

Commentary

How Green Possibilities Can Help in a Future Sustainable Conservation of Cultural Heritage in Europe

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Abstract: We are moving towards a future that must be more sustainable in several aspects of society. Culture and cultural heritage have been recognized as indispensable parts of the sustainable growth of society, and the conservation model implemented in Europe has been considered as an example to follow at the economic, environmental, and social levels. The achievement of excellent results and the development of new technologies for the conservation of cultural heritage have highlighted the fundamental need for a method of sustainable conservation. In this commentary paper, we discuss two aspects that can contribute to sustainability in the future of conservation science: the use of innovative chemical products and the monitoring of outdoor sites by means of the forecast of the impact of dangerous factors on artistic surfaces. We are focusing mainly on the material aspect of cultural assets and how hard science can help in sustainable conservation. Even if the concept of sustainability has an ever-growing presence in our society, and different approaches have been given in different fields, it is still difficult to come up with a specific definition that can include the various hues of the world of cultural heritage conservation. The case studies presented in this paper are related to the European area and the advancements made for the sustainable preservation of such heritage. Considering the results obtained from both the chemical and the forecast side, we will try to summarize concisely the tasks that must be achieved in order to indicate as sustainable an approach to diagnostics for cultural heritage, including both the trans-disciplinary features of cultural heritage science and the scientific conservation of materials.

Keywords: forecasts; cultural heritage sustainability; green chemistry; sustainable conservation



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1. Introduction

The concept of sustainable development and sustainability has been developed only in recent times. In 1987, the World Commission on Environment and Development (WCED) introduced a broad definition of such thought: “Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs” [1].

This definition seems adequate if applied to the main purpose of the science of cultural heritage conservation, which is to guarantee the preservation of artistic and historical heritage for the widest period of time, assuring its use for future generations. Sustainability should include actions we take today to extend the life of a system (a building, a painting, or a statue).

Although sustainability was born as a topic related to the environment, nowadays the concept encompasses many aspects of reality, and it is no longer just limited to environmental issues. Therefore, in literature it is possible to find definitions of sustainability in different fields: economics, health, business, and tourism [2–5]. Soini and Birkeland [6] explored the scientific meaning of cultural sustainability in an interesting political and

theoretical discussion, which is not the focus of the present article, based on the technical approaches to being more sustainable in the field of material culture.

We want to clarify that in this text, we refer to cultural heritage in its material aspect, therefore including everything that concerns the degradation of materials and that involves an artistic, historical, and social impoverishment. The material aspect is obviously linked to the aesthetic side, and it is the carrier of the artist's message. Cesare Brandi—who helped to build the pillars of the modern philosophy of restoration—stated that the surface aging marked the passage of time, and it is therefore synonymous with the authenticity of the artwork itself [7]. Furthermore, the International Council on Monuments and Sites (ICOMOS) stated that the preventive conservation actions must be prioritize. This means a minimum intervention on historical and artistic materials, when this is possible to be actuated. [8,9]. The conservation of material culture ensures the preservation of the ancient models of manufacturing, therefore knowledge of the past, and its cultural and artistic message on which society developed in the previous centuries.

As stated before, there are several meanings regarding the concept of sustainability, and this occurs also in the cultural context. We mean by sustainability all actions aimed at developing protective materials and/or analytical methodologies that fall into the green chemistry family.

The conservation of cultural heritage materials was recognized as a representative sustainable pattern already at the beginning of this century. This model could be applicable to the other fields of society [10], and the European Commission has accepted the different dimensions of the cultural asset, in its physical, aesthetic, social, and economic sides. The policymakers explained the need to reach an integration of such areas to valorize and preserve cultural heritage [11]. Indeed, the economic, social, cultural, and environmental systems of the entire society are interconnected, and it is not possible to consider them separately.

The definition of sustainability for conservation science could include all the interpretations of the other fields, because a cultural object has its own economic importance; it is useful for the psycho-physical well-being of people; and it is obviously closely connected to tourism. Cultural heritage is strictly interconnected with other realities (economical, environmental), and it participates actively in the sustainable development of society, [9] being recognized as the pillar of modern sustainability, at the same level of other fields (Figure 1) [6,12]. Monuments, artworks, archaeological finds, and all the objects belonging to the cultural context are a collective heritage that belong to everyone. All these aspects have a key role in the achievement of a general sustainable development, as the cultural system is able to build social capital and to contribute to social cohesion and equity [9], thus impacting on economic growth.

