7. BÖLÜM

MOISTURE DAMAGE IN HISTORICAL MASONRY BUILDINGS: A BIBLIOMETRIC ANALYSIS OF GLOBAL RESEARCH TRENDS (2000–2025)

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1. Introduction

From prehistoric times to the present, the geography of the world has hosted numerous civilizations and contains a wide variety of cultural heritage assets with different functions and characteristics. Structures such as bridges, inns, defensive works, places of worship, and dwellings reflect the social life, technological level, economic capacity, and aesthetic understanding of the societies that created them, thereby acquiring the status of cultural memory. These structures not only met the architectural needs of their own periods but also serve as historical documents that build a bridge between the past and the future.

Preserving this heritage and transmitting it to future generations is a fundamental condition for ensuring cultural continuity and the survival of social identity. However, the survival of these structures with their original values often faces significant challenges. Social, cultural, and economic factors, combined with climatic conditions, natural disasters, and physical deterioration processes, pose serious threats to their existence.

The main causes of physical damage observed in historical buildings include user-related interventions, climatic effects, and natural disasters such as earthquakes or fires. These factors weaken the performance conditions necessary for buildings to remain safe, healthy, and durable. Among them,

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moisture is one of the most critical problems, as it often accelerates and triggers existing deterioration processes.

Moisture enters a building through three main pathways:

1. The rise of ground moisture through porous building materials,
2. The penetration of rainwater into the structure due to failures in roofs, drainage, or other envelope components,
3. The condensation of airborne moisture within or on the surface of structural elements, followed by its spread through capillarity (Kuzuimamlar,1995; Erten,1996).

Uncontrolled moisture causes cracking, freeze–thaw cycles, surface loss, and disintegration in masonry; decay in wooden elements; and corrosion in metal components. Salt crystallization accelerates chemical deterioration and leads to efflorescence, while damp environments provide favourable conditions for the growth of biological organisms such as mold and fungi. Moreover, as moist building materials have high thermal conductivity and consequently low surface temperatures, achieving indoor comfort becomes difficult even with intensive heating, which in turn increases energy consumption (Erten, 1996).

Therefore, preventing or minimizing moisture-induced deterioration has become a priority in conservation strategies for historic buildings. Moisture insulation practices aim to block different sources of moisture—including precipitation, rising damp, pressurized or unpressurized water, and vapor diffusion—from penetrating building components. In this way, the lifespan of materials is prolonged while ensuring a healthier and more comfortable indoor environment.

Studies in the literature demonstrate that moisture directly reduces the strength of building materials, accelerates chemical damage through salt crystallization, and triggers biological processes. Research particularly focused on Europe and the Mediterranean emphasizes that different sources of moisture—such as capillarity, rainfall, groundwater rise, and condensation—cause long-term damage that is extremely difficult to reverse (Lubelli et al., 2018).

However, most existing studies are based on laboratory-scale experiments or short-term observations. Comprehensive meta-analyses that holistically

evaluate long-term monitoring data, climatic variables, and the micro-environmental conditions of buildings remain limited (Vandevoorde et al., 2009). Furthermore, systematic studies investigating moisture-related deterioration in the context of climate change are insufficient. Changes such as increased rainfall, temperature fluctuations, and variations in humidity levels have not been adequately addressed in relation to their accelerating impact on historic masonry structures. Additionally, data obtained through modern digital technologies are rarely integrated into review studies, which limits evidence-based decision-making in conservation practices.

Evaluating the effectiveness of conservation and intervention methods against moisture-induced damage requires an interdisciplinary approach. A systematic analysis of the scope, orientations, collaborations, and research gaps in the literature can contribute to developing more effective strategies in this field. For this reason, bibliometric analysis was employed to examine scientific publications on moisture-related deterioration in historic masonry buildings.

Bibliometric analysis is a method that examines large data sets through statistical techniques to reveal the evolution of a research field, identify emerging topics, and highlight influential publications, countries, authors, and institutions (Donthu et al., 2021; Ho et al. 2020; Obaideen et al., 2022). Documents, authors, keywords, and sources are analysed through graphs, network mapping, and clustering techniques (Hakimi et al., 2024). Bibliometric mapping, in turn, involves the visualization of such data using VOSviewer software. Developed by the Centre for Science and Technology Studies (CWTS) at Leiden University, VOSviewer is a commonly used tool in quantitative scientific analyses (Hosseini et al., 2018), which has been widely used in multidisciplinary fields in recent years (Ding et al., 2023). With data retrieved from bibliographic databases such as Web of Science, Scopus, Lens, and Dimensions, the software enables network, overlay, and density visualizations to identify international research trends.

Moreover, Biblioshiny was used to obtain the performance data of the publications acquired from the search, such as the time-span of the research, number of sources and publications, number of authors, and annual scientific production, among others (Elshabshiri et al., 2025). Biblioshiny was used due to its user-friendly platform and its comprehensive visualization of publication

performance data (Obaideen et al., 2022; Ullah et al., 2022; Linnenluecke et al., 2019). In addition, the world map diagrams were produced using Datawrapper, an online mapping tool, due to its user-friendly interface and versatility in displaying and translating data onto a world map (Obaideen et al., 2022).

This study is significant as it evaluates moisture-related deterioration in historic masonry buildings from an interdisciplinary perspective. Its originality lies in the systematic analysis of academic publications from 2000 to 2025 through the combined use of bibliometric analysis and bibliometric mapping. As a result, publication trends, leading researchers, institutions, countries, and keyword clusters in the field have been comprehensively visualized.

