The most important function of art and science is to awaken the cosmic religious feeling and keep it alive

(Albert Einstein)

Background

Fifty years ago a tragedy shocked the world: the city of Florence, one of the most precious jewels that the international community has inherited, was devastated by a severe flood event, leading to several casualties and the loss or deterioration of many artworks. The assessment of an independent International Committee [1] has ascertained that, to date, insufficient action has been taken to reduce the risk of an analogous event that might lead to a similar tragedy.

Florence is of course just one of the cities of art that have suffered from the impact of natural catastrophes[2]. Moreover, cultural heritage is at increasing risk from natural disasters due to climate and environmental change[3] as well as ageing infrastructures. Several recent events have shown that, in spite of the longstanding attention devoted to these issues, institutions and population are often unprepared to face these events.

These facts have motivated the decision of the **InterAcademy Partnership (IAP)**, a global network of academies, to engage in an active campaign aimed at increasing national governments' awareness of the need for greater attention to safeguarding the cultural heritage in our cities of art. The present Charter is the first step in this direction.

We stand by the lasting commitment of international institutions to preserve and protect our cultural heritage, that started with the *Convention on the Protection of the World Cultural and Natural Heritage* adopted by the General

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[1] The International Technical and Scientific Committee (ITSC), comprising of six distinguished scientists and engineers from Europe and USA, chaired by Gerald Galloway (Glenn L. Martin Institute Professor of Engineering at the University of Maryland, USA), was appointed in 2014 by the Mayor of Florence, Dario Nardella, and the President of the Tuscany Region, Enrico Rossi. The task of the ITSC was to assess progress made in mitigating the risk of flooding of the Arno River in the city of Florence. The Final ITSC Report was presented at the International Accademia Nazionale dei Lincei-InterAcademy Partnership Conference: *Florence 1966-2016 Resilience of Art Cities to Natural Catastrophes: The Role of Academies* (Rome, 11 - 13 October 2016).

[2] Drdácký, Miloš, *Protecting the cultural heritage from natural disasters*, European Parliament, 2007.

[3] http://whc.unesco.org/en/climatechange/

Conference of UNESCO in 1972. Moreover, protection of the cultural heritage is affirmed directly in the *EU Treaty* [4], as well as indirectly in the *EU Charter of Fundamental Rights*[5]. Conservation and safeguarding of cultural heritage are also included among the Union's 'supporting actions' aimed at improving the cooperation between the Member States, ruled by the *Treaty on the Functioning of the European Union* (TFEU)[6].

The protection of cultural heritage is also covered in other specific EU regulations. In particular, the *EU Floods Directive* is designed to reduce adverse consequences of floods, including their impact on cultural heritage[7]. The 2015 Flood management plans of European river basins are expected to contain measures that guarantee appropriate protection of cultural heritage from flood hazard.

Finally, the safeguarding of cultural heritage is also part of the renewed international commitment to which the European Union and the Member States abide: the *SENDAI Framework for Disaster Risk Reduction (SFDRR) 2015-2030*, adopted in 2015 at the Third UN World Conference on Disaster Risk Reduction. The inclusion of cultural heritage among the major objectives of *SFDRR*[8] was strongly supported by the **Accademia Nazionale dei Lincei** and its success represents an important recognition of the relevance of the present undertaking.

[4] Article 3.3 of the Treaty of European Union (TEU, Lisbon Treaty) according to which the Union «*shall respect its rich cultural and linguistic diversity, and shall ensure that Europe's cultural heritage is safeguarded and enhanced*».

[5] According to Article 22, the Union «*shall respect cultural, religious and linguistic diversity*».

[6] Article 167 of TFEU, comma 2.

[7] Article 1 of the Directive 2007/60/EC

[8] The declared goal of SFDRR is a «*substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social,* ***cultural and environmental assets*** *of persons, businesses, communities and countries*».

THE CHARTER OF ROME

ON THE

RESILIENCE OF ART CITIES TO NATURAL CATASTROPHES

1. Basic statements

1.1. The distinctive feature of cultural assets[9] **is that they have aesthetic, historic, educational, social, symbolic, scientific, and spiritual value** that, along with their economic value, determine the willingness of people to fund their preservation.

