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**ProCULTHER-NET**

PROTECTING CULTURAL HERITAGE  
FROM THE CONSEQUENCES OF DISASTERS - NETWORK

# TECHNICAL BULLETIN

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# THE PROJECT



**PROCULTHER-NET** is **co-funded** by the Directorate-General for European Civil Protection and Humanitarian Aid Operations - **DG-ECHO** under the European Union Civil Protection Mechanism - **UCPM**, and implemented by a **Consortium** led by the Italian Civil Protection Department (**Italy**) in collaboration with the International Centre for the Study of Preservation and Restoration of Cultural Property - **ICCROM**, the Ministry of Interior-Disaster and Emergency

Management Authority - AFAD (**Türkiye**), the German Archaeological Institute - DAI (**Germany**), the Ministère de l'Intérieur - Direction Générale de la Sécurité Civile et de la Gestion des Crises (**France**), the Fondazione Hallgarten - Franchetti Centro Studi **Villa Montesca**, the Ministry of Culture and Tourism of the Region Government of Castilla y León (**Spain**), the Federal Agency for Technical Relief - THW (**Germany**) and the Suor Orsola Benincasa University - UNISOB (**Italy**) and the University of Porto - UPORTO (**Portugal**).

Building on **PROCULTHER** project, whose it is a natural continuation, **PROCULTHER-NET** is running from **January 2022** to **December 2023** and aims at consolidating a **thematic community** focused on the **protection of cultural heritage** at risk of disaster within the **Union Civil Protection Knowledge Network - KN** and increasing **UCPM interoperability standards** by reinforcing **know-how transfer** and learning processes on the **inclusion of cultural heritage protection** in **disaster risk management** processes within the **KN**.

[Click here](#) to join the KN and find out more on **PROCULTHER-NET!**

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# FOREWORD



*By Catherine Magnant, Head of Unit and Deputy to the Director, Directorate-General for Education, Culture, Youth and Sport, Cultural Policy Unit, European Commission*

It gives me great pleasure to have the opportunity to introduce the second issue of the PROCULTHER-NET Technical Bulletin. Sharing knowledge is immensely important and I hope that this bulletin becomes a go-to source for the newest developments in the world of cultural heritage disaster risk management.

Right from the start, it was clear that the PROCULTHER project (2019-2021) addressed an issue that is as pressing today as it has ever been – risk management for cultural heritage necessitates not only the attention of the heritage community, but also of a diverse profile of experts, the civil protection

service chief among them. The outreach of this comprehensive and ambitious project, in the form of the methodology produced and the trainings provided, proved that many shared the same outlook.

For us at DG EAC, cultural heritage risk management has been high on the agenda ever since the European Year of Cultural Heritage 2018. Crises that affected our societies in recent years, from conflicts and the pandemic, to earthquakes, floods and wildfires, to name just a few – the latter only exacerbated by climate change – showed us that we need to continue to be invested in this topic and to encourage cooperation, sharing of good practices, exchange of knowledge and real dialogue. I am happy to say that many EU services and institutions recognized this and that we are also supported by our many stakeholders and partners in this venture. It is of particular weight that the PROCULTHER project evolved into PROCULTHER-NET with a wish to develop a knowledge community because true progress can only be achieved by mutual effort.

This issue will bring you testimonies of cultural heritage protection on the ground, and many of the articles will bring the use of digital technologies for cultural heritage into focus, key for risk preparedness and damage assessment. I look forward to the chance to learn and be inspired, and I hope you do too. Happy reading!

# INTRODUCTION

*By PROCULTHER-NET Project Consortium*

This second edition of the Technical Bulletin opens on a case study by the Türkiye Ministry of Culture and Tourism.

The wide-ranging intervention at the Sümela Monastery, going from restoration of the buildings and infrastructures to a rock stabilisation operation, is a powerful example that illustrates the **PREVENTION** section.



*Practical activities at the heart of interdisciplinary training @ DPC*

For its **PREPAREDNESS** section, this Technical Bulletin presents best

practices collected in the field of training, a theme that has been at the centre of PROCULTHER-NET activities in the past months.

Training is the alpha and the omega of preparedness. Workshops are a powerful capacity-building tool for raising awareness, developing skills and creating momentum. The nationwide workshops led by the Research and restoration centre of the museums of France - C2RMF is a striking example of the way training can give impulse to make preparedness policies a reality and not just a possibility, providing museum professionals a step-by-step guidance to draft a Safeguarding Plan.

But training is also essential as the last step of preparedness. An emergency plan is not operational until it has been put into practice, vetted and upgraded, in a continuous improvement cycle. Conducting exercises is therefore necessary to test emergency plans, to practice technical gestures such as handling and packing of movable heritage, to be ready to respond to unforeseen contingencies and, last but not least, to learn to work together as a multi-disciplinary team. Such experience was provided to the experts who took part in the two training sessions organised by PROCULTHER-NET in Volterra (Italy) in March 2023, described in an article by the Italian Civil Protection Department- DPC.

In this edition, the **RESPONSE** section is focusing on the theme of data and apps. The ongoing war in Ukraine has stressed the importance of such digital tools, with the development and field-testing of several downloadable apps to quickly digitise or to assess cultural heritage in emergencies. Three PROCULTHER-NET partners, the International Centre for the Study of Preservation and Restoration of Cultural Property - ICCROM, the German Archaeological Institute - DAI and the DPC share here their complimentary experiences and on-going work in this rapidly developing sector.

To complete the picture on the use of new technologies, the Italian National Fire and Rescue Service - CNVVF reports on the experimental use of the LiDAR in post-seismic assessment of immovable cultural heritage.

A contribution of the Unit for Risk Management and Emergencies in Cultural Heritage of Castilla y Leon - UGRECYL concludes the Response section, by analysing the impact of forest fires on rural cultural heritage – a pressing subject as the summer season is approaching.

Under **RECOVERY**, the Italian Ministry of Culture - MiC makes the case for sorting rubbles of immovable cultural heritage, based on the experience of the 2016 earthquake and its devastating impact on the Basilica of Norcia. This patient and meticulous approach is a cornerstone to ensure reconstruction and to preserve the historical and cultural fabric of a site affected by a disaster.

To conclude this 2<sup>nd</sup> Technical Bulletin – and to return to and wrap up the theme of data – the **FOCUS ON** section looks into the recording of damage to cultural heritage. What do we lose when lose cultural heritage? How do we measure it? In its article, the University of Porto - UPORTO advocates for and proposes a standardized methodology to record damage to immovable cultural heritage, an essential yet missing tool in better understanding vulnerabilities and reducing hazard exposure.



# PREVENTION

## Sumela Monastery restoration and rock reconstruction works

*Author: Beyhan SARICAOĞLU, Master Architect, Türkiye Ministry of Culture and Tourism-MoCT, Trabzon Directorate of Surveying and Monuments*

Preserving historical sites is vital to the survival of cultures and one of the most important ways this is achieved is through restorations. The Sümela Monastery, one of Türkiye most important religious tourism centres, completed its restoration process, and reopened for the visitors.