In conclusion, this research analyses the existing literature through a holistic approach, not only documenting current knowledge but also providing a critical framework to guide future conservation strategies. The adoption of the PRISMA methodology (Page et al., 2020). and the use of VOSviewer allow for the presentation of collaborations, conceptual focuses, and research gaps in a clear and systematic manner. In doing so, the study serves as a pioneering reference point for interdisciplinary collaboration and new research perspectives.

2. Methodology

2.1. Research Design

This study adopts a bibliometric analysis approach, which quantitatively examines academic publications within a specific research domain to systematically reveal the intellectual structure, developmental trends, and existing research gaps in the literature. In this context, the research focuses on studies addressing moisture-induced deterioration in historic masonry buildings.

The general workflow of the research methodology is summarized in Table 1. In the first step, the research topic was clearly defined. In the second step, the Web of Science (WoS) Core Collection database was selected as the primary data source. Subsequently, the retrieved bibliographic records were exported in both .txt and. bib formats.

In the final step, the data were analysed using bibliometric techniques to evaluate publication trends, citation patterns, keyword co-occurrences, and collaboration networks. At this stage, the Bibliometric R package (via the Biblioshiny interface) was employed, while VOSviewer software was used to generate and visualize bibliographic maps. VOSviewer was selected for its ease of use and ability to handle large-scale data and produce clear bibliometric visualisation networks (McAllister et al., 2022; Van Eck and Waltman, 2010).

Table 1. Steps Followed in the Research Methodology

Defining the Research Topic	Deciding on the Database to be Used	Exporting Data	Analyzing Data and Creating Network Maps
Moisture Damage in Historical Masonry Buildings	Web Of Science (WoS)	In .txt and .bib formats	VOSwiever Software and Bibliometrix Tool

2.2. Data Source and Search Strategy

The bibliometric data was extracted from the Web of Science Core Collection database.

The search string was constructed using the following terms:

Table 2. Topic Search

TS = (("masonry building*" OR "historic* masonry" OR "masonry structure*" OR "historic* building*" OR "heritage building*") AND TS = ("moisture damage" OR "moisture-related damage" OR moisture OR humidity OR dampness OR "rising damp" OR "capillary rise" OR "salt crystallization" OR "water infiltration"))

Search limitations:

- Document Type: Articles and Review Articles
- Language: English
- Timespan: 2000–2025

- Web of Science Categories: Engineering Civil, Construction Building Technology, Materials Science Multidisciplinary and Architecture

2.3. Analysis Tools

Two main tools were used for the analysis:

- **Bibliometric R-package (Biblioshiny interface):** Applied for calculating core bibliometric indicators such as annual scientific production, most productive authors, journals, institutions, and countries (Aria and Cuccurullo, 2017).
- **VOSviewer:** Utilized for creating, visualizing, and analysing network-based maps. This included:
  - Co-occurrence mapping of keywords to identify thematic clusters
  - Co-authorship networks among authors and countries
  - Citation and co-citation networks of documents and journals
  - Collaboration networks to assess international research partnerships

VOSviewer to create, visualize, and analyse country, journal, and document maps based on citation, co-citation, and collaboration data, as well as keyword maps based on co-occurrence data and clustering analysis (Obaideen et al., 2022; Shishehgarkhaneh, et al., 2022).

2.2. Analysis Types

The following bibliometric analyses were conducted:

- Publication Performance Analysis: Identification of the most productive authors, institutions, countries, and journals.
- Citation Analysis: Evaluation of the most highly cited publications and authors.
- Keyword Co-occurrence Analysis: Clustering of keywords to determine thematic map and research hotspots.
- Authorship and Country Collaboration Analysis: Mapping and evaluation of collaborative structures and international research interactions.

3. Results

3.1. Performance Analysis

In the analysis covering the years 2000–2025, a total of 247 documents from 50 different sources were identified. The annual average growth rate was

calculated as 13.91%. In total, 863 authors contributed to the studies, of whom 6 produced single-authored publications. The rate of international co-authorship was 21.05%, while the average number of authors per document was 4.27. A total of 1,056 different author keywords were used, and 9,032 cited references were recorded (Figure 1).



Figure 1. Main Information in Bibliometric Software

3.2. Annual Scientific Production

The graph in figure 2 illustrates a generally increasing trend in scientific production between 2000 and 2025.

While production remained at relatively low levels in the early 2000s, it gained significant momentum after 2015 and reached its peak in 2023. The decline observed in 2025 is likely due to the fact that the year has not yet been completed.

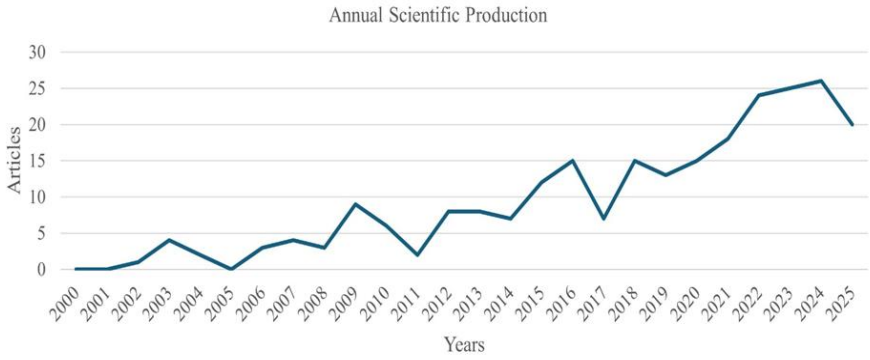


Figure 2. Annual Scientific Production

3.3. Most Relevant Sources

An examination of the sources with the highest number of publications reveals that Construction and Building Materials ranks first, with more than 60 articles. It is followed by the Journal of Building Engineering with 28 articles and Buildings with 23 articles.

