

# Hygrothermal simulation of a historic library: a framework to assess the impact of tourism

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## Abstract

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**Keywords:** keyword 1; keyword 2; keyword 3 (List three to ten pertinent keywords specific to the article; yet reasonably common within the subject discipline.)

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## 1. Introduction

Furthermore, integrated monitoring and simulation strategies have become indispensable tools for understanding the hygrothermal dynamics of these spaces [1]. Environmental monitoring campaigns provide essential data on indoor levels, seasonal variations, and responses to the outdoor climatic conditions.

To complement empirical data, numerical simulation tools such as hygrothermal modelling have proven valuable in predicting indoor environmental behaviour under various scenarios, aiding decision-making processes related to conservation strategies [2]. Despite their potential, the use of simulation in heritage contexts remains limited, with most applications focused on energy performance in modern buildings [3].

The further exploration of such approaches in the current work offers practitioners an evidence-based methodology to navigate complex environmental assessments to enhance the conservation of organic materials. Accordingly, the present chapter contributes to the

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field by focusing on three core objectives: (i) survey the applicable standards and guidelines related to the preventive conservation of cultural heritage under hygrothermal stress; (ii) conduct in situ monitoring of temperature and humidity conditions in selected case studies; and (iii) employ dynamic simulation tools to assess hygrothermal behaviour under different scenarios. The goal is to characterise the indoor climate conditions in heritage buildings, evaluate the potential risks to collections, and support more informed and sustainable conservation decisions.

2. Materials and Methods

Materials and Methods should be described with sufficient details to allow others to replicate and build on published results. Please note that publication of your manuscript implicates that you must make all materials, data, computer code, and protocols associated with the publication available to readers. Please disclose at the submission stage any restrictions on the availability of materials or information. New methods and protocols should be described in detail while well-established methods can be briefly described and appropriately cited.

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This is an example of a quote.

3. Results

This section may be divided by subheadings. It should provide a concise and precise description of the experimental results, their interpretation as well as the experimental conclusions that can be drawn.

3.1. Subsection

3.1.1. Subsubsection

Bulleted lists look like this:

- First bullet;
- Second bullet;
- Third bullet.

Numbered lists can be added as follows:

1. First item;
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All figures and tables should be cited in the main text as Figure 1, Table 1, etc.



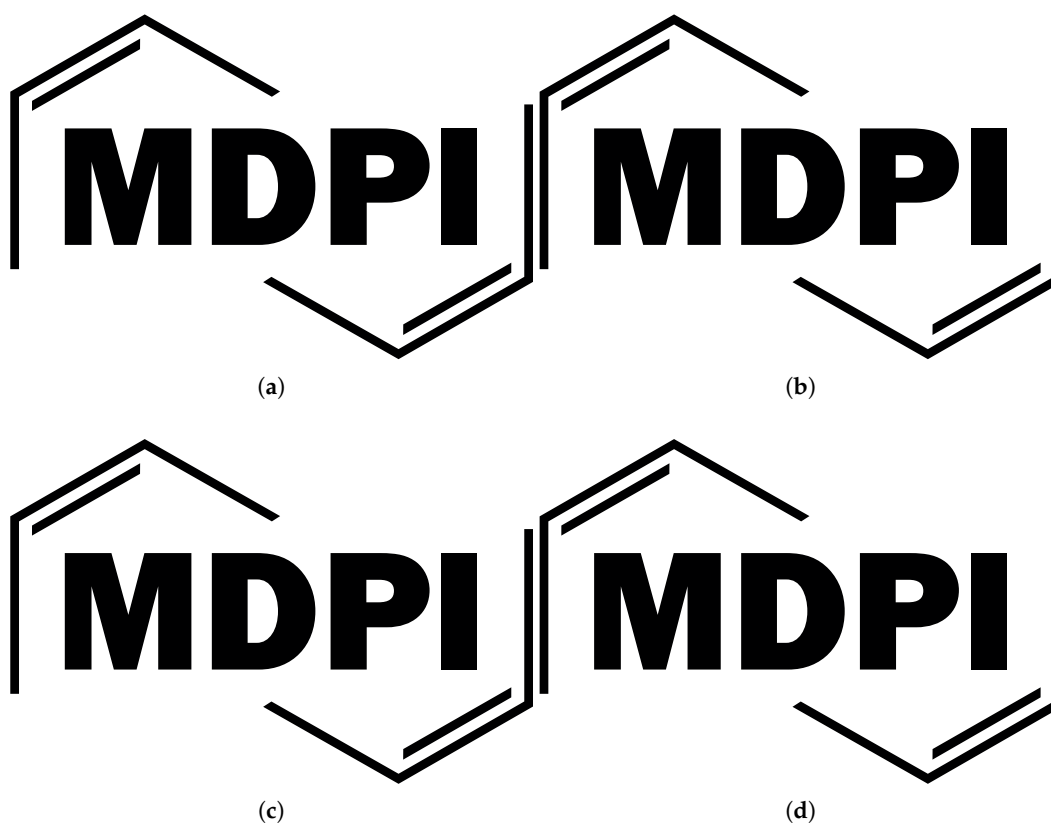
**Figure 1.** This is a figure. Schemes follow the same formatting.