1.2. Some analogy has been suggested between cultural assets and natural resources[10] **as they both require careful management by current generations in order to preserve the rights of future generations to benefit from them** (Principle of Intergenerational Equity)[11].
However, the above analogy is not sufficient to fully capture the concept that, unlike natural resources whose damage can often be 'repaired' through human intervention, **cultural heritage resources are genuinely unique and not replaceable by any means once lost or damaged**. Governments must recognize fully their fundamentally irreplaceable nature as well as the enormous economic impacts of their loss and damage.

1.3. Cities of art[12] **are the main containers of cultural assets, including their peculiar urban fabrics and the conservation of traditional artisan skills that are major ingredients of the socio-economic structure of these cities.** The issues posed by the conservation and sustainable exploitation of cities of art then merit special attention from local and national governments as well as from the international community.

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[9] Some economists define a distinct form of capital, called *cultural capital* (D. Throsby, *Cultural Capital*, Journal of Cultural Economics, 23(1): 3-12, 1999).

[10] This analogy was suggested in D. Throsby, *On the sustainability of natural capital*, Dept. of Economics Res. Paper, N. 10/200, Macquarie University, Sidney, 2005.

[11] This principle was introduced in the report *Our Common Future* of the Brundtland Commission (World Commission on Environment and Development, 1987. Oxford: Oxford University Press, p. 27, ISBN 019282080X).

[12] A concise definition of 'cities of art' is difficult to conceive and possibly useless. The World Heritage Cities inscribed by UNESCO in its World Heritage list have been chosen on the basis of the "*... unique character of the urban fabric and of the historic buildings that compose them*". As 'quality' rather than 'quantity' is evaluated, the only reasonable criterion is the judgement of experts, here the UNESCO Committee.

1.4. Our great cities of art are also often places with multicultural histories and contemporary multiculturalism. This is a major feature that should be reflected in efforts to safeguard these assets.

1.5. The special attention to be devoted to the cities of art has aspects related to their ordinary exploitation (typically tourism): in this respect, strong sustainability[13] requires that the management of the cultural asset of these cities should be such to keep the cultural value constant if not to actually increase it[14]. Furthermore, improving management with the help of modern technologies provides further opportunities to increase the contribution of cultural heritage to the Gross National Product (GNP) of the nation.

1.6. Cities of art must also be able to absorb external shocks without losing their characteristic functions: they must become **resilient cities**[15]. Resilience depends on tangible investments in preservation but also on intangible assets such as the social and institutional capacity of a city/region to be prepared, to react and to adapt to a shock[16]. Increasing the awareness of natural risks among citizens is a further major ingredient of resilience.

1.7. Enhancing the resilience of cities of art to the effects of natural catastrophes is not a uniformly feasible goal. Indeed, earthquakes are still events that cannot be predicted with precision[17] suitable for red alert or evacuation[18]. They are almost instantaneous events, compared to the long time scales involved in their preparation process. While some progress has been made in mapping seismic hazards, our knowledge is not yet satisfactory, and insufficient measures have been taken for the mitigation of the vulnerability of historic buildings.

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[13] Sustainability may attain various levels: weak, sensitive, and strong, depending on how strict the concept of nondeclining capital is (Pearce and Atkinson, *Capital Theory and the Measurement of Sustainable Development: An Indicator of Weak Sustainability*, Ecological Economics 8: 99-123, 1993; see also Serageldin and Grootaert, Defining social capital: an integrating view, in Dasgupta and Serageldin, eds. Social Capital: A Multifaceted Perspective, The World Bank, Washington, D.C., 1999).

[14] Cultural capital stock is essentially non- renewable, but new investments in conservation may increase its quality/value. In addition, contemporary forms of art and architecture can complement the historical capital assets, further increasing the total cultural stock.

[15] Perrings, C., *Environment and development economics 20 years on*, Environment and Development Economics 19: 333–366, Cambridge University Press, 2014, doi: 10.1017/S1355770X14000369.

[16] The 1966 catastrophes that hit Florence and Venice showed that, at the time, these two cities were far from being prepared for those shocks. However, resilience was increased by the reaction of citizens, the voluntary contributions of the national and international communities, and the exceptional effort and ability of the Italian school of restoration that was able to develop innovative *ad hoc* techniques and undertake a massive amount of work that allowed a significant portion of the works of art were saved.