The study of the materials of cultural heritage, their conservation, and the planning of approaches that are sustainable requires the collaboration of professionals from very diverse fields of research. A heterogeneous research group can obtain optimal results in the scientific conservation as well as the valorization of the materials, advancing the research and the approaches necessary to intervene on an artistic surface.

The research of the last 20 years has aimed at defining the human impact on the conservation of artworks, highlighting that we are the major factor in the degradation of cultural heritage, both in a direct and indirect way [13–16], in the same way, as it happens, for the environment. It has been demonstrated that pollution and climate change not only damage human health, but also endanger the conservation of materials, because artistic surfaces also interact with the surrounding environment. Recent studies established a correlation between environmental decay and increasing degradation [17–19]. The evaluation of damage due to an aggressive environment and the identification of possible solutions represent a very challenging task, particularly if the proposed solutions are avant-garde, green, and safe.

Focusing on the European case, the EU has paid much more attention to the possibility of sustainable actions for preservation, thanks to the financing of projects within the Hori-

zon 2020 framework that has guaranteed the development of technologies and products in accordance with a green policy. In addition, the possibility to offer innovative products to be put on the national and international context favored SME development, as required by UE 2014–2020 COSME [20]. The importance of this aspect has also been highlighted in the new Horizon Europe program within the most financed pillar, “Global Challenges and European Industrial Competitiveness”. The new program will be focused on the financing of research projects that will face societal challenges, reinforcing technological and industrial features. The second cluster, “Culture, Creativity, and Inclusive Society”, will include promotion and conservation to both maintain European cultural heritage and to favor technological advancement and the growth of wealth [21]. The main aim of the present article is to share the scientific achievements obtained so far, in order to point out what has been possible to achieve up to now in the field of material culture conservation through the development of green materials for the preservation and the environmental monitoring of outdoor sites as a non-invasive tool for diagnostics and policymakers, focusing on the European case. However, it must be remembered that even if cultural heritage is at the center of the cultural and scientific debate of the European Community, as well as the need to undertake sustainable conservation paths, the topic is relevant in many parts of the world, highlighting the urgency to take action [19,22–27].

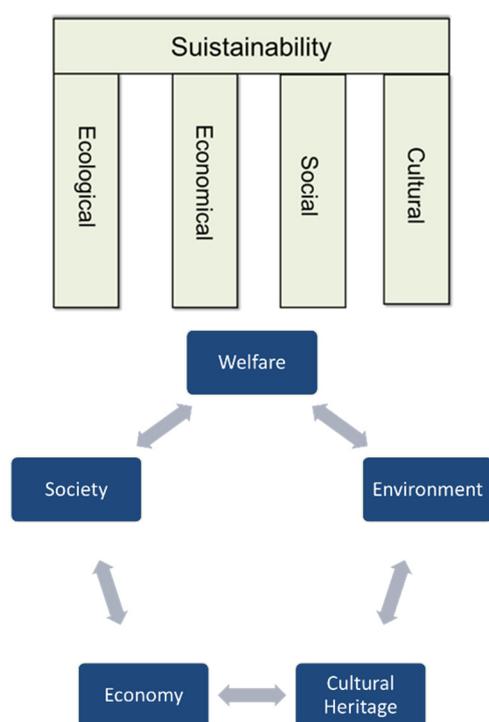


Figure 1. Culture is today considered the fourth pillar of sustainable development, along with social, economic, and ecological sustainability. The study of cultural heritage is inevitably interconnected with many other areas: they are the engine of the economy of many countries; they are within an environmental and social system; and cultural heritage allows the development of welfare that cannot ignore the preservation of past knowledge.

We chose to use a language that is understandable to all the professions involved in the field of cultural heritage, because as highlighted above, the sustainability of cultural heritage involves transversal areas of research and a strong interaction between different disciplines. Therefore, the construction of a common language is required to lay the foundations for a sustainable and culturally rich future. For this purpose, no scientific details of the formulations of the synthesized products or of the methodological procedures followed will be given, but we will show the results obtained in practice, the technological

advances, and how they can be used for a sustainable future in the sciences applied to cultural heritage.