### Historical Background and Structural Features

Sümela Monastery was built on a steep cliff on the outskirts of Mt. Karadag which overlooks Altindere valley, within the boundaries of Altindere Village of Maçka District of Trabzon province, located in the Black Sea Region of Türkiye. It is believed that the Greek name Sumela comes from the word *molasses*, which means black, dark. In addition, the icon of the Virgin Mary in the monastery is thought to have inspired the name of the monastery.<sup>1</sup> The original name of the monastery is “*Panagia Sou Melas*” meaning “Virgin of Mt. Karadag / Mother of God in Mt. Karadag” and is included in the Ottoman Empire records as Monastery Suomale. The words “*stou mela*” in the Greek language mean “in the mela” on the land, on the black, on the black mountain. Over time, the use of Turkish from the Soumela form has turned into “Sümela”.<sup>2</sup>



*The Courtyard of the Sümela Monastery © MoCT*

There are various rumours that the foundation of the monastery dates back to the 4<sup>th</sup> century and it is claimed that it was founded by two monks named Barnabas and Sophronios from Athens during the reign of Byzantine Emperor Theodosius I (375-395), and the monastery was restored and expanded by Emperor Justinianus (6<sup>th</sup> century).<sup>3</sup> In official sources, the oldest known establishment dates back to the 14<sup>th</sup> century. It is said that the Principality of Trabzon

<sup>1</sup> Eyice, S., “Trabzon Yakınında Meryem Ana (Sümela) Manastırı, Belleten, Vol.30, s. 243-264, 1996.

<sup>2</sup> <https://www.sumela.gov.tr/tarihce/sumela-adinin-etimolojisi>

<sup>3</sup> Eyice, S., “Trabzon Yakınında Meryem Ana (Sümela) Manastırı, Belleten, Vol.30, s. 243-264, 1996.

Komnenos dominated this region during this period. Alaxios Komnenos III (1349-1390), one of the Trabzon Komnenos, who had a unique policy and had close and intricate relations with the Turkish principalities, can be considered the main founder of this monastery.

Sümela monastery is reached by a path of approximately 300 meters from the end of the roadway. A large aqueduct adjoining the mountain and extending to the southwest extends to the level of the door at the top of the stairs. Toilets, a cafeteria building and the box office are in the outer courtyard where the aqueducts are located. The monastery is reached by a steep staircase from the outer courtyard. When the iron gate at the entrance to the monastery complex is passed, stone structures called guard rooms begin on the right, and there are terraces on the left and a steep staircase in the middle of these structures leads down to the inner courtyard. On the left side of the courtyard are the kitchen sections, the holy spring, and the priest rooms. Next to these rooms, there is a small chapel and a rock church.

In the north of the church, there is a 24-room section such as chapels and monk rooms, which are located in an irregular way. On the right side of the courtyard is the building block consisting of guest rooms and library buildings.



*Pathway to the Monastery © MoCT*

### **Works of the Ministry of Culture and Tourism for the Monastery**

Until 1986, when it was opened to visitors, no record of any restoration or arrangement work was found in the Monastery. In the monastery, project studies were carried out at certain intervals between 1987-1997, and implementation works were carried out in 1998-2006. In 2013, the "Sümela Ruins of Sümela Monastery Survey, Restitution, Restoration, Structural Strengthening, Mechanical Engineering, Electrical Engineering and Landscaping Project" was carried out in order to open the entire monastery complex to visitors and to carry out a holistic restoration. In 2015, "Geological and Geotechnical Research and Strengthening Project of the Rocks Around Trabzon Sümela Monastery" was prepared due to the stone falls. In 2016-2019, "Trabzon Sümela Monastery Restoration and Landscaping Project" was carried out. In 2019-2022, the "Stone Fall Hazard Precautions Project Around Trabzon Sümela Archaeological Site" was carried out. After all these works, all parts of the monastery were opened to visitors in 2022.



*Another view of the courtyard © MoCT*

### Restoration Process

Restoration practices in Sümela Monastery were carried out within the framework of restoration projects approved in 2014. In this context, the pathway leading to the monastery was reorganized and rebuilt. The pathway consisted of a steep sloping dirt road and in some parts the path was overtaken by exposed roots. Therefore, within the scope of the project, wooden stairs and platforms were created on the pathway to protect the tree roots and facilitate walking in bad weather conditions. In addition, problems such as spillage and moss on the monastery walls caused by the intense humidity were eliminated and these areas were strengthened with hydraulic lime mortar.



*Entrance © MoCT*

Afterwards, the missing stones of the aqueducts in the outer courtyard were replaced and their joints were strengthened. Beams were placed between the arches. Toilet sections with inadequate usage conditions were renewed and enlarged. The roof of the cafeteria building, which was being demolished, was strengthened, its joints were renewed, interior plasters and installations were made and it was turned into a museum-cafe building. Flooring plans were made in the outer courtyard, and the courtyard walls were strengthened. In addition, the

wooden elements, joint and roof of the box office building located next to the monastery entrance stairs were renewed.

After exiting the entrance hall at the main entrance, the terraces on the left were reinforced and the water accumulated in the terraces was drained up to the courtyard. In the kitchen, holy spring and priest rooms on the left of the inner courtyard of the monastery, the originality of the structures was preserved and joint renewal, improvement of wooden elements and renewal of roof covers were carried out with minimal intervention. In the building block, which is called the student rooms and guesthouse, located on the right of the courtyard, construction materials that are not suitable for the building were modified and productions such as joint, plaster, wooden door-window were renovated. The rotten parts of the beams between the floors were removed and the roof construction was strengthened.



*Student Rooms and Guesthouse © MoCT*



*In-room view © MoCT*

Throughout the restoration process, within the framework of the general purpose of the restoration practices, the principles of removing the non-original material from the area with minimum intervention and completion and carrying out studies for the protection and consolidation of the structure were followed and adhered to.

### **Rock Stabilisation Process**

A project carried out in order to stabilize the rock block on the entrance gate of the Sümela Monastery. Along this process, the rock block was detected by aerial imaging, laser scanning and rope access.

During this process, a large number of suspended rock fragments, altered surfaces, dry trees stuck on the slopes, piles accumulated in the embankments and emptied sections were encountered.



*Hillside rock cleaning © MoCT*

The works started with the cleaning of the slopes and precautions were taken against the pieces of rock that could fall on the Monastery's entrance way. The free surface was cleaned to a large extent on the rocky surface, the stones that were about to fall were removed by breaking them, and the stones that could be recuperated were fixed. A rock barrier was built for the stones that could fall from above.



*Courtyard scaffolding © MoCT*

While designing the rock and stone fall project; Influencing factors such as lithological description, definition of discontinuities, morphological structure of the slope, definition of possible stability problems, frequency of occurrence of the problem, seismicity of the area, environmental factors, priority of protection and lifecycle of the protection operations implemented were taken into consideration. Scaffolding which had a minimum contact with the structures was built to protect the structures in the monastery from rockfalls during the works. In addition, a moisture barrier was used to protect the frescoed surfaces from environmental conditions. Small pieces of rock carry a high risk of falling rocks and stones due to snow, water, wind effect, animal movements and plant roots. Personnel working in the slope area are also more likely to be harmed. Therefore, the entire slope area was covered with steel wire.