[17] Peresan A., Kossobokov V. G. and Panza G.F., *Operational earthquake forecast/prediction*, Rend. Fis. Acc. Lincei, 23: 131-138, 2012, doi: 10.1007/s12210-012-0171-7.

[18] Such prediction is indeed very appropriate for many low-key, but very effective, preventive and preparedness actions (Kantorovich L.V. and Keilis-Borok V.I., *Earthquake prediction and decision-making: social, economic and civil protection aspects.* In Proc. International conference on earthquake Prediction: State-of-the-art, pp. 586-593, Scientific-technical contributions, CSEM-EMSC, Strasbourg, France, 1991. Based on: "*Economics of earthquake prediction*", Proc. UNESCO conference on Seismic Risk, Paris, 1977).

Other natural hazards (river and coastal floods, hurricanes and volcanic eruptions) are more predictable than earthquakes, at least in principle, and last for a longer period of time. Landslides and debris flows fall into an intermediate category: they also take place within a very short time, but their occurrence is sometimes 'announced' by precursors and they are often associated with predictable storm events.

2. Actions needed

2.1. Governments and international institutions must be aware that the protection of cultural heritage from the impact of natural catastrophes will require greater *ad hoc* attention in the near future. This awareness needs to be disseminated to the public, especially younger generations, enhancing their education on the value of cultural heritage as crucial elements of the identity of communities and on the duty of societies to preserve it for future generations. **Governments and international institutions should also acknowledge that cities of art deserve a special status, such to require a higher level of protection,** defined with respect to appropriately chosen '**design catastrophic events**'.

2.2. Research in the various scientific fields related to the protection of cultural heritage from natural hazards needs to be promoted and funded at both national and international level. The establishment of international networks of research centers, cooperating to advance our present understanding of crucial unsettled issues, should be strongly favored and supported[19]. In particular:

- Current knowledge of ***seismic hazard evaluation*** is in an evolving stage: indeed, in spite of significant involvement of the international scientific community, the basic prediction problems remain mostly unsolved. In the early 1990s, the Global Seismic Hazard Map was published as a main outcome of the Global Seismic Hazard Assessment Programme (GSHAP). Criticism levelled over the probabilistic approach underlying GSHAP and the debate that

[19] A European Project focused on vulnerability of cultural heritage to climate change (Noah's Ark, 2004-2007: Global Climate Change Impact on Built Heritage and Cultural Landscapes, European Commission Project n° SSPI-CT-2003-501837, http://noahsark.isac.cnr.it.) was conducted under the EU's Sixth Framework Programme for Research. The work, based on a quantitative approach, «(…) established the great importance of water as a threat to heritage, despite temperature being so often identified as the key aspect of climate change (…)». An output of this project was the Atlas on the Climate Change Impacts on European Cultural Heritage. The 237 World Heritage Cities included in the UNESCO list were later subject to detailed scrutiny by the World Bank (Climate-resilient, Climate-friendly World Heritage Cities, Urban Development Series, World Bank Group, 2014).

[13] The current debate originates from a group of scientists who questioned the scientific basis of the probabilistic approach (e.g. H. Castaňos and C. Lomnitz, *PSHA: is it science?*, *Engineering Geology 66:315-317 (2002)*, and V. G. Kossobokov, A. Peresan, and G. F. Panza, *Reality Check: Seismic Hazard Models You Can Trust, EOS, 2015*. These scientists believe that this area of research is in a state of crisis and a new paradigm of earthquake occurrence should be sought. For the opposite viewpoint see, e.g., T. Jordan, *The Prediction Problems of Earthquake System Science*, Seismological Research Letters, Volume 85, Number 4, July/August 2014; or W. Marzocchi, *Seismic Hazard and Public Safety*, *EOS, 94(27), 2 July 2013.*

followed[20], suggest that much effort is still required to reach a broad scientific consensus on appropriate procedures to map seismic hazards and identify the catastrophic earthquake to be expected at each site.

The evaluation of ***seismic vulnerability*** of historic structures is an equally challenging research topic that deserves an increasing specific effort for the development of tools and procedures to simulate the expected damage under strong earthquake motions.