Two aspects will be the focus of this work, which will be dealing with sustainable conservation. The first one is related to the development of innovative chemical products, which directly affects material conservation and the eventual dispersion in the environment of chemical agents used during the restoration processes. The second aspect regards the monitoring of outdoor sites by means of the forecast systems, and subsequently the preventive conservation of outdoor sites. These two tools should be essential to ensure sustainable conservation and the technological and cultural development of society. We highlight that these are only two aspects of a very complex reality that includes also the variability of the composing materials, the sites for conservation, the climatic conditions, and so on. In order to avoid a superficial discussion of different materials and different countries, we consider the results obtained especially on European cultural heritage exposed outside (i.e., buildings, artistic surfaces, and statuary). Furthermore, we aim at indicating the possible tasks needed to obtain a sustainable preservation of cultural heritage, considering the scientific and analytic aspect of conservation science, while also trying to encompass the problem related to the transdisciplinary features of cultural heritage, which do not allow only a single way of proceeding. In this context, it is necessary to have a broad vision on issues that are also very different from each other (from scientific conservation to the social and economic impact of an artistic asset).

2. Sustainable Conservation through a Chemical Approach

Cultural heritage materials, whatever their composition and location (indoor or outdoor), are susceptible to deterioration caused by various factors: thermo-hygrometric conditions, mechanical stress, electromagnetic radiation, and biodeterioration are just few examples [28–32]. These conditions can modify their aesthetic appearance as well as their composition [33,34]. The need to preserve the artistic and the material aspects of artworks is the key point that makes the approach to these goods different from any other material.

Up to now, researchers proposed methods and products to guarantee both the protection and the original appearance of the artistic surface, although many of the synthesized compounds were harmful for the environment and the operators [35,36].

Indeed, the conservation and restoration of cultural heritage assets is often linked to non-standardized restoration techniques (ethics always requires case-by-case solutions) involving the use of solvents and other mixtures of chemicals, as well as biocidal products, which can make an exhaustive risk assessment difficult for both the operator and the end user. Although the concept of sustainability has struggled to fit into the world of restoration, today it is essential to ensure compliance with safety standards, just like in other areas of production.

One of the main challenges in recent years has been developing innovative products for conservation and restoration that respect both the environment and the operator [37]. This need has grown stronger with the advancement of research as well as with the awareness of environmental and cultural sustainability [6,38]. Green chemistry is now emerging in the research for cultural heritage conservation as a result [39–41].

However, the discussion about the synthesis of green products for consolidation and preservation is still open, because these compounds must also respect other restrictions, such as compatibility with heterogeneous surfaces, and they must not alter the artistic message of the author, according to the philosophy of restoration.

Today, the field of green chemistry research is a very specific and expanding sector, and is mainly concerned with the elimination of products—both primary and secondary—that can be toxic to the environment, people, or animals. In fact, green chemistry aims at promoting innovative chemical technologies that reduce or eliminate the use of general hazardous substances in the design, manufacture, and use of chemical products [42–44]. The main goals of green chemistry are summarized in Figure 2.



Figure 2. The main goals of a sustainable synthesis and application of a chemical product.

Connected to the concept of green chemistry, there is chemical sustainability.

Chemical sustainability means the possibility to synthesize something that must be durable and stable over time, without compromising health and the environment, and this fits with the modern approach to restoration. Research is giving more attention to the development of protocols and products for consolidation and restoration that respect the sustainability and the green chemistry guidelines, considering the main features required as well such as durability, transparency, compatibility with ancient material, and easy synthesis and application (Figure 3). As Lo Schiavo and collaborators reported [45], green conservation of cultural heritage includes eco-sustainable practices in alternative to the traditional methods and products that, as we said before, are often toxic. Acrylic polymers and corrosion inhibitors (such as benzotriazole (BTA)) are still widely used in the restoration field, even if they are recognized to be dangerous not only for their nature, but also for the need to use toxic solvents for their removal, although sometimes they are used along with non-toxic or innovative green compounds [35,46–48].