The International Journal of Architectural Heritage and Materials and Structures fall within the range of 15–20 publications, while Case Studies in Construction Materials stands out with 12 articles. Journals such as the Journal of Building Physics, Engineering Structures, Civil and Environmental Engineering Reports, and the International Journal of Building Pathology and Adaptation appear in the list with fewer contributions. This distribution indicates that the research topic has been predominantly concentrated in journals focusing on building materials and engineering (Figure 3).

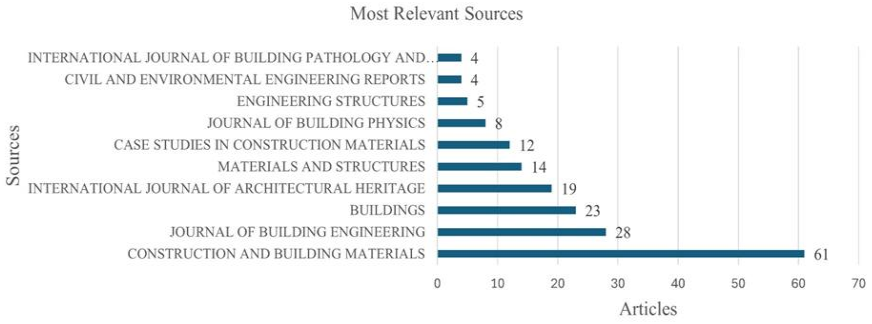


Figure 3. Most Relevant Sources

3.4. Most Productive Authors

An analysis of the most productive authors shows that Franzoni E ranks first with 12 publications, demonstrating a clear dominance over other researchers. Gentilini C follows with 7 publications. Authors such as Viles H, Pavlik Z, Lourenço PB, Li Y, De Freitas VP, and Černý R each contributed 5 publications. Delgado JMPQ and Carloni C are also represented in the list with 4 publications each.

These results indicate that leading research in the field is concentrated within a core group of authors (Figure 4).

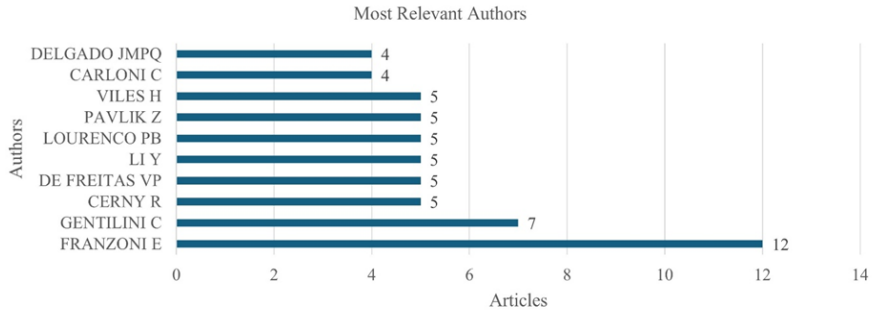


Figure 4. Most Relevant Authors

The three-fields plot embedded in the Bibliometric tool allows us to understand the complete bibliometric research in one figure and exhibit proportionality among the content (Mumu et al., 2021). The three-fields plot presented in Figure 5 provides a comprehensive visualization of the interconnections among highly cited articles (left), their authors (middle), and the authors' key research themes (right) within the field of historic building moisture and deterioration studies from 2000 to 2025, further enhancing our understanding of the bibliometric landscape. A detailed analysis of the diagram reveals several important trends:

- **Central Authors and Influential Publications:** The diagram highlights authors such as Franzoni, Gentilini, and Lubelli as central figures within the research network. Their works, including seminal publications on building materials and deterioration mechanisms, act as key nodes connecting multiple research themes. For instance, Franzoni's publications in Construction and Building Materials (2014) and Gentilini's work (2012) on material conservation demonstrate high citation counts, indicating their influence in shaping subsequent studies. Lubelli's research similarly occupies a pivotal position, reflecting its role in advancing knowledge on moisture-related damage and mitigation strategies in masonry structures.

- **Research Themes and Keywords:** The keywords associated with these authors—such as moisture, rising damp, microstructure, mortar, and historic buildings—illustrate the dominant conceptual focus within the field. These terms suggest that current research does not solely aim at understanding deterioration processes but also extends to applied interventions, including the

evaluation of material performance, durability enhancement, and the development of novel testing methods.

- **Connections Between Publications, Authors, and Concepts:** The diagram visually demonstrates how individual articles feed into broader thematic areas. Articles authored by these central figures often span multiple keywords, suggesting that their research has a multi-dimensional impact. For example, studies on rising damp not only analyse the physical phenomena but also address remediation techniques and preservation strategies for historic masonry.

- **Implications for Future Research:** The three-field plot indicates that research in historic building conservation is interdisciplinary, linking materials science with heritage preservation and structural engineering. The strong connectivity between central authors and key concepts underscores the continuing relevance of these foundational studies and suggests potential areas for future investigation, such as advanced microstructural analysis, improved conservation methods, and sustainable maintenance strategies.

