. We analyze the particular conditions of the study scope to place the reader in a different reality from Europe or North America.

1.1. Study case

National University of La Plata (UNLP) was founded in 1906 by Dr. Joaquín V. González, in need of a modern, scientifically–based university, far from the characteristic academicism of contemporary high learning institutions.

It began to work under the precepts of research, extension, and the incorporation of professors and doctors from foreign recognized educational institutions. The university acquired prestige and became renowned in Latin America, oriented to empirical knowledge education, representing the new paradigm of university reform —which supported in 1918— based on respect, freedom, justice and rejecting traditional dogmatism.

Nowadays, 110,000 students attend the university, which offers 110 university degrees, has 18 departments, 21libraries and 12 museums. Entry is unrestricted, degree level education is free for every native and foreign student. The investment per capita is US$2100/year (2012).

Throughout its 108 year history, libraries as well as historic archives have increased in number and value, because there are rare, curious books and incunabula. The valuation of these documentary collections help us find— from architectural design— store places that warrant environmental conditions to mitigate the impact over

time and the ageing of organic material. The challenge consists in reaching these optimal preservation conditions by means of passive air- conditioning strategies in storage places and, in that way, allowing the duration of the assets throughout their lifetime.

The Construction and Maintenance General Directorate of UNLP rules and supervises—centrally— every action taken on buildings.

1.2. Site features

La Plata City is situated 34° 55 South and 57° 57 West (fig.1a). According to Köppen´s classification, its climate is temperate mesothermal subtropical, without dry season.

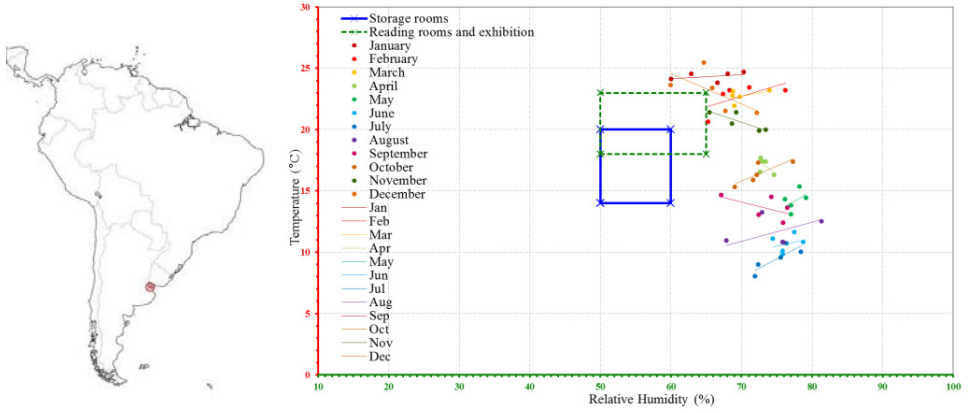

Fig. 1. La Plata City location, Argentina; Conservation conditions according to UNI 10586, 1997. Climogram for La Plata.

Summers are mild with an average maximum temperature 28,5°C and winters are not harsh with minimum temperatures around 6,7°C. Relative humidity is high, between 71 and 86%. Fig. 1b shows a comparison between average monthly temperatures during the last five years, their tendency and proposed conservation conditions. We obtained weather data from a Davis weather station, situated on the outskirts of La Plata .

During the whole year, outdoor hygrothermal conditions do not satisfy the condition proposed by UNI 10586 Standard for graphic document conservation [12].

During cold months (June, July and August), relative humidity is around 10% higher than in warm months (December, January and February). In these warm months, temperature exceed the allowed range for storage areas, but it is closer to comfort temperature, which is optimal for exhibition and reading-rooms.

Site analysis shows that— in spite of a temperate climate— it would be necessary to design air-conditioning strategies in order to achieve the ideal preservation of paper documents. However, it is not usual for buildings to have air-conditioning equipment that have been adapted for preservation purposes.

The R&D project intends to develop a management and continuous monitoring method. It is important to set up an interdisciplinary team to attack the preventive conservation issue considering not only the collections but the storage building structure as well.

2. Methods

This procedure has been applied many times by the authors within the university premises [13, 14]. This transference project intends to establish this practice as a routine in the institutions, training the personnel in charge of preservation. The methodology is based on 5 pillars: (I) building data collection, (II) diagnosis, (III) monitoring, (IV) surveys and (V) evaluation.

