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Sustainable conservation and restoration of built cultural heritage: Introduction to the SCORE Project

Beatriz Menéndez¹, Natalia Perez-Ema², Alessandra Bonazza³, Inge Rörig-Dalgaard⁴, Anna Maria Ferrari⁵, Claudia Garcia-Solis⁶, Sergio Gomez-Cornelio⁷, Johanna O'Byrne⁸, Patricia Quintana⁹, Benjamin Quesada¹⁰, Susana de la Rosa¹¹, Javier Reyes¹², Maria Pia Riccardi¹³, Luis Valdeon¹⁴

¹ CY Cergy Paris University, France

² Consejo Superior de Investigaciones Científicas - Universidad Complutense de Madrid, Spain

³ Consiglio Nazionale delle Recherche, Italy

⁴ Danmarks Tekniske Universitet, Denmark

⁵ Università Degli Studi di Modena e Reggio Emilia, Italy

⁶ Instituto Nacional de Antropología et Historia, Mexico

⁷ Universidad Politécnica del Centro, Mexico

⁸ REMPART, France

⁹ Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional, Mexico

¹⁰ Universidad del Rosario, Colombia

¹¹ Universidad Juárez Autónoma de Tabasco, Mexico

¹² Universidad Autónoma de Campeche, Mexico

¹³ Università degli Studi di Pavia, Italy

¹⁴ GEA Asesoría Geológica, Spain

Mots clés

Built cultural heritage

Green restoration

Climate change

Circular economy

Abstract

The SCORE project aims to bring together an intersectoral, international and multidisciplinary group that includes a wide range of actors – includes scientist from different disciplines, consulting companies, training organisations and non-



governmental organisations – in order to strengthen collaborative research and innovation in eco-friendly conservation, restoration, and rehabilitation.

Matching cultural heritage requirements with sustainable, economic and social aspects becomes essential and require highly qualified labour for conception, execution and conservation works. The SCORE project objective is to reduce the ecological footprint of the materials and methods employed in built cultural heritage conservation.

- **Introduction**

Extensive research and innovation efforts have been made worldwide to conserve the Built Cultural Heritage (BCH), but more work must be done to consider the ecological footprint of the materials and methods employed during conservation works. Matching cultural heritage requirements with ecological, economic and social aspects (1) becomes essential. We should combine the needs of society with the obligation to protect environmental and natural resources while contributing to sustainable future development: circular economy principles.

The SCORE project aims to bring together an intersectoral, international and multidisciplinary group that includes materials scientists, biologists and civil engineering researchers, restorers, archaeologists, art historians, Life Cycle Assessment specialists, climatologists, practitioners, consulting companies, training organisations, decision-makers and non-governmental organisations; in order to strengthen collaborative research and innovation in eco-friendly conservation, restoration, and rehabilitation. It aims to support the development of a series of innovative materials and methods dedicated to BCH conservation, integrating the circular economy concept, climate change and ecological footprint constraints.

- **Objectives and Actions**

The SCORE project contributes to the implementation of three objectives:

1. Development of “green” innovations: materials and methods for the conservation of ancient buildings based on a circular economy philosophy.
2. Two-way assessment of impacts of the environment on materials and of materials



on the environment: Climate conditions and atmosphere composition determine BCH materials' behaviour and, at the same time, the BCH conservation impacts greenhouse gases emissions and then climate change.

3. Transfer to society: Training and knowledge transfer on both innovative and traditional materials and methods with a low environmental impact.