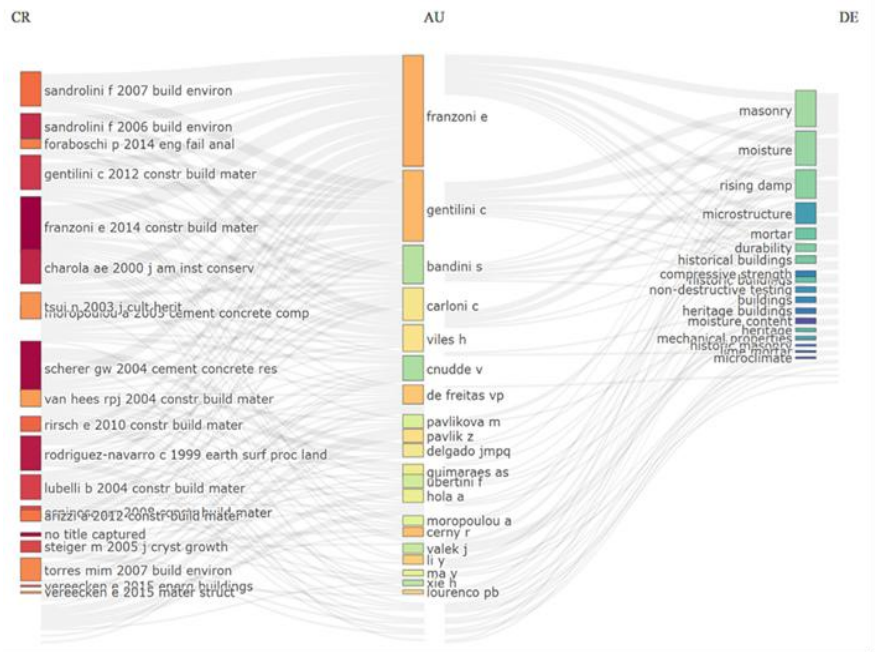


Figure 5. Three-field plot analysis- references (left), authors (middle) and author's keywords (right)

In conclusion, the three-field plot analysis demonstrates that concepts such as moisture, rising damp, and microstructure occupy a central position in the research field, while authors such as Franzoni, Gentilini, and Lubelli have assumed leading roles. Furthermore, it reveals that research is not limited to understanding deterioration mechanisms but also extends to applied dimensions, including the conservation of historic buildings, the enhancement of durability, and the development of new testing methods.

3.5. Country Scientific Production

An analysis of the countries with the highest number of publications shows that Italy holds a clear leading position with 37 articles. Italy is followed by China and Spain with 20 publications each, and Portugal with 19 (Figure 6).

Among countries with moderate levels of output, the United Kingdom, the Czech Republic, and Poland stand out. These findings indicate that scientific production in this research area is particularly concentrated in Mediterranean and European countries, while North American countries have contributed a comparatively smaller number of publications.

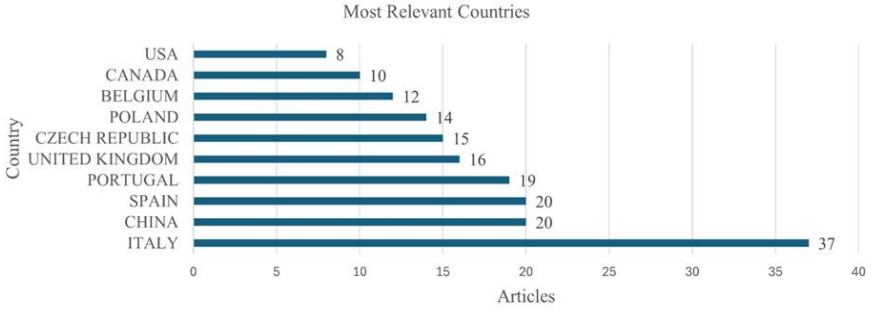


Figure 6. Most Relevant Countries

An analysis of citation data shows that Italy, with 802 citations, maintains its leadership not only in terms of publication volume but also in scientific impact. Portugal, the United Kingdom, and Belgium follow Italy in this regard. Despite having a relatively high number of publications, countries such as China and Greece exhibit comparatively lower citation counts. Conversely, Belgium, with fewer publications but a high number of citations,

demonstrates that it has produced studies with relatively lower output yet higher scientific impact (Figure 7).

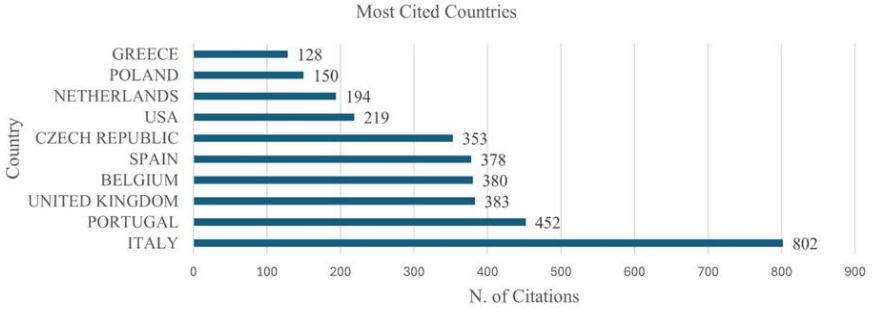


Figure 7. Most Cited Countries

Overall, Italy demonstrates a clear superiority in both quantitative terms (number of publications) and qualitative terms (citation impact). Portugal, the United Kingdom, and Belgium also stand out with high citation values, positioning themselves as important actors in the international scientific exchange within the field.

When publication output and citation performance are considered together, it becomes evident that the effectiveness of countries in this research domain should be assessed not only by the volume of production but also by the scientific impact and influence of the studies produced (Figure 8).