The building data collection consists in the envelope morphology study. Plans are drawn and the volumes analyzed, glazing/wall relation (%) and envelope thermal transmittance (W/m^2K) are calculated.

The diagnosis corresponds to phase I in UNI 10829 Standard [15]. The surface is divided in a 5x5m grid and inner temperature and humidity are controlled at every node. During this procedure, particular situations like air stagnation or air speed change have to be detected at certain nodes due to natural ventilation, mechanical ventilation or interaction with the air-conditioning system.

In the monitoring step (phase II), an extended measurement of temperature and humidity is made at the significant points detected in the former step. Wireless U-12-012, U10-003 and U23-001 Onset Hobo data loggers are used, with outdoor weather protection. As weather conditions do not change abruptly, these measurements are divided four times, each one corresponding to season central periods, for 15 days every 30 minute.

A survey is conducted to collect significant parameters such as: opening hours, quantity of people, eventual air – conditioning schedule, and type of light sources. Enquiries should also be made about concrete envelope, collection issues (leaks, mold, plague) and mitigation actions carried out previously.

The evaluation consists of the comparison between monitoring results and ideal predetermined parameters. The Standard gives us temperature (t) and relative humidity (RH) ranges— which are recommended to delay document damage—, as well as maximum variations per unit of time, to prevent physical and chemical modifications due to sudden changes in variable conditions. The Standard provided values, will be utilize when no other specification is available. To compare our results with reference amounts, absolute maximum and minimum values are calculated, average values, T and RH standard deviation, daily amplitude or deviation index (DI) and performance index (PI) [16,17]. In this last step, a spreadsheet is made, where summarized monitoring data is collected(Appendix A).

The instruments belong to the Laboratory of Architecture & Sustainable Habitat (LAyHS). Temperature and humidity sensors were placed in stores, shelves and reading-rooms in a group of university buildings. The studied institutions have diverse building features. In general, two large groups can be described: Group A, which comprehends most of the cases, are situated inside the Faculty building. They are massive buildings, more than 50 years old. In this typology, we find gas or electric heaters and no cooling systems. Group B comprehends buildings recently built or adapted to host libraries. They are less than 30 years old, with lighter envelopes. Two of them are provided with centralized cooling systems.

The monitoring process began in 2011 and since then we have refined analytical techniques reaching this point of being able to transmit them to the staff of the institutions involved. Currently, we are working on the diffusion of the project and inviting other institutions to participate and elaborating reports to explain— in a simple and concise way— the issues that have to be solved.

3. Results

We monitored 12 institutions which belong to UNLP throughout the four seasons. The concrete outputs show diversity, but in all cases, the critical period is summer. Inner temperatures in libraries exceed the standard maximum allowed. In contrast, we observe stable values, with low deviation indexes. In winter, PI is better but show great variation when heating systems are on during opening hours. In the case shown, the central heating system provokes a drastic decrease of relative humidity, around 25% in relation to outdoor humidity and 15% in relation to indoor optimal value. All campaigns display better results in autumn and spring: when rooms are naturally ventilated.

Considering Group A building envelope (Library of Physics), wall (42cm solid brick) thermal transmittance (U) is 1,52 W/m^2K, U roof (reinforced concrete slab) is 4,15 W/m^2K and U window (simple glazed wooden and iron) is 5,88 W/m^2K. For Group B buildings (Appendix A) , U wall (double hollow brick with air chamber) is 1,02 W/m^2K and U roof (accessible reinforced concrete slab with attic and coating) is 2,79 W/m^2K and U windows (simple glazed Al) is 5,88 W/m^2K..

We conducted a survey with responsible personnel in each institution. According to their answers for 29% of personnel the main cause of damage is humidity, 21% insects, 17% microorganisms, 14% out of range temperature, and 12% inadequate user manipulation. The last 19% of personnel found other causes of damage. These data are essential to validate project actions because it means that the personnel is involved and understands the importance of this issue.

Fig. 2. Example of the Report Chart made for the Joint Library of Veterinary and Agricultural Sciences.

