Assessment of the internal higrothermal conditions in the General Library of the University of Coimbra

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The library of the University of Coimbra was definitively installed in Coimbra in the year 1537.

Nowadays the library occupies two buildings: the Library of King John V built in the beginning of the VIII century that houses books of the XVI and XVIII centuries, and the Edifício Novo (New Building), installed in the former building of the Faculty of Letters and adapted to the new functions between 1952 and 1958.

The objects stored in the old library are made essentially of paper, leather, wood and different kinds of glues, and it is well known that these materials exhibit an hygroscopic behaviour, that is, they tend to balance their humidity with the surrounding environment and they will respond to the cyclic variations of ambient temperature and relative humidity.

Two different kind of indoor environments present in the library, among those which have been investigated between 2008 and 2009, are described in order to characterise the different internal conditions and their correlations with the outdoor environment. This correlation can be taken as a measure of the sensitivity of the envelope of the building to the outdoor climate changes, influence that can be attributed, in particular, to the permeability of elements of the envelope such as the windows.

Temperature between 18 and 22°C and relative humidity between 50% and 60%, slightly different from those suggested in table 1 and 2, are considered ideal for conservation purposes in this analysis.

The S. Peter Room is a large room (area 23.9m x 7.5m and 5.5 high) where collections of books from the VII to the IX centuries are stored. This room is located in the second floor of the building and the external façade, facing north, has eight large windows and it hasn't air conditioning devices to control indoor conditions. The walls, made essentially of stone, are about two meters thick. Figure 1 shows a net influence between the exterior and the indoor conditions. It is then expected that these last ones can not respect the considered criteria for conservation purposes.

Indeed Figure 1 shows that although relative humidity ranges between 50 % and 66% during

almost 60% of the time, temperature is below 15 ºC near 40% of the time and above 22 ºC for almost 20% of the time, being respected the “ideal” interval only during about 10% of the time.

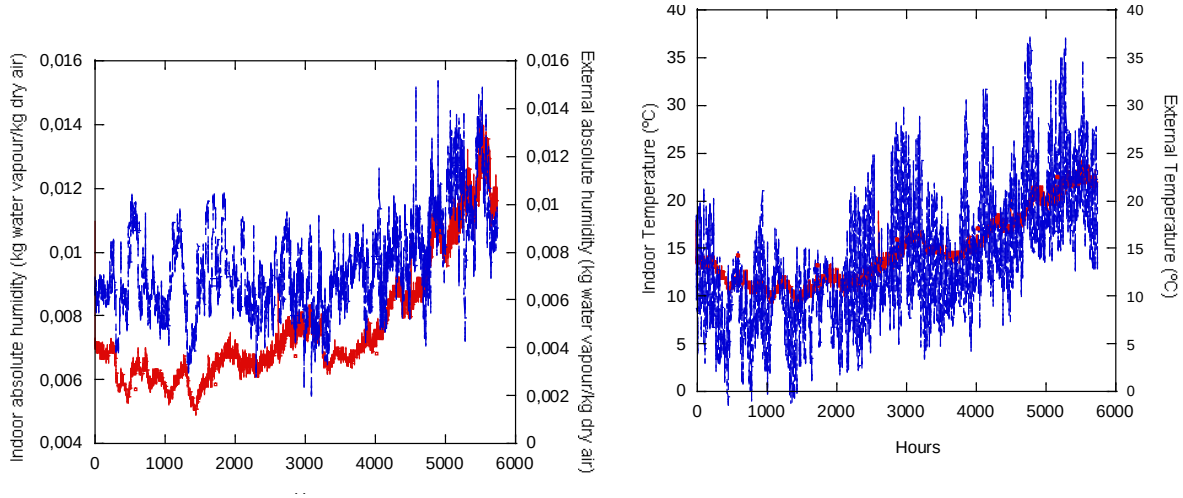

Figure 1 Indoor (red line) and outdoor (blue line) values of absolute humidity and temperature during the entire period of data acquisition (13/11/2008 to 10/07/2009), in S. Peter Room.

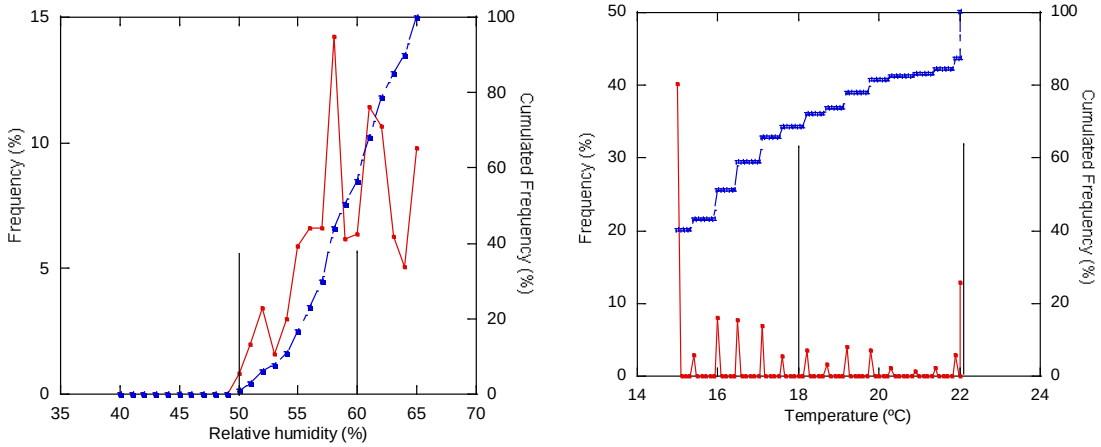

Figure 2 Frequency and cumulated frequency for relative humidity and temperature in S. Peter Room (“ideal” intervals between vertical bars).