The risky blocks identified during the project phase were fixed simultaneously with the covering process. In these areas, respectively; steel rope connection anchoring with bolts, frame rope construction, high-strength steel wire mesh covering, horizontal steel rope line and IBO bolts fixing to the bedrock productions were made. A map of the slope area was prepared to describe the anchorage and containment system and containment measures for each major block.



*Slope area steel wire application ©MoCT*



*Slope Area Map © MoCT*

It was recommended to fix the large rock blocks with specified risk 500/550 with anchors 32 mm in diameter and 4.0 - 6.0 m long. Anchors were mounted on rocky blocks with vertical fractures with intermediate roughness.

### **Conclusion**

Sümela Monastery, which is included in UNESCO's temporary list of World Heritage sites, is of great importance in terms of cultural heritage. The Monastery has entered a holistic restoration process since 2013 after natural disasters, structural deformations and human destruction. In order to ensure the structural continuity of the monastery, to preserve the memory of its architectural features and not to be affected by the negative effects of nature, the restoration process was completed by ensuring rock stabilization with minimal restoration intervention.

As a result, the monastery, whose resilience was increased against the risk of disasters and other issues, was reopened to visitors after the restoration works.

# PREPAREDNESS

## Training and exercise: an effective approach to build cultural heritage protection capacity

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*Authors: Veronica Piacentini and Gabriella Proietti, Architects, Italian Presidency of the Council of Ministers - Civil Protection Department - DPC*

Emergency management operations coordinated by the responsible bodies in charge of disaster management, especially in case of events affecting large areas, include the first most urgent Search and Rescue (SAR) operations followed by the next most compelling activities aimed to safeguarding public safety and where possible to the timely return of the population to their homes, and subsequent urgent measures to reduce inconvenience and further possible damage. Accordingly, the most urgent activities to be implemented are those of damage and post-event structural usability assessments on public and private buildings, cultural heritage, infrastructure and strategic facilities (schools, hospitals, barracks, etc.). The reason for such essential monitoring activities is to enable the return of the population to their safe homes, and the reuse of infrastructure and strategic facilities even for the intervention of the relief forces working on-site in the course of emergency management operations.

Furthermore, with regard to activities aimed at the reconnaissance and safeguarding of cultural assets in emergencies, the ultimate goal is also to ensure the maintenance of artistic-historical-cultural structures to help increase the resilience of communities and pass on such heritage to future generations. Indeed, often buildings and assets falling under the category of cultural heritage, may represent the community's place of worship or their main sociocultural reference.

The safeguard of cultural heritage affected by disasters in Italy has been considered a topic of great interest for several years now, and especially in more recent years, also as a result of the numerous experiences in the field (Abruzzo earthquake 2009, Reggio Emilia earthquake 2012, and Central Italy earthquake 2016), a process of knowledge and sharing has been undertaken with the Ministry of Culture - MiC, the National Fire and Rescue Service, the Army, the Carabinieri Command for the Protection of Cultural Heritage and the Civil Protection Volunteer Associations, aimed not only at organizing and improving emergency management activities but also at developing a more comprehensive regulatory framework covering the various phases of forecasting, prevention and emergency response.

In particular, in the last decade, the Civil Protection Department has started a process of sharing with the MiC and the Regions, regulatory standards and operational guidelines dedicated to training in the field of cultural heritage protection, with the aim of creating an increasing number of trained personnel, volunteers and technical experts, capable of providing their support in the various emergency activities of this particular field.

The different cultural heritage protection activities to be carried out in case of a large-scale emergency scenario:

- damage and structural usability assessment and securing of buildings/restricted assets (rapid assessment, more in-depth assessment with damage and usability assessment forms, initial securing interventions),
- damage assessment and securing of movable heritage (on-site interventions or relocation to a safe place),
- protection of movable cultural heritage/covering of cultural heritage exposed to degradation (collapsed walls, frescoes and mosaics subject to weather conditions),
- identification and establishment of temporary storage facilities for cultural heritage,
- debris management (cataloguing, triage and transferring to a safe place),
- assessment of the impact on intangible cultural heritage (ceremonies, traditions, rituals and practices of a religious or secular nature).

Therefore, in order to ensure the necessary personnel to carry out the activities described above, the following training programs have been defined:

- Training for Technical Experts on cultural heritage damage and structural usability of immovable cultural heritage;
- Training for Operations Coordination Experts for the protection of cultural heritage;
- Training for Civil Protection Volunteers and Public Administration Officials operating in the field of movable cultural heritage protection in the framework of civil protection activities.



*Field exercise under the PCH: Inventorying movable heritage March 2023, Italy @ DPC*

Furthermore, continuing on a path of support and promotion of such activities in the European arena, developed through a number of projects co-funded by DG ECHO, such as PROMEDHE, PROCULTHER and PROCULTHER-NET, a first pilot project for the training of experts in cultural heritage protection from the consequences of disasters under the Union Civil Protection Mechanism was also proposed.



## Training for Technical Experts on cultural heritage damage and structural usability of immovable cultural heritage

Damage and building usability assessment activities are focused on expeditious inspections that make use of suitable recording forms and require the use of technical experts with proven professional skills and experience, for the proper use of these structural usability assessment forms and knowledge of operating in emergency contexts.

In this regard, the Italian Civil Protection Department - DPC, issued "*Operational Directions for the training of technical experts of the public administration, voluntary organizations and professionals registered in the rolls of orders and colleges*" dated 29/10/2020, aimed at defining specific training courses addressed to technical experts of the public administration, voluntary organizations, as well as professionals enrolled in the Orders and Colleges, in order to ensure the integration of the skills and professional experience of the same, with specific knowledge that will allow their use in the post-seismic emergency, in particular, in the activities of assessment of damage and usability of structures, including cultural buildings, within the coordinated action of civil protection, at different levels of institutional and territorial competence.

Based on these Directions, the Department, in agreement with the MiC, has launched a first pilot course in 2021 for cultural heritage technical experts (CH technical experts).

The inspections for the damage and building usability assessment of churches and buildings declared to be of cultural interest are aimed at identifying the cultural heritage that may pose a risk to the population and those that can instead continue to be used, in order to reduce the citizens' risk and further possible damage. The course focuses on how to fill out the official forms recognised throughout the Italian territory for the damage assessment of churches and buildings.

Damage assessment operations on churches, buildings and various cultural heritage assets (towers, arches and small monuments), are aimed at:

- assessing the damages and usability conditions of the structures, including with respect to any tremors following the main event;
- establishing the possible need for provisional works for the protection of public safety and to limit damage to the structures themselves and to what they contain.

The course aims to provide technical experts with the essential elements for assessing the damage conditions and the structural usability of churches, buildings and various artworks built in masonry, through training on the emergency relief recording tools, ensuring an unambiguous interpretation of all the data contained in the different sections of the forms and providing a systematic and codified approach throughout the country.

