# AIRCHECQ

## Air Identification & Registration for Cultural Heritage: Enhancing Climate Quality

**Contract - BR/132/A6/AIRCHECQ**

## Summary

**Context:** Environmental conditions have a profound impact on the preservation of heritage collections: optimal conditions can significantly prolong the lifetime of heritage objects. The AIRCHECQ project does not consider the 'most appropriate preservation conditions' for heritage collections as a technical solution that eliminates all problems at once, but rather as a goal that should be strived for. Improving preservation conditions must be considered as a sequence of low-cost and/or temporary mitigation actions that are sufficiently good for the time being, interspersed with some advanced (i.e., high-cost) mitigation actions. The sequence of mitigation actions can be seen as a specific path in a roadmap of many possibilities as is illustrated in Fig. 1. Each path contains moments where decisions must be made (e.g., select the most appropriate action). These moments are shown as nodes. Due to a lack of information, there is always some uncertainty about the decision taken. This means that the AIRCHECQ approach must be considered as a decision-making process under conditions of uncertainty. To select the most appropriate mitigation actions, it is important to have an insight in the evolution of the indoor air quality. Up to this day, the most common way to evaluate the environmental preservation conditions is to monitor temperature, relative humidity, the intensity of visible light and UV radiation and visualize the trends using line graphs. However, the evaluation of the environmental appropriateness from such graphs is not straightforward.

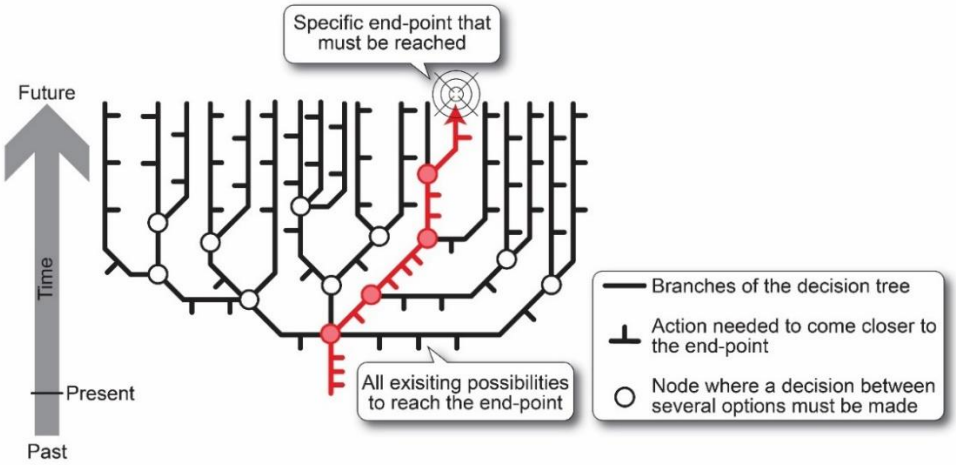


Fig. 1: AIRCHECQ approach of preventive conservation where a decision-making process is needed to find the most appropriate road in the numerous possibilities to achieve the end-point. The road map consists of decision nodes and actions.

**Objectives:** Despite the importance of indoor air quality for heritage conservation, its assessment is a complex and challenging task. Experienced heritage professionals continuously assess indoor air quality through their senses (e.g., too much light in a room, too warm, a strange smell, etc.). However, intuitive risk perception does not always rate the risk in the same way as quantitative analyses: underestimation of genuine risks or panic for small risks might occur. Moreover, intuitive perception might result in different or contradictory opinions between stakeholders. More importantly, decision makers prefer scientific underpinned arguments to intuitive arguments when they have to invest their scarce resources in mitigation actions that remain invisible (i.e., reducing future harm). Objective indoor air quality assessments are an important issue in preventive conservation. In addition, the assessments should be visualized in such a way that all heritage professionals are able to evaluate the indoor air quality themselves. To achieve that goal, the project developed several methods and tools that allow heritage guardians to evaluate indoor air quality. A work process that formalizes the inspection of rooms, a monitoring system that is also able to monitor parameters such as the concentration of particulate matter and gaseous pollutants, and software that converts the measurements into indoor air quality assessments while considering a specific collection of material type. These tools give heritage caretakers the support to make better choices on the most appropriate mitigation actions.

**Methodology:** After a thorough inspection of the building and the collection, the first step in objective IAQ assessments is the acquisition of environmental information. This implies registering and managing a considerable amount of data. The absolute values and trends of the monitored parameters visualized with graphs only give an indirect impression of that IAQ. In the context of the AIRCHECQ project, it became clear that such information is perceived by many heritage guardians as very technical and difficult to interpret. The complexity of the analysis of environmental measurements explains why too often data are collected but never analysed, especially when there are no obvious signs of alarming situations. During the AIRCHECQ project, 5 alternative methods have been developed to determine the environmental appropriateness. They are described in the list below. These methods can help heritage professionals in selecting the most appropriate mitigation actions from collected data.