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Title 1	Title 2	Title 3
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<sup>1</sup> Tables may have a footer.

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**Table 2.** This is a wide table.

Title 1	Title 2	Title 3	Title 4
Entry 1 *	Data	Data	Data
	Data	Data	Data
	Data	Data	Data
Entry 2	Data	Data	Data
	Data	Data	Data
	Data	Data	Data

\* Tables may have a footer.

Text.

Text.

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3.3. *Formatting of Mathematical Components*

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This is the example 1 of equation:

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$$a = 1,$$

(1)

84

the text following an equation need not be a new paragraph. Please punctuate equations as regular text.

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This is the example 2 of equation:

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$$a = b + c + d + e + f + g + h + i + j + k + l + m + n + o + p + q + r + s + t + u + v + w + x + y + z$$

(2)

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Please punctuate equations as regular text. Theorem-type environments (including propositions, lemmas, corollaries etc.) can be formatted as follows:

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**Theorem 1.** *Example text of a theorem.*

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The text continues here. Proofs must be formatted as follows:

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**Proof of Theorem 1.** Text of the proof. Note that the phrase “of Theorem 1” is optional if it is clear which theorem is being referred to. □

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The text continues here.

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4. Discussion

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Authors should discuss the results and how they can be interpreted from the perspective of previous studies and of the working hypotheses. The findings and their implications should be discussed in the broadest context possible. Future research directions may also be highlighted.

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5. Conclusions

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This section is not mandatory, but can be added to the manuscript if the discussion is unusually long or complex.

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6. Patents

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This section is not mandatory, but may be added if there are patents resulting from the work reported in this manuscript.

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**Author Contributions:** For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used “Conceptualiza-

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tion, X.X. and Y.Y.; methodology, X.X.; software, X.X.; validation, X.X., Y.Y. and Z.Z.; formal analysis, X.X.; investigation, X.X.; resources, X.X.; data curation, X.X.; writing—original draft preparation, X.X.; writing—review and editing, X.X.; visualization, X.X.; supervision, X.X.; project administration, X.X.; funding acquisition, Y.Y. All authors have read and agreed to the published version of the manuscript.”, please turn to the [CRediT taxonomy](#) for the term explanation. Authorship must be limited to those who have contributed substantially to the work reported.

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## Abbreviations

The following abbreviations are used in this manuscript:

- MDPI   Multidisciplinary Digital Publishing Institute
- DOAJ   Directory of open access journals
- TLA   Three letter acronym
- LD   Linear dichroism

Appendix A

Appendix A.1

The appendix is an optional section that can contain details and data supplemental to the main text—for example, explanations of experimental details that would disrupt the flow of the main text but nonetheless remain crucial to understanding and reproducing the research shown; figures of replicates for experiments of which representative data are shown in the main text can be added here if brief, or as Supplementary Data. Mathematical proofs of results not central to the paper can be added as an appendix.

Table A1. This is a table caption.

Title 1	Title 2	Title 3
Entry 1	Data	Data
Entry 2	Data	Data

Appendix B

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References

1. Camuffo, D. *Microclimate for Cultural Heritage: Measurement, Risk Assessment, Conservation, Restoration, and Maintenance of Indoor and Outdoor Monuments*, 3rd ed. ed.; Elsevier, 2019.

2. Lucchi, E. Review of preventive conservation in museum buildings. *Journal of Cultural Heritage* **2018**, *29*, 180–193. <https://doi.org/10.1016/j.culher.2017.09.003>.

3. Iskandar, L.; Faubel, C.; Martinez-Molina, A.; Beeson, S.T. Quantification of inherent energy efficient features in historic buildings under hot and humid conditions. *Energy and Buildings* **2024**, *319*, 114546. <https://doi.org/10.1016/j.enbuild.2024.114546>.

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