The course deals particularly with the churches and the building damage assessment forms, as well as the rapid assessment forms for the other kind of artefacts (towers, arches,

fountains, cemetery shrines, etc.). To date, in the country, about 100 technical experts have been trained on damage assessments of immovable cultural heritage.

### **Training for Operations Coordination Experts for the protection of cultural heritage**

For the management of emergency activities at national scale, the Civil Protection Department employs on the territory a Directorate of Command and Control (DI.COMA.C.), as the coordinating body of the components and operational structures of the National Civil Protection Service, in support of the Head of the Civil Protection Department. The DI.COMA.C. is the coordinating body that operates by activating the support cells, among others the Cultural Heritage Protection Cell within which the representatives of the administrations, agencies and voluntary organizations jointly collaborate for the fulfilment of the assigned tasks and objectives.

The course is aimed at technical experts to be employed in the coordination activities of the Cultural Heritage Protection Cell at the different levels of territorial and institutional coordination; it is accessed, based on the planning of needs adopted by the individual regions in agreement with the DPC and MiC, only by Public Administration technicians and MiC officials with proven years of experience in participation in cultural heritage and Aedes<sup>4</sup> coordination and location scouting activities.

### **Training of civil protection volunteers and public administration officials on the protection of cultural heritage in civil protection activities**



*Securing damaged cultural heritage during the Belice Exercise, October 2018, Italy © DPC*

As a result of recent emergencies as well as in national field exercises, the need has emerged, on the one hand, to inform public administration officials involved in the management of cultural heritage emergencies about the activation and operation of the structures of the National Civil Protection Service; and, on the other hand, to increase the technical-operational capacity of specialized volunteers to support cultural heritage protection activities put in place during the management of civil protection emergencies.

<sup>4</sup> The AeDES sheet - Usability and Damage in Seismic Emergencies - is for the quick assessment of damage, the definition of emergency response measures and the assessment of the post-seismic usability of buildings of ordinary structural typology (masonry, reinforced concrete or steel framed or baffled) for housing and/or services. This sheet cannot be applied to buildings that do not fall into this typology, such as industrial buildings (e.g., prefabricated sheds), monumental buildings (in particular churches), or other artefacts (such as reservoirs, etc.), nor can it be applied to bridges and other infrastructural works. The sheet has been used since the 1997 Umbria-Marches earthquake and in all subsequent earthquakes.

As part of the collaboration between the Department of Civil Protection and the MiC, training activities have been set up for National Civil Protection Service personnel on cultural heritage protection in emergencies. In particular, in April 2019, jointly with the MiC, the "*Minimum Requirements for the Training of Civil Protection Volunteers and Civil Service Officials on the Protection of Cultural Heritage in Civil Protection Activities*" were defined, on the basis of which a number of courses, mainly aimed at civil protection volunteers, were carried out, training more than 270 civil servants and 400 volunteers who can be deployed, on the national territory, in support of such activities, put in place by the relevant structures of the MiC.

The formats and contents of two types of training modules were defined as follows; the first aimed at volunteers registered within civil protection organizations and associations, and the second for the personnel of the MiC, the Regions and local authorities, the Carabinieri Command for Cultural Heritage Protection, the National Fire and Rescue Service, as well as additional individuals involved in cultural heritage protection activities, within the MiC's competence, in civil protection emergencies, particularly in case of national scale disasters.

The above training modules have already been tested, in agreement with the Regions concerned and in close collaboration with the competent Secretariats of the MiC, during the exercises: SeismicBat 2017, in Puglia, for the module reserved for officials only; Neiflex 2018, in Veneto; and Belice2018 in Sicily. In 2018, two editions of the course were organized by the Department, at the national level, which allowed the establishment of an initial core of officials and volunteers trained according to the above-mentioned Minimum Requirements. Subsequently, by several regions' initiative and with the collaboration of the Department, more training courses were organized at local level.

Attending the courses and passing the final tests are prerequisites to ensure an effective and coordinated participation of experts - particularly of civil servants and civil protection volunteers - in activities within the MiC's competence, even more when they are implemented as part of national scale emergencies coordinated by the Department.

This, considering that the implementation of appropriate consistent and organic training, aimed at the dissemination of knowledge, procedures and skills, can generate an overall improvement, in terms of timeliness, efficiency and effectiveness, of actions to secure cultural heritage in civil protection emergencies.

The organization and participation in the courses in question, moreover, facilitates direct contacts between the different actors involved, leading to an increase of synergies, improvement of interaction and collaboration between institutions in charge of cultural heritage protection in emergencies; in this sense, it is highly desirable that the two types of courses mentioned above - addressed both to volunteers and officials - are carried out jointly.

The training modules are structured in such a way to allow the two courses to be administered in a single edition, aimed at officials and volunteers at the same time. In this case, only some parts of the courses, will require to separate the learners in two groups. At the conclusion of the training activity, the practical simulation test will involve the participants from both

courses, and a final test aimed at verifying the level of the learners' advancement after attending the course.

### **Cultural Heritage Protection Exercise**

Based on the needs experienced in the course of a succession of actual disasters that have hit Italy in the last 15 years, the idea of training and experimenting with better operability in the sector of cultural heritage protection has led the DPC to test, thanks to a number of exercises conducted on the field, the activation procedures, safeguarding methodologies and functionality of intervention models, in order to establish a common emergency management method, both at the national and regional level.

Therefore, the area of cultural heritage protection has been included in all national and international exercises, which the Department annually conducts on its territory: NEIFLEX on 6 - 8 June 2018; PROMEDHEX - Lucca Earthquake Exercise on 18-21 June, 2018; Belice on 26-27 September, 2018; EXE FLEGREI 17-20 October, 2019; Strait Earthquake Exercise 4 - 6 November, 2022.

The exercises have always been preceded by training courses, such as those described above, designed to train civil protection technicians and volunteers, who will then continue to collaborate over time to integrate the part concerning cultural heritage in the regional Civil Protection plans and to improve their operations.

A fundamental aspect of the simulation exercises is to involve the competent subjects on the territory for the activities to be carried out (as already mentioned Superintendence for cultural heritage, Regional Civil Protection, National Fire and Rescue Service, the Carabinieri Command for the Protection of Cultural Heritage, the Army, Civil Protection Volunteers) and to propose concrete, real problems to be tackled together: assessment of the situation of cultural heritage following an earthquake or flooding, organization of the assessment of the conditions of the buildings and the works contained therein, evacuation of movable assets, identification of temporary storage for the evacuated movable assets, etc.

For this reason, it is important to include in the exercise scenarios, created ad hoc to exercise the cultural heritage experts' teams, a multiplicity of movable assets to be assessed and possibly evacuated, representing the different case histories addressed in the training courses

### **Training for Cultural Heritage Experts of the Union Civil Protection Mechanism**

Within the framework of the DG ECHO-funded project PROCULTHER-NET, with the main objective of bringing closer and creating a link between the field of disaster risk management and the field of cultural heritage and based on the experiences described so far, it has been proposed a "Protecting Cultural Heritage Course" - PCH, a pilot course for training cultural heritage experts to be potentially deployed within the Union Civil Protection Mechanism-UCPM.