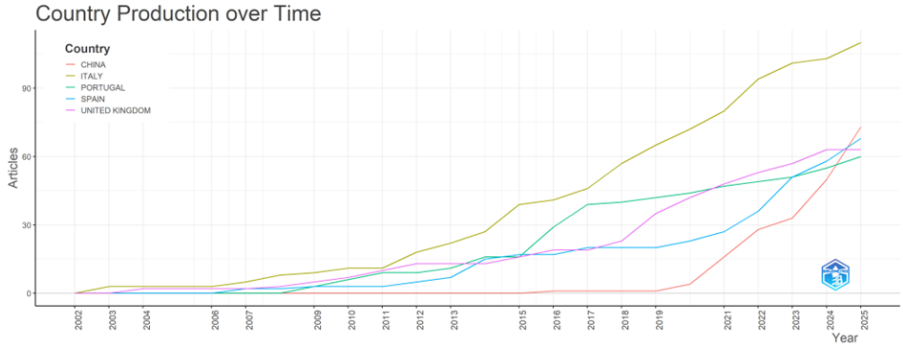


Figure 8. Country Production Over Time

3.6. Collaboration Networks (Author & Country Level)

This collaboration network illustrates the scientific partnerships among authors in the research field. In the map, nodes represent individual authors and links indicate co-authored publications, while the size of the nodes reflects author productivity and colour groups denote clusters of collaboration

Franzoni, Elisa and Gentilini, Cristina appear among the most central authors in the network, positioned within a large research group characterized by strong collaborations and high productivity.

The green cluster surrounding these authors represents a highly productive group with intensive cooperative ties. Cnudde, Veerle also stands out as a key central figure. As a leading scholar within a Belgium-based research group, Cnudde has collaborated with researchers across different continents and disciplines. This structure demonstrates the strong presence of international and interdisciplinary collaborations. Another cluster, represented in purple, includes figures such as Lubelli, Barbara, van Hees, Rob P. J., and Menéndez, Beatriz. This group is particularly distinguished by technical and experimental studies (Figure 9).

Overall, the collaboration network shows that leading authors in the field are concentrated in several central hubs and are typically involved in multiple co-authored works. At the same time, the distinct color-coded clusters also indicate the presence of relatively independent research groups within the literature.

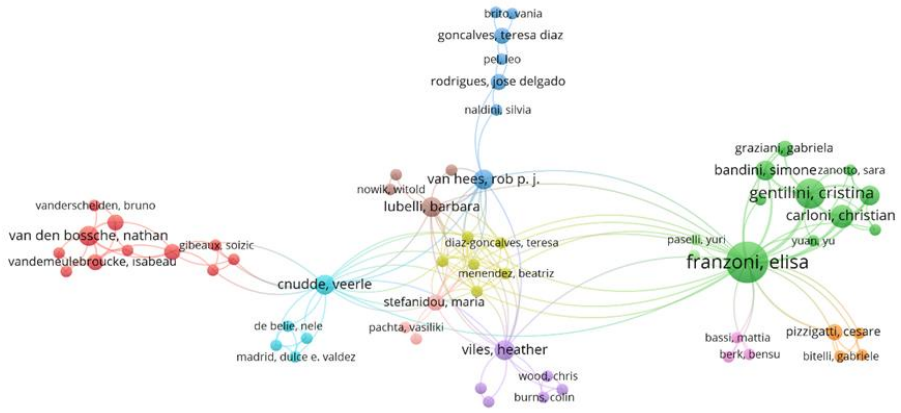


Figure 9. Co-Authorship of Authors

Figure 10 visualizes the international collaboration network. In the network, nodes represent countries, while the links indicate co-publication relationships between them.

The size of each node corresponds to the number of publications from that country, whereas the thickness of the links reflects the intensity of collaboration.

The visualization shows that countries such as Italy, Portugal, Spain, the Netherlands, and the Czech Republic occupy central positions with extensive collaboration networks. In addition, Belgium and Poland are found to have particularly strong connections with Canada and Romania, while Turkey collaborates primarily with Italy, the United Kingdom, and the Netherlands. This structure reveals that research on moisture-related deterioration in masonry buildings is predominantly concentrated around a Europe-centered collaboration network.

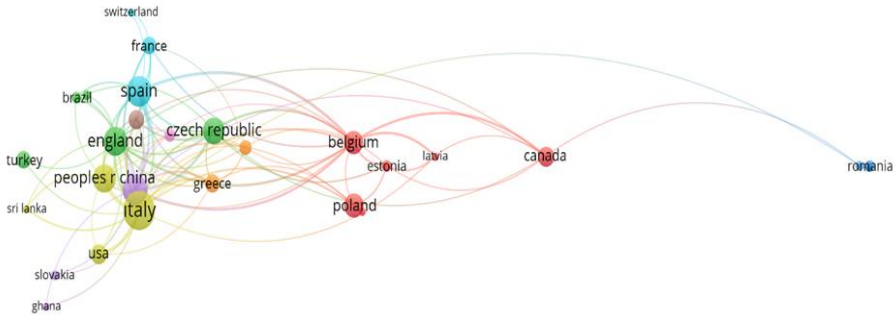


Figure 10. Citation of Countries

3.7. Most Cited Articles

Table 3 shows that one of the most highly cited studies in the field of moisture damage in masonry structures is the work by Cardell et al. (2003).