The research and innovation action is based on two kinds of built cultural heritage in two geographical and climatic areas: vernacular built cultural heritage in Europe and archaeological sites in Yucatan (Mexico). Although different, these two kinds of built heritage use similar materials and construction techniques that can be transmitted and adapted from one to another. In both cases, BCH faces the same environmental constraints: (i) Climate change which threatens the protection of both monuments and vernacular buildings, in the light of current and future climate conditions (3) (4); (ii) The ecological footprint of the restoration (monuments) and rehabilitation (vernacular) materials and methods which must be minimized. The main climate types of the selected areas are extremely different, according to the Köppen-Geiger climate classification (5): equatorial (Aw) in Latin America and several different warm temperate climates (C) in Europe. This allows us to study the behaviour and durability of BCH conservation materials and techniques in different climate conditions, generating different weathering processes such as biological colonisation in climate A, salt crystallisation in climate C, etc., to extend the results obtained to other world regions. Built heritage conservation materials should meet three criteria: innocuity, compatibility and retractability (6), (7). Even if restoration methods for monuments are subjected to more constraints than vernacular cultural heritage, sustainability aspects must not be neglected. Research on traditional building techniques and new inorganic materials will help to reduce the environmental impact of restoration campaigns. Practitioners and the environment are potentially exposed to risk factors during restoration works; a circular economy model must minimize these risks (8).

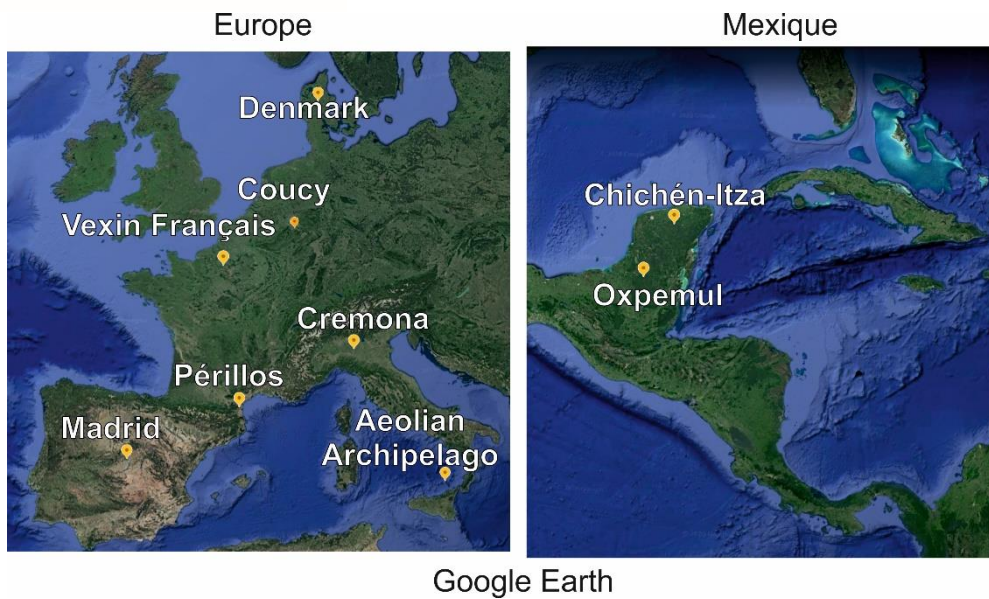


Fig. 1. SCORE case studies

The selection of case study (figure 1) sites was based on several criteria: (i) historical and architectural interest, (ii) geographical proximity and accessibility by research groups, (iii) research groups' previous experience in the material and building techniques employed, (iv) a wide range of climatic conditions. More details about the case studies can be found at www.score-project.net.

To achieve their objectives, the SCORE project implements a designed bespoke methodology which consists in working through “implementation loops”, as detailed below and in figure 2

- a) Bibliographic review, documentary and “in-situ” study of sites.
- b) Laboratory and “in-situ” studies to characterize ancient materials, their conservation degree, composition and physical properties.
- c) New materials design: mortars and renders, bricks, consolidants, water repellents, biocides, etc.
- d) Durability tests in laboratory and “in-situ” to determine the long-term behaviour of ancient and new materials in different environmental conditions. Based on the results obtained, formulations may be reviewed.
- e) Environmental performance and eco-friendly characteristics of materials and conservation methods. Life Cycle Assessment methodology will be used. The results will be used to review the proposed formulations.

