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Assessment of the indoor environmental conditions of a baroque library in Portugal

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Abstract

This paper presents the preliminary results of the study of the indoor environmental conditions in a Baroque building of a XVIII century library, located in the heights of the historic centre of the University of Coimbra (UC), which was established 727 years ago. Since these conditions play a very important role in the conservation of the books and the wood bookshelves, experimental surveys based on permanent measurements of the hygrothermal air conditions and of particulate matter concentrations are being carried out since early October 2016. Some early results of this short term study are presented and discussed.

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1. Introduction

As stated in [1], '*contaminants levels must be maintained at low concentrations for human health and to guarantee the correct preservation of works of art and cultural heritage*'. Besides the building itself – the XVIII century Baroque library of the University of Coimbra –, the books kept inside are also part of this heritage, and due to its organic characteristics, these are vulnerable to hygrothermal variations and contaminants. At the same time, the deposition of dust, e.g. in the shelves and painted woods, results in a negative visual effect, such as the loss of brightness and "opacity" of colours, due to their accumulation and cementation in works of art [2], [3], also

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contributing to deterioration processes [2], [4], [5].

The first studies dedicated to the indoor environmental conditions of this Baroque library were conducted at the end of last century, at a time when it was still used as a traditional library, though with a small number of users (by this time, the university community was already served by the General Library, built in the 1960s).

In 2013, the buildings of ‘University of Coimbra – Alta and Sofia’ were declared a World Heritage Site by UNESCO [6], turning the *Baroque Library* into part of an important tourist circuit in Portugal. Currently, it closes only 5 days a year, receiving up to 60 visitors every 20 minutes - over 400,000 tourists in 2015, becoming the third most visited monument in Portugal. Similarly to other contemporary libraries, such as the *Old Library* of the Trinity College in Dublin (Scotland) [7], the *Baroque Library* in Coimbra is daily open for visits: 7h/day in winter and 11h/day in summer time.

In face of this new reality, the Rectorate of the University has been very concerned about the heritage preservation and started a research project focused on the accurate characterization of the indoor environmental conditions within the Baroque library and on the assessment of risk situations, both for heritage and health issues.

Since the indoor conditions play a very important role in the conservation of the books and the wood bookshelves, experimental surveys based on permanent measurements of the hygrothermal air conditions and of particulate matter concentrations are being carried out since early October 2016, in order: (i) to assess the current indoor environmental conditions (IEC) of the library; (ii) to investigate whether the risky IEC are mainly caused or not by the increased occupancy / visiting rate; (iii) to propose mitigating interventions and alternative strategies.

The measuring campaign included the monitoring of the following parameters: indoor air temperature (T_a , °C), relative humidity (RH, %), carbon dioxide concentration values (CO_2 , ppm) and particulate matter (PM, $\mu g/m^3$). These were registered every ten minutes during the entire monitoring period, during day and night time. Indoor/outdoor relations were established and collected data were compared with different guidelines – national and international standards. Some early results of this short term study are presented and discussed.

2. Method and object of study

The case study is located in the heights of the historic centre of the University of Coimbra (UC), at the southwest end of the university courtyard, 120 m above the sea level, as shown in Fig. 1, a). In terms of climatological data, the average monthly rainfall (AMR) varies between 10.9 mm in July and 126.2 mm in December, the rainiest month. Additionally, the average monthly mean (AMM) temperature values vary between 10.4°C in December and 20.4° in August, the hottest month [8]. The Baroque Library was built between 1717 and 1725, and the decoration works lasted for another three years [9], [10]. The library is composed of ‘*three floors: the Noble floor, richly decorated space, the most emblematic face of the House of the Library; Intermediate Floor, workplace and acted as the guard house; the Academic Prison, which worked here from 1773 until 1834*’ [11].

The library is exclusively naturally ventilated. Some of the external walls are more than 2.0 m thickness and internally, the Noble floor walls are integrally covered by wood shelves. Herein are comprised circa 40,000 volumes [11]. The Intermediate floor has always been the deposit of the Library; nowadays it is open to the public and it also hosts small exhibitions.

It is daily open to visitors: (a) winter (31/10/2016 to 1/3/2017): 9h00 – 13h00 & 14h00 – 17h00; summer (16/3 to 30/10/2016): 9h00 – 20h00.

2.1. The monitoring campaigns

Between October and December 2016, several parameters were monitored, namely: indoor air temperature (T_a , °C), relative humidity (RH, %), carbon dioxide concentration values (CO_2 , ppm) and particulate matter (PM, $\mu g/m^3$). Table 1 presents a list of the equipment used during the monitoring campaigns: October and November/December 2016, as well as the interval between records. During the first monitoring campaign the Library was open to public according to the summer schedule (9h00 – 20h00) and during the second campaign visits were possible according to winter time (9h00 – 13h00 & 14h00 – 17h00).

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