Significant progress made in the area of ***real time monitoring*** (see the Global Seismographic Network and the recently proposed First European Urban Seismic Network) must be further enhanced. Structural ***monitoring, surveying and diagnosis*** of historic buildings must become a systematic practice, implemented with the help of innovative methods, relying on the use of modern technologies. This is a prerequisite for the identification of adequate solutions for structural management and protection as well as for the large funding required.

- Enhancing the resilience of cities to the ***risk of flooding*** is also a longstanding problem. Classical tools for flood risk mitigation employed in the last century (levees and reservoirs) give rise to long-term environmental impacts[21] that can no longer be ignored. This is a complex problem: implementing ***environmentally friendly tools for risk mitigation*** is particularly difficult as current land use often prevents the possibility of reestablishing 'natural' fluvial processes. Hence, the challenge for planners is to identify a portfolio of measures such as to maximize the beneficial effect for cities of art while leading to a manageable environmental impact.

Climate change adds additional complications, raising fundamental issues that affect ***flood hazard mapping***[22]. This includes the increasing need to monitor and maintain natural settings associated with cities of art (e.g. ***historical parks and wetlands***), which are increasingly at risk to unusually strong and abrupt meteorological events as well as to the long term effects of natural and anthropogenic subsidence. Moreover, the economic development of cities of art affects the co-evolution of the built and natural environments and actions tend to become contentious[23].

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[21] Levees, preventing the inundation of the flood plain, drive bed aggradation and subsidence of the flood plain. Rivers then tend to become pensile, which implies the need for further heightening of the levees, leading to a vicious circle. Moreover, levees defend the upstream reaches at the expense of the downstream river course where peak flows increase. *Reservoirs* have a number of beneficial effects (water storage, reduction of flood peaks, energy production) but they interrupt sediment transport, reducing the amount of sediments supplied to the downstream reaches that then undergo bed degradation. The use of levees and reservoirs, along with oil extraction, is the main cause of the widespread process of sinking deltas.

[22] In particular, the common assumption that natural systems can be treated as *stationary* has been recently questioned (Milly, P.C.D. et al., *Stationarity is dead. Whither water management?*, Science, 319, 573-574, 2008). Moreover, interpreting current trends of flood intensification is not obvious (Hall et al., Understanding flood regime changes in Europe: a state of the art assessment. *Hydrol Earth Syst Sci 2014, 18:2735–2772. doi:10.5194/hess-18-2735-2014*) and identifying appropriate 'adaptation' measures to adjust hydraulic protection to such highly uncertain climate projections remains an open issue.

[23] Dasgupta, P., *The nature of economic development and the economic development of Nature*, Economical and Political Weekly, XLVII: 38-51, 2013.

- Finally, it is increasingly recognized that achieving resilience to natural hazards requires an interdisciplinary approach, as reducing the risk originated by the most impacting hazards calls for an **integrated framework**.

2.3. Vulnerability of cultural heritage sites and assets to hazardous events characterized by sufficiently large durations (floods, hurricanes, volcanic eruptions, tsunamis), can at least be reduced by appropriate management of the event. Essentially, the forecast-decision-response system needs to be continuously improved, developing innovative procedures for the real-time assimilation of remote sensing observations.

2.4. Resilience requires accurate planning of the post-event emergency phase. Protocols defining the appropriate measures to implement in the emergency phase following a catastrophic event are crucial in order to safeguard any damaged works both in the short and long term. These protocols, periodically updated and approved by all the relevant Institutions, should be available to the entity in charge of coordinating the rescue efforts.

2.5. Recovery of damaged cultural assets is the last major ingredient of resilience. Governments must be aware that the success of the recovery phase depends crucially on the preservation of major schools of conservation/restoration, where unique knowledge and skills are transferred to the new generations. These schools may also benefit from the interaction with advanced research centers where innovative technologies for the diagnosis, stabilization and treatment of damaged works are developed. Supporting these activities by providing human resources and adequate funding is a duty of national and international institutions.

2.6. The above actions require innovative policies: in particular, *ex ante* assessment of social costs and benefits associated with risk-reducing investments, should be integrated in public policies and planning[24]**.** Pursuing this approach raises a few challenges. Firstly, estimating non-market benefits, including the value of a life saved, is yet an unsettled issue, although socio-economic and applied psychology techniques are available to quantify benefits that markets do not capture in terms of prices. Secondly, governing institutions must be able to weigh appropriately the long-term benefits of current investments[25]. Third, adequate funding must be made available to invest in reducing risks[26].