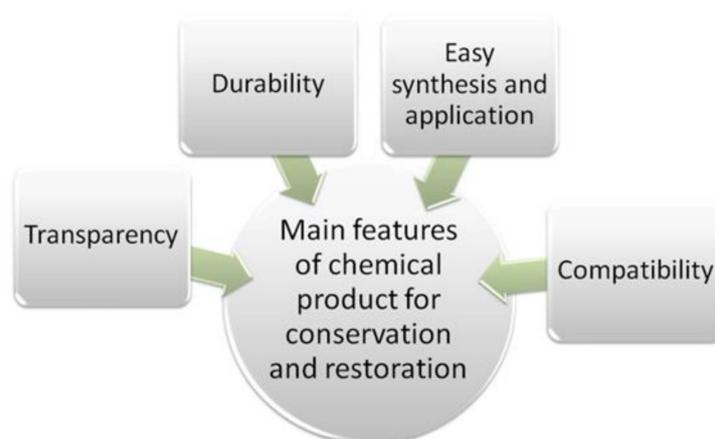


Figure 3. The main goal of a sustainable synthesis and application of a chemical product.

The role of nanosciences has been fundamental for the advancement of eco-friendly products in the field of restoration and diagnostics. Indeed, it allowed the development of sophisticated functional materials with a low environmental impact. In this regard, Baglioni

and his collaborators [49–52] proposed hydrogels, micelles, and microemulsions able to remove organic materials in a selective way, thus respecting the original heterogeneous surface of the artwork. The solvent that performs the cleaning function is immobilized in the polymer network of the hydrogels, and this is the reason for the low toxicity of these formulations, along with the low environmental risk [51]. The formulations proposed are mainly applied for the cleaning and consolidation of immovable artworks, also when the surface shows a great heterogeneity (i.e., polychrome surfaces). Some of these products are now available in the field of restoration, especially for cleaning and consolidation purpose, substituting the toxic compounds.

Nanocomposites and surface cleaning have given promising results in the work of Zarzuela et al. [53]. Here, the researchers developed and optimized C-S-H gel for the healing of nano- and micro-cracks of cementitious materials, focusing on the porosity and the consequent loss of materials. The ability of silica oligomer to produce a gel in contact with the calcium ions in portlandite (one of the most common cementitious materials) allowed obtaining a compound highly compatible with the historic substrate, thus respecting the rules of the restoration. In this case, a double result was obtained: (i) the chemical compatibility of the consolidation compounds occurring thanks to the polymerization of the silica oligomer in presence of portlandite and water, and (ii) the ecofriendly and non-toxic product obtained, which is similar to the original one.

In recent years, TiO₂ has raised great interest because it joins two important features for historical surfaces: self-cleaning and self-healing. This is possible thanks to its chemical and physical properties. Stone surfaces can be very different from each other, and each monument needs a tailored approach, considering also the environmental conditions that cause specific damage. Durable, effective, transparent, and hydrophilic nanocomposites have been recently synthesized to be applied on stone materials [54–56]. The photocatalytic properties of TiO₂ have been a great innovation in the field, not only for the cleaning of the surface, but also for the degradation of organic and inorganic pollutants [57–59]. However, an important consideration about the impact of TiO₂ in the environment must be made, because the discussion is still open, and research will clarify the impact of this compound in the environment. In fact, Ferrari and collaborators [60] clearly exposed the eco-design and the methodology of application of these nano-functional materials in order to reduce or eliminate the possible impact on the environment. They also stated that this material is too recent to be certain about the effect when it is dispersed in the environment.

It must be remembered that the synthesis of these products always requires a preliminary study on the material on which it must be applied and on the conditions that have caused its degradation. This implies that the product is specific to each case study, and laboratory tests on artificial specimens are mandatory before application on the historical surfaces exposed in a specific environment [61]. Furthermore, it should not be forgotten that although modern consolidation and restoration interventions include advanced compounds and technologies, they are always invasive operations for the work of art, and must be limited in time. In this regard, we will see in the next paragraph which tools can help in the planning of invasive interventions and, in particular, how it is possible to avoid them thanks to monitoring and risk forecasts.

3. Modelling and Prediction of Climate Impact as Tool for Sustainable Conservation

As defined by the International Council of Museums, Committee for Conservation (ICOM-CC) preventive conservation comprises all the actions and measures aimed at minimizing the deterioration or the loss of materials in the future. It deals with indirect actions, which do not interfere with the material directly.