- f) Durability test results will be used to establish new dose-response functions for different weathering effects under continuous climate changes or extreme events on BCH conservation.
- g) Past climate data and simulations of climate models for future periods will allow us to know future climate conditions and their differences from past ones.
- h) Past, current and future material weathering will be determined using dose-response functions and climate model “predictions”. Formulations will be approved or redesigned based on the results obtained.
- i) Validation of new materials and methods if they fulfil all the required conditions: compatible with real case materials, eco-friendly and durable in present and future conditions.

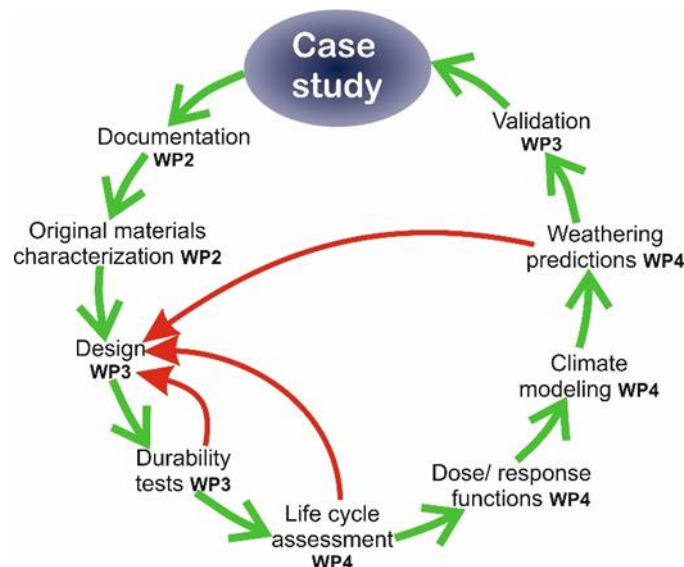


Fig. 2. SCORES working methodology.

● Conclusions

The SCORE project's expected results are:

1. Green restoration and rehabilitation products and methods: new products and methods proposed to practitioners, project managers, public and private owners.
2. Research contributions: a) new dose-response functions to estimate the effect of continuous processes (temperature rise, relative humidity changes, mean rain, etc.), b) critical threshold for extreme events (heatwave, rainstorms, dry seasons, etc.), c) future weathering maps in selected areas based on climate model simulations.



3. Training and academic actions, and dissemination of results.
4. Development of a large international and multidisciplinary network dedicated to green restoration and rehabilitation projects.

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References

1. BALLIANA E, RICCI G, PESCE C, ZENDRI E. Assessing the value of green conservation for cultural heritage: Positive and critical aspects of already available methodologies. *Int JI of Conservation Science* 7, Special Issue 1, 2016, pp. 185-202.
2. BONAZZA A., SABBIONI C., MESSINA P., GUARALDI C., DE NUNTIIS P. Climate change impact: mapping thermal stress on Carrara marble in Europe. *Sci of the Total Environment*, 407, 2009, pp. 4506-4512.
3. BONAZZA A., MESSINA P., SABBIONI C., GROSSI C. M., BRIMBLECOMBE P. Mapping the impact of climate change on surface recession of carbonate buildings in Europe. *Sci of the Total Environment* 407, 2009, pp. 2039-2050.
4. KÖPPEN-GEIGER. World Map of the Köppen-Geiger climate classification. <http://koeppen-geiger.vu-wien.ac.at>. [Online]
5. FORSTER. A.M. Building conservation philosophy for masonry repair: Part 2 - "principles". *Structural Survey*. 28, 2010, pp. 165-188.
6. PETZET, M. Conservation of Monuments and Sites : International Principles in Theory and Practice. s.l.: hendrik Bäsler verlag Monumenta II, MONUMENTA II, ICOMOS, 2013, p. 268.
7. Organisation, World Health. Circular economy and health: opportunities and risks. WHO Regional Office for Europe.