This study particularly examined the damage caused by salt-induced deterioration in stone structures in marine environments in detail and has become a fundamental reference in the literature. Similarly, Franzoni (2014) addressed various methods for mitigating rising damp issues in historic masonry walls, emphasizing that this remains an unresolved research area.

Table 3. Most Global Cited Documents

Document	Total Citations
Cardell C, 2003, Construction and Building Materials	164
Franzonı E, 2014, Construction and Building Materials	126
Lubellı B, 2018, Materials and Structures	107
Arızzı A, 2012, Construction and Building Materials	104
Cerny R, 2006, Construction and Building Materials	91
Vejmelkova E, 2012, Construction and Building Materials	83
Cultrone G, 2007, Construction and Building Materials	81
Gentılını C, 2012, Construction and Building Materials	81
Ananıa L, 2012, Construction and Building Materials	70
Hall M, 2004, Construction and Building Materials	70

On the other hand, Lubelli et al. (2018) proposed improvements to make salt crystallization tests in porous building materials more effective and reliable, highlighting the need for the standardization of experimental methods. Arizzi, Viles, and Cultrone (2022) provided important data on the durability of lime-based mortars through their experimental tests, contributing to the preservation of traditional materials. Additionally, Černý (2006) investigated the effects of chloride binding on building materials, helping to better understand the deterioration mechanisms caused by the combined action of moisture and salts.

These highly cited studies reveal the main research directions in the field and demonstrate that topics such as salt crystallization, rising damp, and material durability are central focuses in research on moisture damage in masonry structures.

Additionally, research by Vejmelková (2012), Cultrone (2007), and Gentilini (2012) has received over 80 citations, contributing significantly to the literature. This indicates that studies published especially since the 2000s have played a pivotal role in shaping the research area.

The fact that a large portion of these studies were published in Construction and Building Materials highlights the journal as one of the key outlets in this field. Moreover, most of the highly cited articles focus on material behaviour, the performance of brick and stone structures, and conservation methods,

suggesting that moisture-induced deterioration has predominantly been examined at the material level in the literature.

However, citation counts are concentrated in the 50–100 range, with only a few studies exceeding 120 citations. This distribution demonstrates that while the topic is gaining increasing attention in the academic community, research is still clustered around a limited number of pioneering studies.

According to the Table 4, the most locally cited references in the dataset include the works of Franzoni (2014), Scherer (2004), and Rodriguez-Navarro (1999). As shown in the table, the most frequently cited reference is Franzoni's 2014 article published in Construction and Building Materials. This study is widely referenced in the literature as it investigates the deterioration processes of building materials under moisture exposure and discusses conservation strategies in detail.

Table 4. Most Local Cited References

Cited References	Year	Citations
Franzonı E, Constr Buıld Mater, V54, P123	2014	19
Scherer G.W, Cement Concrete Res, V34, P1613	2004	18
Rodrıguez-Navarro C, Earth Surf Proc Land, V24, P191	1999	17
Charola A. E, J Am Inst Conserv, V39, P327	2000	16
Sandrolını F, Buıld Envıron, V41, P1372	2006	15
Gentılını C, Constr Buıld Mater, V37, P181	2012	14
Franzonı E, Constr Buıld Mater, V65, P405	2014	11
Vereecken E, Energ Buıldıngs, V89, P231	2015	11
Rırsch E, Constr Buıld Mater, V24, P1815	2010	10
Sandrolını F, Buıld Envıron, V42, P1966	2007	10

The second most cited reference is Scherer's (2004) publication in Cement and Concrete Research. This article provides an in-depth analysis of the deterioration mechanisms of cement and concrete structures, focusing on moisture penetration, salt crystallization, and microcrack formation. It has become a fundamental source for understanding the durability of porous construction materials.

In third place, Rodriguez-Navarro's (1999) article in Earth Surface Processes and Landforms examines the impact of salt crystallization on stone materials in the context of geological and environmental processes. The study provides a theoretical framework that has been frequently applied in the conservation of cultural heritage structures.

Furthermore, Charola (2000) emphasizes the significance of salt damage in the conservation of historic buildings, while Sandrolini (2006) presents comprehensive analyses on the effects of moisture and environmental conditions on building envelopes. Similarly, Gentilini (2012) and Vereecken (2015) contribute to the field with studies focusing on moisture transfer, energy performance, and building physics.

Overall, these findings reveal that the most frequently cited references in the field predominantly address moisture effects, salt crystallization, the durability of porous building materials, and the conservation of cultural heritage structures. This indicates that moisture-induced damage and material deterioration remain a critical area of research, both from a contemporary and historical perspective.

3.8. Keyword Co-occurrence Analysis

This section presents the co-occurrence relationships and thematic clustering of keywords. The analysis aims to identify the prominent research trends and themes in the studies. The larger, centrally positioned terms represent those most frequently used in the literature, indicating their centrality and high level of interaction. The coloured clusters illustrate groups of keywords that are semantically or thematically related. The keyword co-occurrence map groups together concepts that frequently appear in combination within the examined literature, thereby revealing the main research trends in the field. The clusters represented by different colours point to topics that are thematically close to one another (Figure 11).

- **Red-Orange Cluster-Material Properties and Deterioration Processes:** This group represents studies focusing particularly on the physical and chemical properties of building materials and the mechanisms of moisture-induced deterioration.

- **Blue Cluster -Historic Buildings and Conservation Strategies:** This cluster concentrates on the preservation of historic masonry structures, restoration practices, and issues related to material compatibility.

- **Green Cluster-Structural Behaviour and Durability:** This group encompasses studies addressing the long-term performance and durability assessments of structural elements.