2.7. The effectiveness of innovative funding mechanisms must be explored. Investments typically derive from *standard tax funding* and/or *donations*. Taxes

[24] This is the obvious consequence of Art. 5 of the World Heritage Convention (WHC).

[25] This is a major problem. However, note that the UK treasury has recently issued a *white book* (https://www.gov.uk/.../system/.../climate-resilient-infrastructure-full.pdf) proposing the implementation of guidelines where procedures stemming from recent outcomes in economic theory are incorporated, and justifying public investments in the realm of climate change.

[26] Note that the TFEU includes conservation of cultural heritage among the cases in which state aids may be compatible with the EU internal market regulation. Moreover, the EU Solidarity Fund, established in 2002 as an immediate financial assistance to recover from sizeable natural hazard strikes, includes measures of protection of cultural heritage among the activities for which the Fund may be activated.

are on average relatively more effective and less 'uncertain' as they rely on the top down action of governments. However, donations in favor of specific cultural trusts by the general public present potential advantages. They enhance the participatory experience, which might fuel social capital dynamics. Moreover, social and economic participation can easily extend to the global community as the economic jurisdiction of many cultural sites is beyond the regional/national level. Donations are also relatively more equitable, as one pays according to his/her income and cultural preferences; they are also more 'efficient', as a proportion of the public may pay more than they would through taxes. Donors should then receive adequate recognition and visibility. Finally, public funding should be integrated with private funding, as provided by *insurance companies* or *infrastructure investment companies*. *Complementarity of public and private investments* is key for sustainability and resilience because markets follow public investments and function more efficiently when public interventions are intensified.

3. The role of Academies

3.1. Academies may play an important role in helping to implement Actions 2.1 and 2.2. In particular, the **G-Science meetings** provide a unique opportunity to pursue these goals.

3.2. Academies may also significantly contribute to **publicising** the **increasingly important role of science** in providing advanced techniques used in the complex work of restoration. Furthermore, Academies are the appropriate institutions where scientific knowledge of the resilience of cultural heritage can be systematically collected and conserved for the future generations.

3.3. Academies may provide a permanent **forum to discuss scientific developments on fundamental issues,** notably those raised in Sect. 2.2 and 2.3, that still await to be fully settled. The ultimate goal should be to develop internationally agreed hazard mapping tools and intervention strategies for the protection of cultural heritage. In this respect, the establishment of a 'Cultural Heritage Network of Academies', interested in contributing to the pursuit of this goal through periodic follow-ups to the IAP-Lincei meeting (Rome, 11-13 October 2016), would be highly desirable.

3.4. Risk mitigation of museum collections deserves special attention. Developing and implementing appropriate mitigation measures to reduce their vulnerability requires research that would benefit from the support of academies. Moreover, professional heritage preservation bodies, government agencies and scientific institutions should develop local and international guidelines through the involvement of interdisciplinary teams, including engineers, chemists, geophysicists, conservators/restorers, technicians/mount makers, designers and architects. The establishment of an international network of professionals would allow to share, openly and constructively, information and documentation on appropriate methodologies of damage mitigation on an international scale. This international body could then provide, with the help of academies, support and advice through open forums and publications.

3.5. Finally, Academies have the rare privilege of being devoid of any conflicts of interest: this makes them the best candidates to contribute to **assessments of progress** made in risk mitigation of major at-risk heritage sites.

4. Natural versus man-made disasters.

This Charter focuses on the resilience of cultural heritage to natural disasters. However, the history of mankind warns that cities of arts have often suffered and still suffer from man-made disasters. Conflicts, either in the traditional form of wars or in their modern expression of terrorist actions, have invariably been the source of massive devastations. However, these disasters do not pose a problem of resilience for cities of art: rather, they call for the need of a widespread reaction of the international community that, independently of cultural, political or religious differences, should explicitly brand these actions as actual **crimes against humanity**[27].

[27] Matthiae, P., *Distruzioni, saccheggi e rinascite*, Mondadori Electa, Milano, 2015 (*in Italian)*