Preventive conservation is a very important tool for the protection of materials—museum objects (i.e., paintings, frescoes, archaeological metals) [62–64], books, paper [65–68], or wooden materials [69–71]) and large artworks—as it allows long-lasting conservation without any direct intervention on the material, instead monitoring the environmental parameters that can influence their degradation [72–74].

Apart from the advantage of not performing invasive analysis on the materials, preventive conservation allows the reduction of maintenance and restoration costs [75].

It should also be remembered that the restoration intervention, from diagnostics to cleaning, could be invasive. Therefore, environmental monitoring reduces costs because it guarantees long-term conservation, which is usually cheaper than restoration.

The monitoring can be performed for indoor environments, where the thermo-hygrometric parameters are studied in order to maintain the correct conditions of preservation [18,62,65,66,70,76–79]. The indoor preventive conservation methods and results would require a separate discussion, as it is a complex topic; it concerns numerous materials that have different behaviors depending on certain conditions of the museum/building. As mentioned in the introduction, in this context we will deal with the preventive conservation of outdoor environments, whose conservation is directly related to atmospheric pollution and environmental parameters. This also allows us to show how the conservation of cultural heritage and that of the environment are directly related, and that sustainability is a concept that simultaneously affects many aspects of life.

The reason for this choice also lies in the fact that the environmental monitoring of outdoor monuments is closely linked to the durability of green products for two main reasons. Firstly, the outdoor conditions (i.e., pollution, acid rain) determine the length of life of the original surfaces, as well as of the products that are applied on them. Secondly, the transboundary control of emissions is strictly related to sustainability, and monitoring with maps and forecasts is an essential tool for decision-making processes on the conservation of both cultural heritage and the surrounding environment. As reported by Bertolin [18], the degradation of outdoor sites affects other sectors, such as tourism and regional economies, highlighting the need to find an adequate plan for restoration and maintenance.

Therefore, the research concerning the evaluation of surface recession (or the destruction of material due to aggressive agents and/or conditions to which it is subjected) due to pollution and the environmental factors considered depend on the detail needed for the surface regression, acquired by different methods of environmental monitoring [14,76,80,81]. It is necessary to consider numerous environmental parameters at the same time (temperature, humidity, geographical position, rain, heat), as well as the expected impact of environmental policies and their influence on long-term forecasts, especially when they are aimed at reducing air pollution. For example, Wang clearly explains why the evaluation of flood risks due to environmental monitoring and forecasts is essential in preserving and managing cultural heritage monuments and historic cities [82].

The convention on long-range transboundary air pollution (CLRTAP) held in Geneva in 1979 opened the discussion on the dangerous effects of transboundary air pollution on several ecosystems, but cultural heritage materials have been considered only since 1983, thanks to the Multi-Assess project [83]. Moreover, European projects such as CULT-STRAT [84] were funded in order to investigate the impact of pollution on outdoor sites. In this contest, Tidblad and Kucera worked on the development of dose-response functions to predict the combined effects of pollutants and meteorological variables on cultural materials [85–88]. The dose-functions allowed calculating the acceptable corrosion rate, identifying the future risks areas for materials, and building the maps where the materials are more in risk of danger.

The climate models and damage functions can give a quantitative evaluation of the surface recession of several materials, and the results can be graphed on the European map, as shown in Figure 4 [16]. These kinds of maps can be very useful for heritage sustainability management: it is possible to observe the evolution over the years, considering different scenarios that usually depend on the effectiveness of the reduction of pollutants thanks to environmental policies.

In the case study reported in Figure 4, it is shown that the surface recession and corrosion of limestone, copper, and bronze will be lower than 30% in 2030—good results to be improved in the future, especially in Eastern Europe where the damage will be stronger than other parts of Europe.