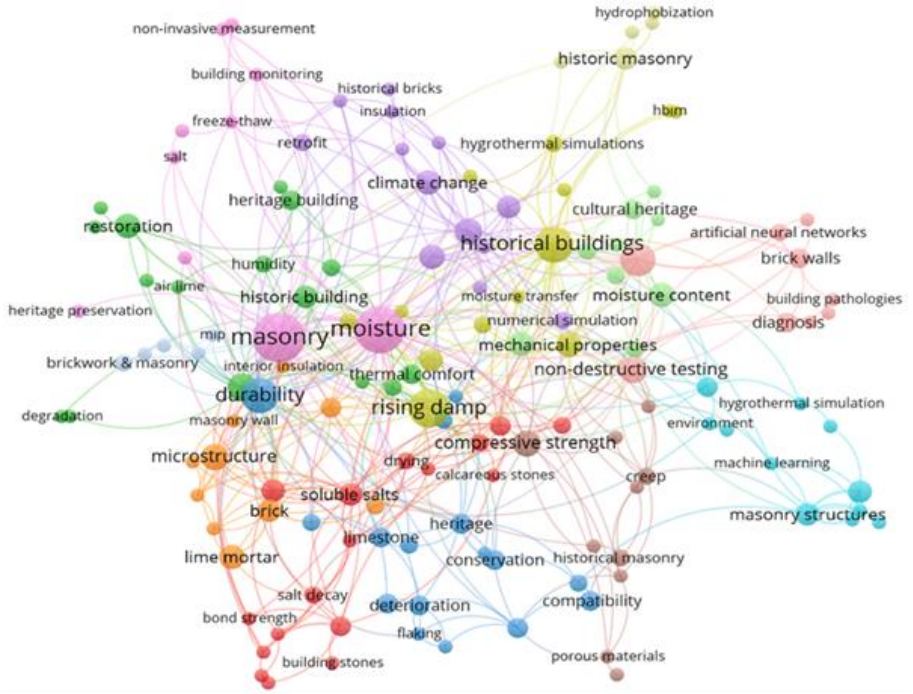


Figure 11. Co-Occurrence of Keywords

- **Purple Cluster-Energy Performance and Indoor Conditions:** This cluster includes research exploring the relationship between moisture, indoor climate control, energy efficiency, and climate change.

- **Yellow Cluster-Simulation and Computational Methods:** This group covers studies that investigate the movement and effects of moisture within structures through computer-based modelling approaches.

- **Light Blue Cluster-New Technologies and Structural Health Monitoring:** The terms in this cluster reflect the use of AI-based technologies for detecting and predicting moisture-related damage, representing

contemporary research that integrates modern engineering approaches into the field.

This network analysis reveals the thematic diversity and research trends in scientific studies on moisture-induced deterioration in masonry structures. The literature is shaped around core themes—such as moisture, durability, salt damage, and the conservation of historic buildings—forming a multidimensional knowledge structure. Such analysis may guide the identification of priority areas for future research.

The concepts of masonry, moisture, and rising damp hold central importance in understanding and managing moisture-induced deterioration in masonry structures. While the literature initially focused on material and structural durability, recent years have seen a growing emphasis on technology-supported solutions such as artificial intelligence and machine learning. The term historical buildings are strongly associated with all major keywords, indicating that the issue of moisture is particularly addressed within the context of cultural heritage (Figure 12).

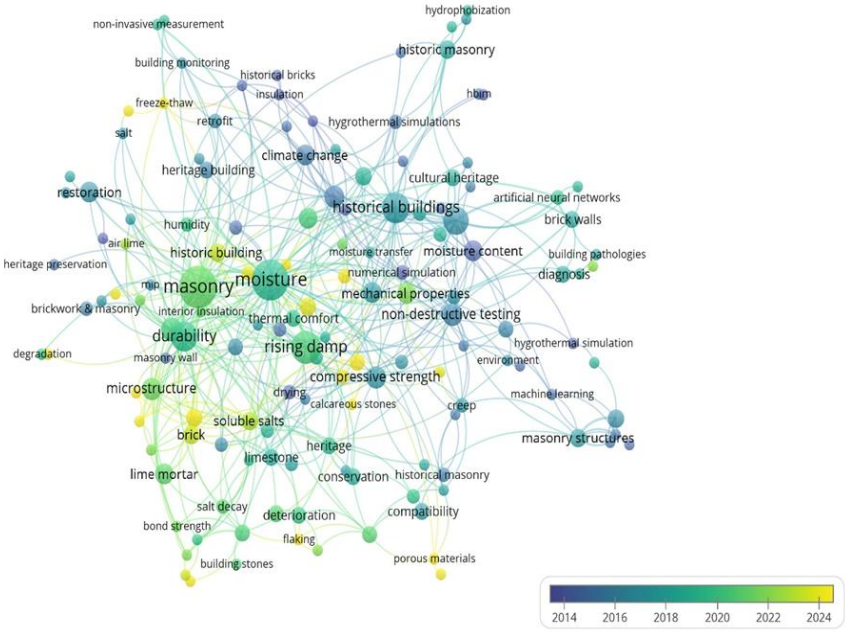


Figure 12. Overlay Visualization

3.9. Thematic Evolution and Trend Topics

This graph represents a thematic map, which analyses the conceptual structure of themes within a scientific field along with their level of development and degree of centrality. The vertical axis indicates the level of development of the themes, while the horizontal axis represents their centrality—namely, their connectivity and significance within the field. The map is divided into four main quadrants: Motor Themes, Basic Themes, Niche Themes, and Emerging or Declining Themes (Figure 13).