The main objective of the project is consolidating a thematic community focused on the protection of cultural heritage at risk of disaster within the Union Civil Protection Knowledge Network and fostering multi-disciplinary and risk-based exchange practices to support and complement the efforts made by the European Union in the field of civil protection, facilitating the transfer of knowledge, as well as the integration of innovative practices/processes/ instruments at an institutional level having also the opportunity to expand, simultaneously, capacities of functional groups/experts at each national level.



*Field labs during the PCH March 2023, Italy © DPC*

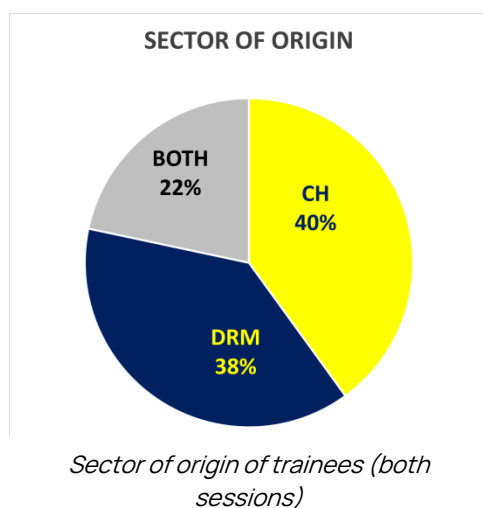
Among the elements that form the basis for the further consolidation of this thematic community are:

- The “[Key Elements of a European Methodology to address Protection of Cultural Heritage during Emergencies](#)”, the only document currently agreed and available at European level providing a common understanding for improving preparedness capacities at the national and European levels;
- Terms of reference for the setting-up of cultural heritage module(s) able to reinforce disaster preparedness and, in case of emergency, to support national response actions of affected countries under the umbrella of UCPM.

Moreover, with a view to ensuring interoperability between deployed modules to assist operations in a coordinated and effective manner, additional training objectives can be summarised as follows:

- To feed knowledge-building efforts and ensure that decision making processes become more effective and consistent with the progress made in the field of cultural heritage protection in emergency,
- To reinforce the adoption of standards to guide disaster risk management (DRM) operations in a coordinated and sustainable way at national and European level,
- To reinforce knowledge and skills to allow cascading know-how transfer on issues related to the protection of cultural heritage at risk of disaster,
- To ensure an effective exchange between participants and promote the definition of synergies aimed at strengthening the basis of a thematic community focused on the protection of disaster-prone cultural heritage.

The PCH was intended to enhance knowledge, skills, and procedures for the creation of UCPM-driven modules or teams dedicated to the protection of cultural heritage at European level, as well as to reinforce resilience capacities at national level. Building on the main assumption of PROCULTHER-NET, that it is imperative for the two different communities to work in synergy, the course was addressed to disaster risk managers and cultural heritage experts and, to encourage the widest possible participation and meet the training quality standards of the 35 States participating in the UCPM, it has been proposed in two editions, the first one held from 6 to 10 March, the second one from 20 to 24 March. Thanks to this approach, 70% of the Countries participating in the Mechanism<sup>5</sup> signed up for the initiative: sixty selected professionals made up the interdisciplinary group of trainees that allowed for a proactive debate on the inclusion of cultural heritage in risk management processes, an issue that is bound to feed and strengthen the Union Civil Protection Knowledge Network.



A few numbers may help to frame the skills represented in the two editions: 40% were cultural heritage experts, 38% disaster risk managers and the remaining 22% had a background covering both sectors. Indeed, the excellent cooperation by the UCPM States National Training Coordinators during the selection of candidates, ensured an excellent balance of represented expertise: experts in civil protection and disaster risk management, members of the armed forces, archaeologists, professional firefighters, structural engineers, architects, restorers, archivists and researchers from the world of disaster risk management and cultural heritage. The training module

consisted of 5 face-to-face days, each lasting about 8 hours, including a few additional hours conducted in virtual mode.

The International School of Higher Education – SIAF, located in Volterra (Pisa, Italy), hosted the in-presence days of the training course, whose programme dealt with the following thematic issues:

- CIVIL PROTECTION AND CULTURAL HERITAGE: INSTITUTIONAL AND LEGAL FRAMEWORK
- INTERNATIONAL MISSIONS: PHASES OF THE ACTIVATION PRACTICAL ISSUES
- OPERATIONAL ISSUES ON THE FIELD
- SECURING CULTURAL HERITAGE (IMMOVABLE, MOVABLE AND INTANGIBLE)
- EXERCISE AND EVALUATION

A team of thirty lecturers and trainers have made up the core group engaged in sharing new key information to increase the dialogue among experts working in the field of disaster risk

<sup>5</sup>Albania, Austria, Belgium, Bosnia-Herzegovina, Bulgaria, Cyprus, Croatia, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Malta, the Netherlands, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain and Sweden (some Countries participated in both editions).

management, and cultural heritage protection, to improve the technical and operational capacities needed to reinforce UCPM capacities to support, upon request, countries overwhelmed by disasters specifically in the field of cultural heritage protection.

The lectures delivered were propaedeutic to the practical activities proposed to prepare participants to the final field exercise that concluded each training edition. Thanks to the availability and excellent collaboration of the local authorities and the Superintendence of Volterra, this beautiful town hosted the exercise scenario planned by the group of architects, engineers and risk management experts from the Italian Civil Protection Department, in collaboration with the Project Management Consortium. Course participants played the role of the cultural heritage protection module in the exercise simulating the activation of the Mechanism by Italy after an earthquake with impacts on cultural heritage.

The proactive participation and commitment of the participants in this initiative, including the final exercise and the overall rating given to the training module, will reflect on a strong motivation to be ambassadors, both at national and international level, of the importance of including cultural heritage protection in disaster risk management processes.

All of the training courses described above are characterized by two basic aspects:

- the first regards the explicit desire to have experts in cultural heritage and DRM work side by side, in a completely complementary manner, starting from the firm belief that the ones are dependent on the others and that only through a close synergy between these two elements can we actually succeed in protecting and safeguarding cultural heritage at risk of disaster.
- the second concerns the co-presence in the training courses of theoretical lectures, practical workshops and concluding exercise activities, in which the participants, organized in mixed teams (cultural heritage experts and emergency experts), concretely test the procedures and notions learned in the course.

This approach represents an unfailing element of the training standards and minimum requirements applied throughout the country to be then shared and implemented, with the collaboration of all partners, also in the international pilot courses organized within the PROCULTHER and PROCULTHER-NET projects.

From the experience gained over the past few years in the field of training, we believe that the approach used can be considered in this sense correct and it is hoped that in the future there will be further opportunities to test and implement even in the international field the training standard described above and that the result of this work can become part of the training path adopted by the UCPM for training sessions specifically aimed at the protection of cultural heritage in emergency contexts.