ENVIRONMENTAL MONITORING REPORT

About the building	Joint Library. Faculty of Agricultural and Forestry Sciences-Faculty of Veterinary Science. New construction. 2008
Storeys. Location to the ground floor	+/-0,00 Entrance, lockers(129,3m²) +3,00 shelves, reading, office, services (724,5m²) +6,00 shelves, reading (379m²)
U-Value (W/m²K)	Walls 1,02 W/m²K; roofing 2,79W/m²K; glassing 5,88W/m²K
Transparent-to-opaque groove ratio	25,66 %
Data of monitoring	DL 25, 26 Y 27
Datalogging sectors	Inside shelves +3,00, office, and shelves level 6,00.
Systems	Central HVAC system through air ducts. Halogen + fluorescent lightning.

Table. 1: Physic description of the building.

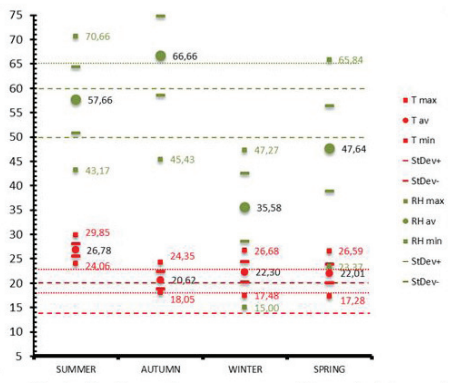

Fig. 1: Absolute maximum, average , minimum absolute, and standard deviation of temperature and relative humidiy collected in each monitoring campign.

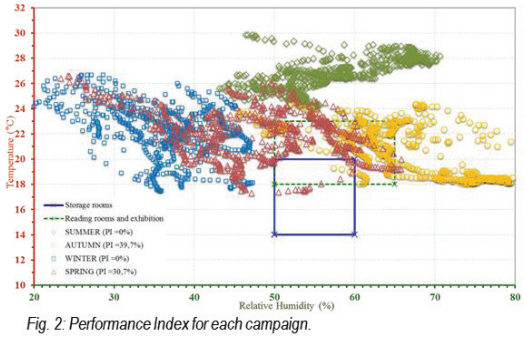

Fig. 2: Performance Index for each campaign.

Datalogger Reported: bookshelf level +3,00

Conservation Conditions UNI 10586:1997	Storage rooms	Reading rooms	Daily range
Temperature	14 - 20°C	18 - 23°C	2°C
Relative Humidity	50 - 60%	50% - 65%	5%

The **performance index (PI)** is the percentage of time when the measured parameter lies within the recommended tolerance interval

The **deviaton index (DI)** measures de percentage of days when de daily range is lower than the maximum admissible

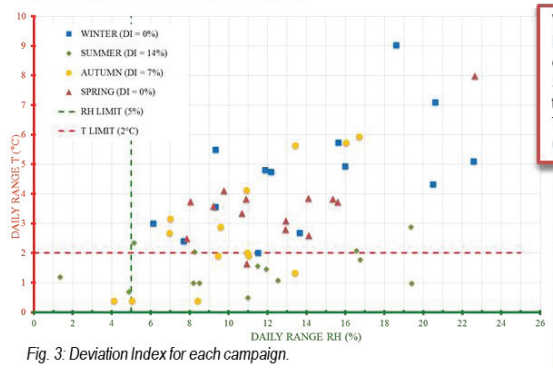

Fig. 3: Deviation Index for each campaign.

Warnings:
RH extremely low and wide range of daily variations in winter due to heating system.
Summer shows out of range conditions though steady hot temperature.
The building shows best performance during mid season, under free running condition.

4. Conclusions

This paper explains the historical and economic situation of an Argentine university with a valuable heritage to preserve. It also presents the progress and setbacks of an R&D Project when trying to implement standardized environmental monitoring procedures for preventive conservation. This is the first attempt to implement this kind of plan for University Libraries network.

We take Italian standards and experiences and adapt them to our reality. We propose an adaptation to use in university libraries. We provide a standard report model that allows each institution to understand its situation and main issues.

In the audit process, we met staff well disposed and eager to achieve better results. They showed concerned about the state of the collections and the lack of personnel, while energy saving and sustainability are not relevant issues for them.

We observed deficiencies in envelope quality, mainly because of its low thermal resistance and malfunctions in air-conditioning systems.

The analysis of temperature and relative humidity is performed simultaneously because — in humid climates— integrated variables become more efficient to understand the behavior of the conservation environment.

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