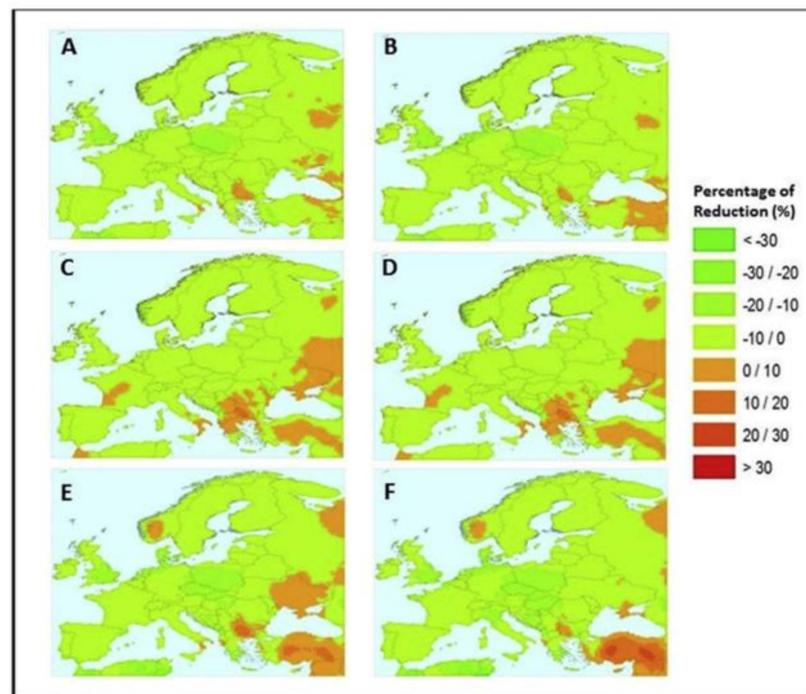


Figure 4. Percentage differences between 2010 and 2030 of surface recession of limestone, Goth_natl and TSAP scenarios (A,B); mass loss of copper for Goth_natl (C) and TSAP (D) scenarios; mass loss of bronze for Goth_natl (E) and TSAP (F). Reprinted from “Impacts of air pollution on cultural heritage corrosion at European level: What has been achieved and what are the future scenarios”, *Environmental Pollution* 2018 (2016) 586–594, F. Di Turo, C. Proietti, A. Screpanti, M. F. Fornasier, I. Cionni, G. Favero, and A. De Marco; copyright 0269–7491/©2016, with permission from Elsevier.

These kinds of research outputs help to plan adequate decisions in order to minimize the damage on surfaces, an essential aspect in the adaptation strategies for preventative conservation. Proposing accurate strategies and establishing effective tools to face the degradation of our cultural heritage are the pillars of the non-invasive, non-destructive, and sustainable conservation of such a class of goods.

Research of great interest for the future scenarios was carried out by Reimann’s group [14]. Here, attention was on the erosion and flood risks in the Mediterranean area, considering the UNESCO World Heritage, in a time range between 2000 and 2100. The researchers established the risk indices, taking into account the environmental policies adopted to reduce air pollution and climate change risks. The results showed that 13% of sites in Europe are at risk of flooding, while 91% are at risk of erosion. Venice, Dubrovnik, Tyro, and Tel Aviv will be the most affected cities in the future, with priceless loss of their heritage.

In addition to natural risks, air pollution was one of the most important parameters in the development of dose-response functions, highlighting how many human activities play an important role in pollution that causes severe damage on carbonate and metals surface. Among these, acid rain is one of the most problematic because the damage involves three processes: (i) the presence of sulfuric and nitric acid, (ii) their wet deposition on the surface, and (iii) the presence of low pH. Consequently, surface recession, black crusts, and erosion are just a few examples of the carbonate alteration.

It has been proved that pollution and climate change can deeply affect the surface recession of carbonate stones and Carrara marble, as highlighted in Bonazza’s works [89,90]. The research shows that between 1961 and 1991, there was an increase of 30% in surface recession of carbonate stones, especially in Central Europe, Scandinavia, and Scotland, regions that should be monitored in the future in order to avoid further damage. An increase in Carrara marble thermal stress in the future scenarios is also expected, having

developed a more realistic dose-response function that considers the increase of heating in the next years.

Climate change is considered a major factor for the physico-chemical stress changes occurring on the materials in the future [80,91–94]. The researchers determined the meteorological parameters and changes most critical for cultural heritage, predicting the effects over the next 100 years.

The mathematical approach had a key role in predicting the future damage, identifying also the main variables affecting the life of buildings, and integrating the vulnerability and risk factors [89,95,96]. Following the work of Philips [97], who first presented the Cultural Heritage Risks Index (CHRI) [98], Carroll and Aerrevaara [96] suggested a numerical scale to evaluate the relative influence of factors on cultural heritage materials. Grossi analyzed and predicted the damage in ancient and modern infrastructures caused by the freeze-thawing cycles, which changes over the years dependent on the increase of global temperatures [99]. They developed a mathematical model to predict the damage, applying multiple models to produce probabilities of various outcomes. The results cover the years 1961–1990 and 2070–2099, proposing a damage risk that is simple and easily calculated and understood.