# PREPAREDNESS

## “Culture, Rescue: all hands on deck!”: National authorities to assist in drafting emergency plans to protect cultural heritage

*Authors: Marie Courselaud, in charge of preventive conservation, Research and restoration center of the museums of France (C2RMF), president of the Bouclier Bleu France (BbF) and Jocelyn Périllat-Mercerot, in charge of studies in preventive conservation, C2RMF; coordinator of the BbF sections*

The protection of heritage against major risks is a recent concept on a global scale. The Hague Convention of 1954, dedicated to the protection of heritage in times of crisis, is exclusively devoted to armed conflicts and does not take into account natural or anthropogenic risks that may threaten cultural heritage. It was not until the year 2000 that awareness began to grow with the Kyoto Declaration in 2004, followed by the Kobe Declaration in 2005 at the World Conference on Risk Prevention. On a European scale, various significant initiatives were launched: the Delta plan during the second half of the 20<sup>th</sup> century for protection against flooding in the Netherlands, the Noé project devoted to the protection of cultural assets in the Mediterranean arc against major risks. At the same time, European programs have emerged in various countries arousing a reflection on the protection of heritage<sup>6</sup> but also on a European regulation by which Member States are compelled to take into account cultural heritage in the prevention of flood risks.<sup>7</sup> At the end of the 2010s, pressure to encourage the various stakeholders to consider and control the risks to heritage is becoming increasingly strong. The 2015-2030 Sendai Framework for Disaster Risk Reduction reinforces the point.

What is the situation in France? How do the authorities position themselves on this subject? What is the level of awareness and involvement of the authorities and the various stakeholders? What means and resources are available?

The protection of heritage does not only involve the people who are in charge of it but also a larger ecosystem of experts in the field of risks, crises, rescue, etc. In France, heritage protection has been built in non-linear steps by relying on the Ministries of Ecology, Interior and Culture.

The reduction of risks depends first of all on knowledge. This knowledge and the resulting regulations are carried by the Ministry of Ecology: “The State draws up plans for the prevention of foreseeable risks”.<sup>8</sup> Cultural establishments can therefore refer to the various risk prevention plans to develop their protection strategies. In the framework of the law on the modernization of civil security in 2004 and the ORSEC<sup>9</sup> decree of 2005, both issued by the

<sup>6</sup> Examples include the ResCult project which aims to increase the resilience of cultural heritage: <https://www.sdis04.fr/projets-europeens/rescult>

<sup>7</sup> <https://eur-lex.europa.eu/legal-content/en/TXT/PDF/?uri=CELEX:32007L0060&from=SK>

<sup>8</sup> Article L.562-1 to 9 of the Environment Code

<sup>9</sup> The ORSEC is a multi-purpose French emergency crisis management plan. Under the authority of the Prefect, it organises the mobilisation, implementation and coordination of the actions of all public and private bodies involved in the general protection of the population. ORSEC was originally an acronym for “organisation des secours”



Ministry of the Interior, the legislator created an obligation in terms of safeguarding heritage, without however explaining the *modus operandi*. On the part of the Ministry of Culture, a series of notes and circulars have been issued since the year 2000 to encourage establishments to draw up their safeguarding plan.

Despite a significant level of awareness among authorities on the subject of protecting heritage from risks and strong recommendations to engage institutions in this work, the 2018 study conducted by the Centre for Research and Restoration of the Museums of France - C2RMF shows that few museums have an operational safeguard plan (17% in 2018). How can this observation be expressed when training courses exist and there is a plethora of documentation on the subject? After surveying the institutions, it appears that there are many reasons for this: the absence of a regulatory framework that obliges institutions to have plans; the lack of knowledge about risks and crisis management; the variety of skills required (analysis of the vulnerability of the building/collections, scientific component, logistics, human resources), which are not all represented in small institutions; the absence of identified national interlocutors; the absence of a standard model and tools that facilitate the drafting of safeguard plans. In general, this work is considered too technical and time-consuming, regardless of the size of the museum or its human and material resources: this undertaking has become, in fact, a non-priority subject in the agenda of museums.

To respond to these different issues, the C2RMF to develop a rigorous support method, reproducible on a national scale, that would enable cultural institutions to develop a safeguarding plan within a year. In place since 2019, this method is based on the support of experts from both the heritage and civil protection fields. Organized in one-day sessions every two months, the workshops allow for the gradual exploration of each of the safeguard plan's themes in a collaborative manner. Between each session, “homework” is submitted on the theme addressed (session 1: data collection; session 2: prioritization of collections; session 3: identification of withdrawal and treatment areas; session 4: human and material resources; session 5: preparation of an exercise; session 6: implementation of a full-scale exercise in a volunteer museum). In parallel with the method, various tools were developed to help museums in the drafting of their document and thus to harmonize the different supports on a national scale: a model safeguard plan, an automatic prioritization assistance application, a guide to computerizing safeguard plans. This work has made it possible to support approximately 200 museums in different regions of France (out of the 1220 museums labelled as “Musée de France”), free of charge and for a period of 3 years; to create links with the emergency services; to identify national referents for both heritage (archives, museums, libraries) and emergency services (each departmental fire and emergency service has since

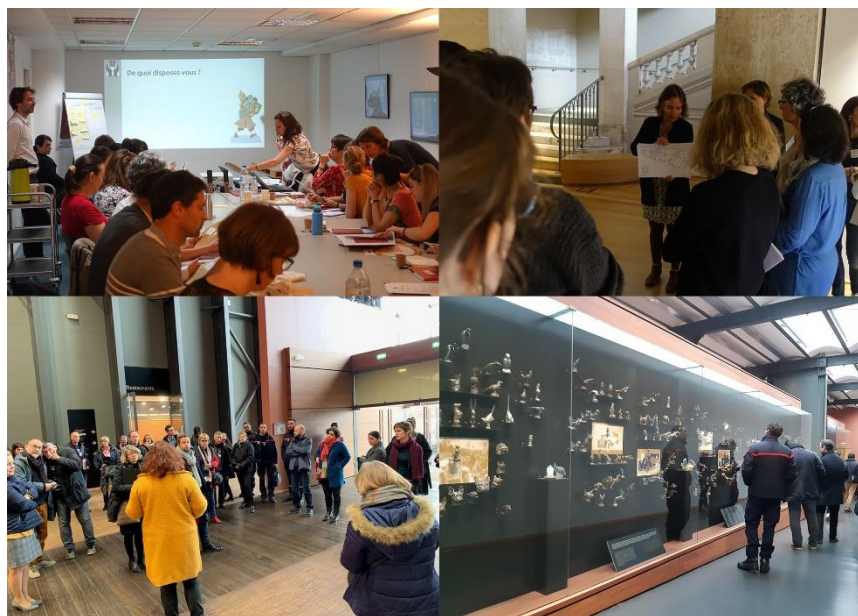
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(organisation of emergency services); in 2006 it became “organisation de la réponse de sécurité civile” (organisation of the civil protection response). The acronym ORSEC is now widely used by first-aid workers, and must be supplemented either by the name of the associated function (Orsec-Novi, Orsec-hébergement, etc.) or the risk being dealt with (Orsec-inondation, Orsec-cyclone, Orsec-accident ferroviaire, etc.). The name ORSEC is gradually being used to encompass all names such as “rescue plan”, “emergency plan” or “specialised rescue plan”. Source: <https://www.interieur.gouv.fr/Le-ministere/Securite-civile/Documentation-technique/Planification-et-exercices-de-Securite-civile>

## “Culture, Rescue: all hands on deck!”: National authorities to assist in drafting emergency plans to protect cultural heritage

identified a “heritage referent” at the request of the Ministry of the Interior); to share practices and inter-professional knowledge.