The analysis of the data shows that the room is very sensible to changes in outdoor conditions. The large windows and the associated permeability can explain this dependence, especially under strong winds.

The Strongbox, with area 12.8 m x 6.5 m and 4.44 m high, is a space located in the basement of the building and, for security reasons, the most important and ancient documents (the oldest one

is dated of the year 934) are store in it. Due to the historical and cultural importance of this archive, this room was equipped, with an air-conditioning unit, to maintain temperature and relative humidity within pre-set values.

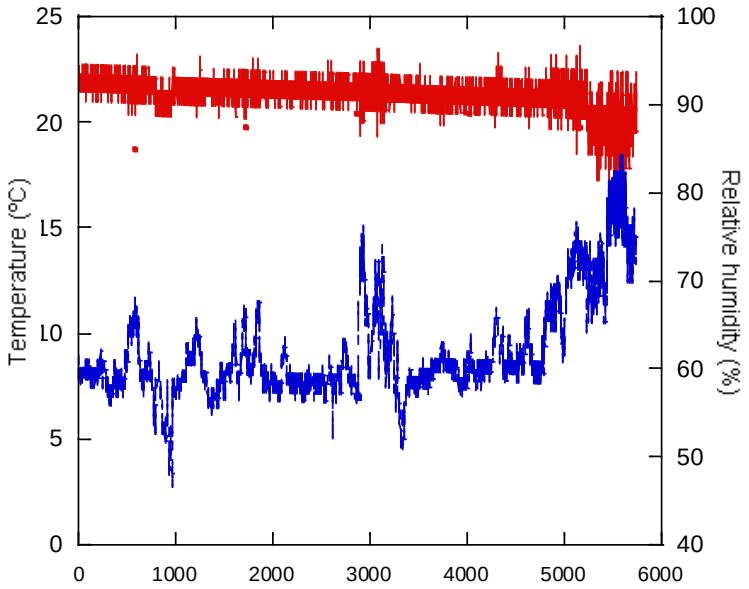

Figure 4 Temperature and relative humidity in the Strongbox for the entire period of data acquisition.

The observation of the results of Figure 4 shows that the air conditioning unit has a very effective control over the temperature. In fact, the set-point for temperature (T=20 ºC) is conveniently respected all over the period of observation. The same can be concluded for the frequency and cumulated frequency of temperature values, the higher frequencies corresponding to temperatures around the pre-set point of 20 ºC and the interval 18ºC<T<20 ºC being respected during almost 100% of the time (Figure 5).

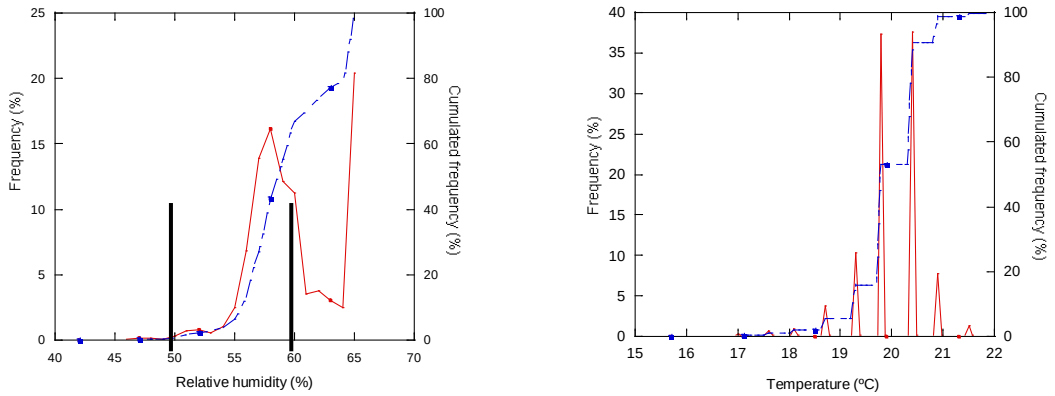

Figure 5 Frequency and cumulated frequency for indoor values of relative humidity and temperature of the Strongbox.

The good control of indoor temperature means that this parameter and the external ambient temperature are independent, and the two signals can not be correlated by any increment of time.

Although the relative humidity seems to be controlled by the system, at least during half of the period (see Figure 4), the data obtained for this parameter deserves further discussion. From the middle of Mars/2009 on (about 3000 hours in x axis of Figure 4), the values of relative humidity show a consistent increase with time and the preset value of 60% is no longer respected, values as high as 80% being attained at the end of the period of observation. In fact, a malfunction on the control of relative humidity was detected at that time by the installer itself and reported to the administration of the library. Since then, attempts have been made to fix the humidification/dehumidification system, apparently without success. Even so, the interval $50\%<\varphi<60\ \%$ for relative humidity is respected during near 60% of the time, as it can be observed in the cumulated frequency distribution of Figure 5.

The methodology proposed seems to be quite adequate to give a clear insight on the actual behaviour of the building, highlighting that, from the point of view of preservation, the existing conditions do not respect the criteria generally accepted to guarantee the integrity of the collections.