1. **Analyse peaks and drops in graphs:** The presence of peaks and drops can be assessed using the concept of risk;
2. **Analyse peaks and drops in different frequency ranges:** Every time series can be decomposed in low-, mid- and high-frequency fluctuations using moving averages. Then the peaks and drops of every frequency range can be studied separately;
3. **Use of an indoor air quality index based on existing norms and guidelines:** Determine the indoor air quality by comparing the collected data with existing guidelines that are relevant for heritage materials;
4. **Use of an indoor air quality index based on material specific criteria:** Calculate the indoor air quality index by converting the measurements of a fixed set of key risk

indicators into the level of risk for a specific material or object type. The conversions are realized by material specific conversion functions;

5. **Extract knowledge about unacceptable risks using datamining techniques:** From the huge amount of collected data, interesting patterns or atypical behaviours are extracted using a filtering method.

**Results:** One of the deliverables of the project is the formalized work process shown in Fig. 2 (i.e., final deliverable 1). That work process is used to find weak spots in buildings and inappropriate environmental conditions that need to be improved. Another important deliverable from the project is the monitoring unit (i.e., Final deliverable 2) that can measure several environmental parameters simultaneously. The data collected with that device can be processed with a user-friendly software that converts the measurements in indoor air quality colour bars (i.e., Final deliverable 3). The colour bars can easily be read by anyone responsible for heritage preservation. The monitoring unit and the software form together a decision support system that visualizes the periods where preservation problems occur. In that way, the decision support system helps heritage professionals in the identification of hazards. The identified hazards define the possible mitigation actions from which an action must be chosen.

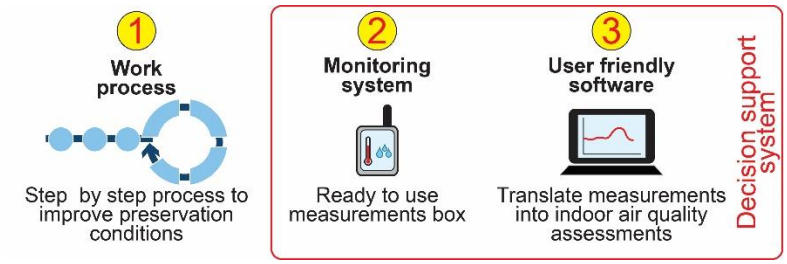


Fig. 2: Overview of the final deliverables of the AIRCHECQ project. The last 2 deliverables form together a decision support system. The work process describes how preventive conservation can be performed practically as a decision-making process.

**Conclusions:** The AIRCHECQ deliverables summarized in Fig. 2 were used to analyse the preservation conditions of several locations. In addition, some mitigation actions were also evaluated. The several case studies demonstrated that indoor air quality can be evaluated in a quantitative way and that such assessments can be presented in a very clear way so that all stakeholders are able to base their decisions on a complete overview and correct understanding of the IAQ situation.

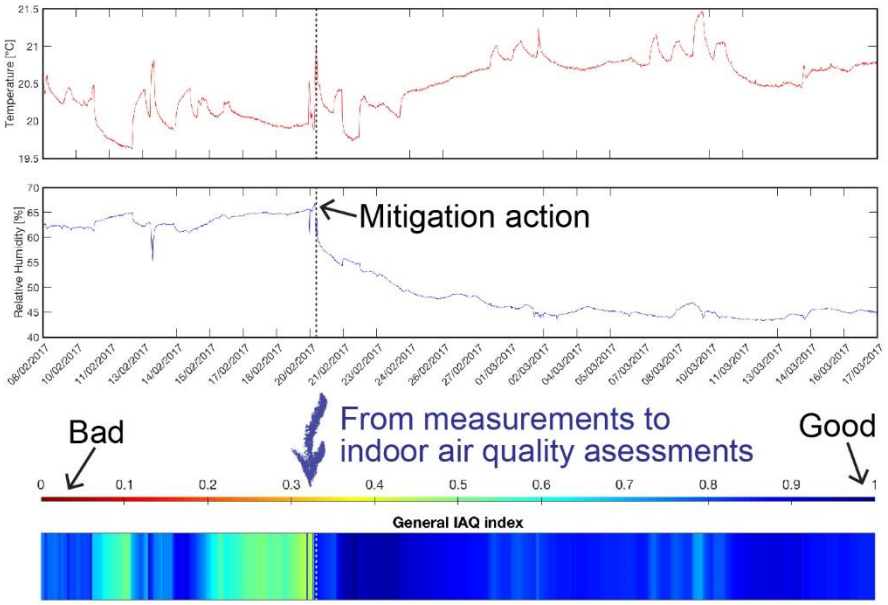


Fig. 3: Visualization of the quantitative assessment of indoor air quality over time calculated for ground wood paper in a small archive. The sudden change in preservation conditions before (green period) and after the mitigation action (blue period) can clearly be seen.

**Keywords:** Preventive conservation, Cultural heritage, Indoor air quality, Particulate & gaseous pollutants, Mitigation actions