These workshops have also been exported internationally, notably to Belgium and more recently to the Principality of Monaco.



*Photos of the different workshops between 2019 and 2022 @ Jocelyn Périllat-Mercerot*

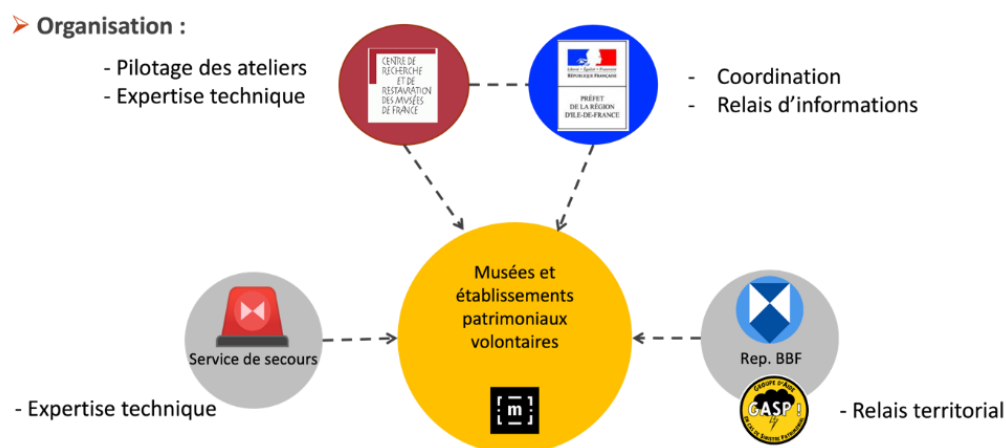
In 2022, approximately 35% of establishments had a safeguard plan. In view of the need and the challenges linked to the “new risks” generated by climate change, it became urgent to extend the method more widely.

Thus, since 2023, the workshops have been held in the form of a webinar open to all interested establishments and emergency services. Approximately 720 people take part every two months (all regions combined, including overseas territories and foreign trainees), while maintaining the foundations of the initiative, i.e., the method and inter-professional collaboration. These webinars are the subject of replays that make it possible to perpetuate the information and raise awareness among the greatest number of people, both professionals and students. By 2024, the Ministry of Culture hopes that 50% of the museums in France will have their own safeguarding plan. Concurrently, major efforts have been made to equip cathedrals with this system, following the fire at Notre-Dame Cathedral in 2019, as well as in archives and libraries. A real convergence<sup>10</sup> of forces between heritage and emergency services has gradually been established to weave a solid network that should contribute to the resilience of heritage in times of crisis. The Chantilly symposium on April 13

<sup>10</sup> <https://eur-lex.europa.eu/legal-content/FR/TXT/PDF/?uri=CELEX:32007L0060&from=SK>

and 14, 2023 is the culmination of this process and will mark the history of heritage protection in France.

Although the “revolution” is underway, we still need to keep it low-key in view of the challenges that await us collectively. The recent report by the *Cour des Comptes* in November 2022 addressing the risk of a 100-year flood in Paris is a reminder that, despite the many efforts now being made, institutions remain insufficiently prepared. In the National Climate Change Adaptation Plan (PNACC 2018-2022), the Ministry of Ecology calls for “new risks” to be taken into account in safeguard plans that partially exist. From a national point of view, important coordination work between services must be envisaged in order to respond to territorial crises. Finally, in the face of geopolitical instability, it is also necessary to work on the recommendations of the Hague Convention, in particular by relying on the military sector. Far from being an end in itself, the drafting of safeguard plans encourages collective, interprofessional reflection, in which unity is strength.



*Workshops organisation diagram by Marie Courselaud*



# RESPONSE

## State-of-the-art and user-friendly technologies for assessing damages on heritage

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Dealing with emergencies to secure and safeguard cultural heritage requires the use of rapidly deployable cognitive tools to gather information and data useful for assessing the consistency and quality of damaged assets. This is in order to undertake measures to reduce the risk of loss of cultural value, following disasters, through an appropriate, rapid and sustainable response methodology as well as to efficiently document damages, have comparable data and make risk-informed decisions for recovery. The terms of reference for comparing different tools and application systems consist in the ability to define or not procedures for data collection retrieval and analyse according to a methodological framework that translates into ease of restitution, standardisation, processing and evaluation to assist in decision-making by ensuring the widest possible use, including a multi-risk perspective.

Bearing in mind the above considerations, here are presented three applications by three PROCULTHER-NET Partners to enable the collection of cultural heritage damage and risk data following the occurrence of emergency events. When compared, the three applications are very similar and, in many ways, even complementary. However, a few distinct features provide suggestions and space to further improve the operability of these tools that have become essential to support the work of experts in the field today, especially in the face of intensifying disasters and increasing climate change impacts.

While the applications of *the International Centre for the Study of the Preservation and Restoration of Cultural Property*- ICCROM and of the *Germany Archaeological Institute* -DAI were tested outside of the PROCULTHER-NET project, on the other hand, the application by the *Italian Civil Protection Department* - DPC was developed within the predecessor project PROCULTHER and represents the implementation of paper forms for the “templates” - contained in the document [“Key Elements of a European Methodology to Address the Protection of Cultural Heritage during Emergencies”](#) - for the collection of cultural heritage data following emergencies elaborated within the same project jointly with the partners.

## Collection of digital data on the field for the assessment of damage to cultural heritage

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*Authors: Pierluigi Cara, GIS Senior analyst, and Cosmo Mercuri, Architect, Italian Presidency of the Council of Ministers - Civil Protection Department - DPC*

### 1. Introduction

The methodological document "Key elements of a European methodology to address the protection of cultural heritage during emergencies" (PROCULTHER, 2021) features a specific section dedicated to the survey of damage on tangible and intangible cultural heritage, in which model sheets (templates), including the procedure for their correct compilation, are provided to facilitate the collection of data on the field.

This year (2023), in the framework of the new PROCULTHER-NET Project, two editions of the first European interdisciplinary course entirely dedicated to the protection of cultural heritage at risk were held in March.

The course provided a valuable opportunity for 60 participants, experts in risk management, civil protection, and cultural heritage representing as many as 24 countries of the Union Civil Protection Mechanism, as well as professionals belonging to the United Nations and Non-Governmental and Humanitarian Organizations, to interact and exchange views and experiences on the subject. During the practical exercises carried out during the course, the techniques and measures for the protection of cultural heritage explored in depth during the classroom lectures were applied and the templates of the Methodology (PROCULTHER, 2021) were used, including the version freely downloadable via app.