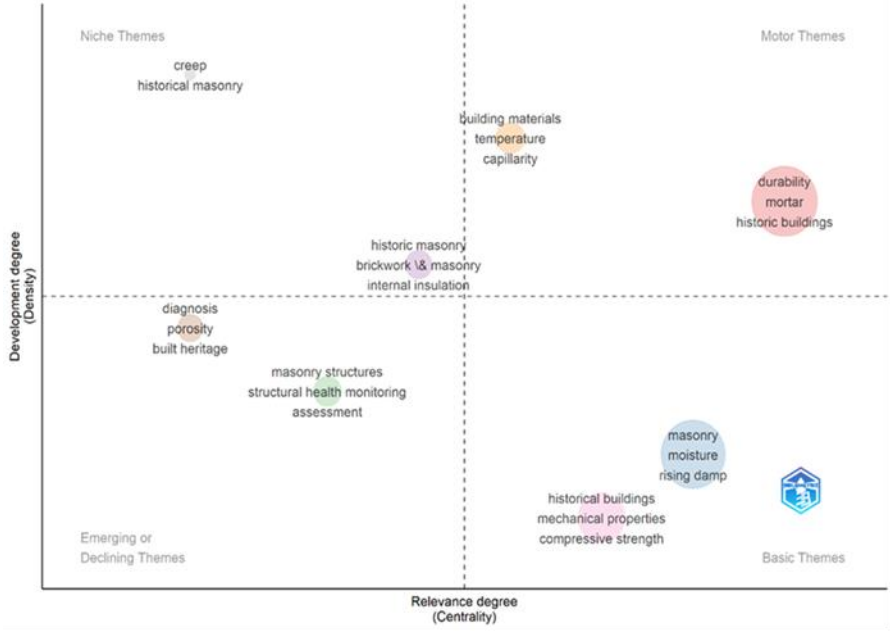


Figure 13. Thematic Map of Author's Keywords

- **Basic themes:** These represent the key terms that are frequently used in the literature, showing strong relevance to the field but lacking sufficient conceptual depth. Terms such as moisture, rising damp, masonry, and mechanical properties fall into this quadrant, indicating topics that are central and well connected in the literature but still expected to gain further conceptual development.

- **Motor themes:** These are the driving themes of the field. In recent studies, these keywords have become increasingly prominent. Terms such as durability, mortar, and historic buildings are positioned in this quadrant,

representing well-developed topics that play a fundamental role in shaping the direction of research.

- **Emerging or declining themes:** These refer to topics that are either in the early stages of development or losing relevance in the literature. Keywords such as diagnosis, porosity, built heritage, and assessment are found in this quadrant, suggesting that these themes may either be emerging research fronts or concepts whose importance is diminishing.

- **Niche themes:** These are highly specialized topics that are well developed but have limited contribution to the broader field. Terms such as creep and historical masonry fall into this category, typically forming the focus of more specialized investigations.

Overall, the graph reveals the thematic evolution of the research field, clearly illustrating how interest has shifted and intensified over time across areas such as building physics, material durability, moisture transfer, and cultural heritage. These findings provide valuable insights for anticipating future research trends.

4. Conclusion

This study quantitatively examined academic publications on moisture-induced deterioration in historic masonry structures between 2000 and 2025. The research methodology consisted of five main steps: defining the research aim and question, designing the study framework, collecting bibliographic data from the Web of Science database, conducting bibliometric analysis using Bibliometric and VOSviewer software, and interpreting the findings.

In total, 247 articles were analysed, revealing a marked increase in academic interest in moisture-related deterioration of masonry structures over the past 25 years. The significant rise in publications during the last decade demonstrates that moisture-induced damage has become a critical research topic in the conservation of historic buildings.

The bibliometric analysis was carried out through co-authorship, citation, co-occurrence, and co-citation analyses. The findings provided comprehensive insights into publication trends over time, the most influential articles, geographical distribution, leading authors and journals, research focuses, and the thematic evolution of the field. In this way, the study offers an objective and systematic evaluation method as an alternative to traditional

literature reviews. This approach not only makes visible the gaps in the literature for researchers but also provides guiding insights for conservation policies and practitioners. In particular, structural integrity, moisture control, and energy efficiency in historic masonry structures were identified as emerging priorities for the sustainable preservation of cultural heritage.

Nevertheless, the present study has certain limitations. First, the analysis relied solely on the Web of Science database; including other databases such as Scopus, Dimensions, or TR Dizin could provide a broader perspective. Moreover, the bibliometric analysis was based on metadata (titles, abstracts, and keywords) rather than full-text content, leaving in-depth textual analyses beyond its scope. Therefore, future studies should integrate multi-database approaches and include larger-scale, full-text content analyses. In addition, the selection of search criteria (keywords, time span, document type, and language) was determined subjectively, which may have introduced a certain degree of bias in the results.

In conclusion, this study has systematically mapped the development, research trends, and collaboration networks of scientific publications on moisture-related deterioration in masonry structures. The results not only evaluate the existing body of knowledge in a comprehensive manner but also provide a roadmap for future research. Moving forward, it will be of great importance to:

- Conduct comparative studies across different climatic regions and material types,
- Strengthen interdisciplinary collaborations,
- Promote the widespread use of advanced diagnostic and monitoring technologies, and
- Develop sustainable, long-term conservation strategies.

Such directions will contribute to safeguarding the cultural heritage value of masonry structures and ensuring their transmission to future generations.

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