It must be remembered that these forecasts are made on the present state of conservation and environmental parameters using scientific data, and therefore the certainty that they will occur exists. However, as highlighted by Carroll and Aerrevaara [96], it is still difficult to predict which scenario will be real. Their numerical scales consider the climate change effect on materials as well as all the approximations that could be useful for the forecast.

Even with all this scientific data and these forecasts, there is still no real concern for the possibility of losing historical and artistic heritage sites, such as that of Venice, due to climatic change and natural hazards. Reflecting on the value of the loss of UNESCO sites and highlighting this issue at the community level could help raise awareness among policymakers and managers about environmental control and climate change that negatively impact not only on health, but also on our culture [100].

Monuments, as well as the entire heritage, are part of the local identity, becoming an essential part of cities' texture and daily life. Therefore, the interest in their preservation has been strong in the research field, which has tried to predict future damage considering several dangerous factors, but the citizen should also be interested and involved in their preservation. For example, Hambly developed an application for smartphones for surveying the sites at erosion risks in Scotland, allowing the participation of citizens in the research with a consequent awareness of the problem of losing part of the common heritage [101]. As highlighted by Nocca [11], it is necessary to produce evidence in order to demonstrate that cultural heritage conservation and valorization is an investment and not a cost, especially when the monitoring is carried out over the years and sustainable actions and products are used.

All these approaches do not require a direct intervention on the material, but allow to structure and plan the conservation, carrying out the restoration operations only when it is strictly necessary. Furthermore, the predictions based on the interaction of aggressive compounds and surfaces allow the observation of the problem from an environmental perspective as well, which is obviously connected with that of the conservation of the material.

Forecasts and risk maps are useful and indispensable tools for organizing decision-making policies aimed at the conservation and enhancement of cultural heritage in a completely sustainable way and ensuring the fruition of culture for future generations.

4. Conclusions

The concept of sustainability is relatively recent, and in the first instance only concerned some areas of society, such as the economy and the environment. Even more recent is the awareness that the implementation of sustainable strategies can and must also be applied in the cultural context.

The definition of sustainability, given by the World Commission on Environment and Development in 1987, is in agreement with the general purpose of the conservation of cultural heritage: the need to give to future generations the possibility of using cultural heritage.

Although in other research fields, sustainability is a clear concept and there are specific objectives (i.e., elimination of toxic products for humans and the environment, reduction of the use of plastics, recycling), in the context of the conservation science of cultural heritage, it is still difficult to find a single guideline. This is mainly due to two factors: the multidisciplinary/interdisciplinary nature of the research on a material of cultural interest and the recent attention to this problem. A conservation problem can be addressed in different ways, but today the interest is towards those methodologies (as well as the creation of green and ecofriendly restoration/consolidation products) that respect the requirements of sustainability. In recent years, the European Community has financed more and more projects aimed at the development of eco-sustainable products, and this is a clear signal of where the research is heading. At the same time, however, invasive consolidation and restoration can be avoided by monitoring the environmental conditions through forecasts. This approach would not only allow avoiding expensive interventions, often carried out when the damage is considerable, but it also helps to deal with and worry about the environmental conditions, the pollutants, which act on the material. Risk forecasts, especially in outdoor cases, allow both to monitor the possible progress of surface degradation, and to consider the environmental and pollution parameters that are at the center of the debate for environmental sustainability. The interconnection of these issues can give an idea of how complex the evaluation of a single case study is and how many factors are necessary to be simultaneously considered in safeguarding cultural heritage, looking at sustainability goals (Figure 5). Likewise, many professionals need to be involved to get the best results.



Figure 5. Schematic summary of the definition regarding the scientific conservation of cultural heritage proposed here.

Therefore, in light of this discussion, we can summarize the general tasks needed to obtain a sustainable conservation of cultural heritage materials.

The sustainable conservation of cultural heritage must ensure the use of the heritage to future generations by means of risk prevention methods and, when this is not possible,

by the use of products that are not dangerous for artistic surfaces, human health, or the environment. The conservative approach that also considers environmental, social, and economic sustainability can be considered sustainable.

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