### 2. The need

The templates created as part of the EU PROCULTHER Project originate from the need to define European standards in order to be able to systematically record and assess the risks and damages that may affect cultural heritage as a result of the impact of natural and anthropogenic events, and to facilitate the resulting decision-making processes capable of generating appropriate responses and effective recovery actions. In particular, it was envisioned to create tools that can be used by a group of specially trained experts belonging to the Union Civil Protection Mechanism (UCPM)<sup>11</sup> in order to support the needs and capacities of potential beneficiary countries in the event of disasters affecting their cultural heritage.

Starting from existing examples (such as, for example, those provided in Italy by the Ministry of Culture (MiC, 2015), and others developed internationally<sup>12</sup>), as well as from lessons

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<sup>11</sup> The Mechanism is a cooperation tool between EU countries and the 8 participating States in the field of civil protection, established by the Commission since 2001, to improve disaster prevention, preparedness and response [https://civil-protection-humanitarian-aid.ec.europa.eu/what/civil-protection/eu-civil-protection-mechanism\\_en](https://civil-protection-humanitarian-aid.ec.europa.eu/what/civil-protection/eu-civil-protection-mechanism_en)

<sup>12</sup> For example, those developed by ICCROM [https://www.iccrom.org/sites/default/files/2018-10/fac\\_toolkit\\_print\\_oct-2018\\_final.pdf](https://www.iccrom.org/sites/default/files/2018-10/fac_toolkit_print_oct-2018_final.pdf)

learned in some cases of emergency management or during dedicated exercises, in (PROCULTHER, 2021) precisely 7 templates have been created to enable an organized collection of data on cultural heritage in order to define urgent protection and recovery measures. They can be a standard reference model in case of lack of others and local authorities recognize the need to use them, or they can complement for specific aspects or activities other data collection tools already in use.

Since their implementation and publication, however, these models have not been able to be effectively tested. The international course at UCPM level mentioned earlier was the first time of their actual use (although in an exercise setting), and, furthermore, it also seemed appropriate to provide alongside their paper edition a digital version, so that the models' effectiveness and real usability could be fully assessed.

### 3. The solution

The ESRI Survey123 app freely downloadable from the ArcGIS Enterprise platform of the Civil Protection Department was used to carry out the automated survey for the above-mentioned Interdisciplinary Course. The adopted solution made it possible to implement the survey at no additional cost and in a short time, in accordance with the organizational diagram provided for the Methodology Templates (PROCULTHER, 2021, pp.120-150).

In figure 1, the diagram shows the three consecutive steps for the conduction of the survey:

1. collection of basic information;
2. assessment of impact and damage;
3. identification of protective measures to be taken.

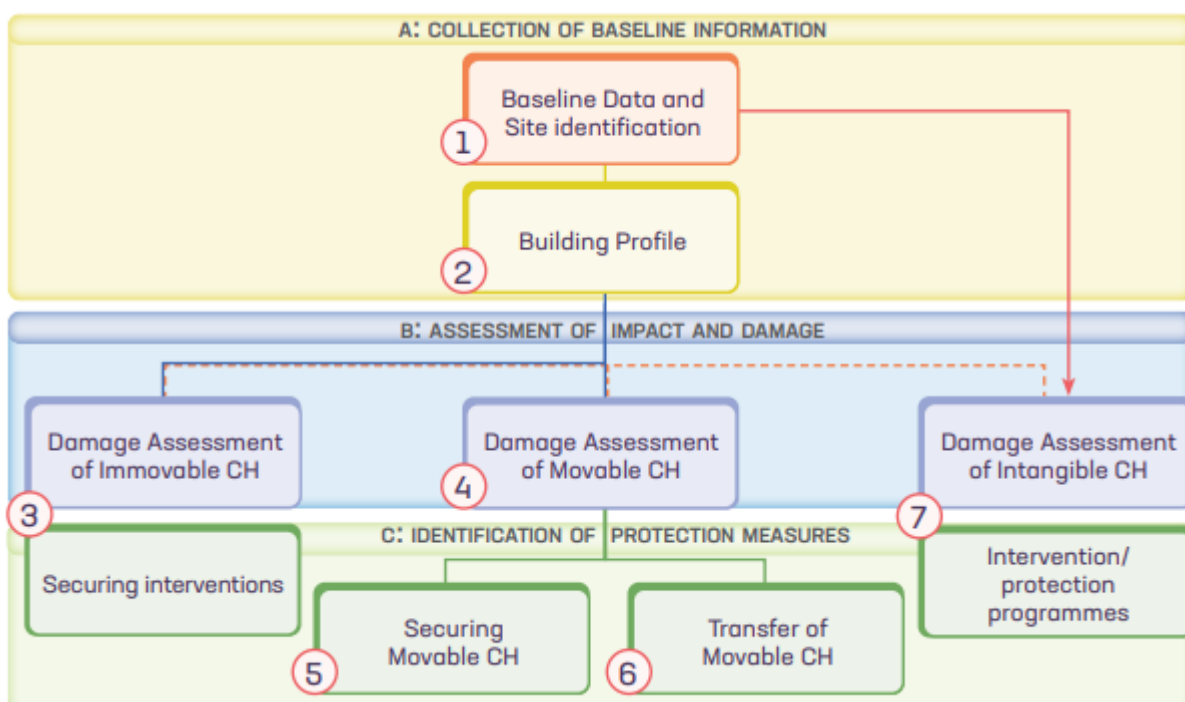


Fig. 1 Template and sequence of activities (the red circles indicate the different Templates)

Source: PROCULTHER, 2021, p.122

While the first action is common for any type of survey on "cultural heritage asset"<sup>13</sup>, the others differ according to the type of asset. The full implementation of the survey according to the methodology (PROCULTHER, 2021) provided for the three actions mentioned, thus involves the compilation of a maximum of 7 sheets. In the diagram in Figure 1, the linking elements between the different sheets, in the different implementation stages, are also visible. Three compilation methods can thus be identified according to the type of cultural heritage asset:

- Immovable cultural heritage: Sheet 1 - Site, Sheet 2 - Building, Sheet 3- Damage assessment and safety action;
- Movable cultural heritage (contained within a "container" building): Sheet 1 - Site, Sheet 2 - Building, Sheet 4- Damage assessment, Sheet 5- Securing and Sheet 6- Relocation;
- Intangible cultural heritage: Sheet 1 - Site, Sheet 2 - Building (optional), Sheet 4 - Damage Assessment (of a movable cultural heritage asset, also optional) and Sheet 7- Damage Assessment and Interventions/Protection Programs.

Within the various sheets, in addition to the reports just seen, a series of link codes have been provided, shared with the Emergency Coordination Centre and related to any additional identification codes provided in the cataloguing systems -where present-, implemented at the level of the State affected by the emergency.

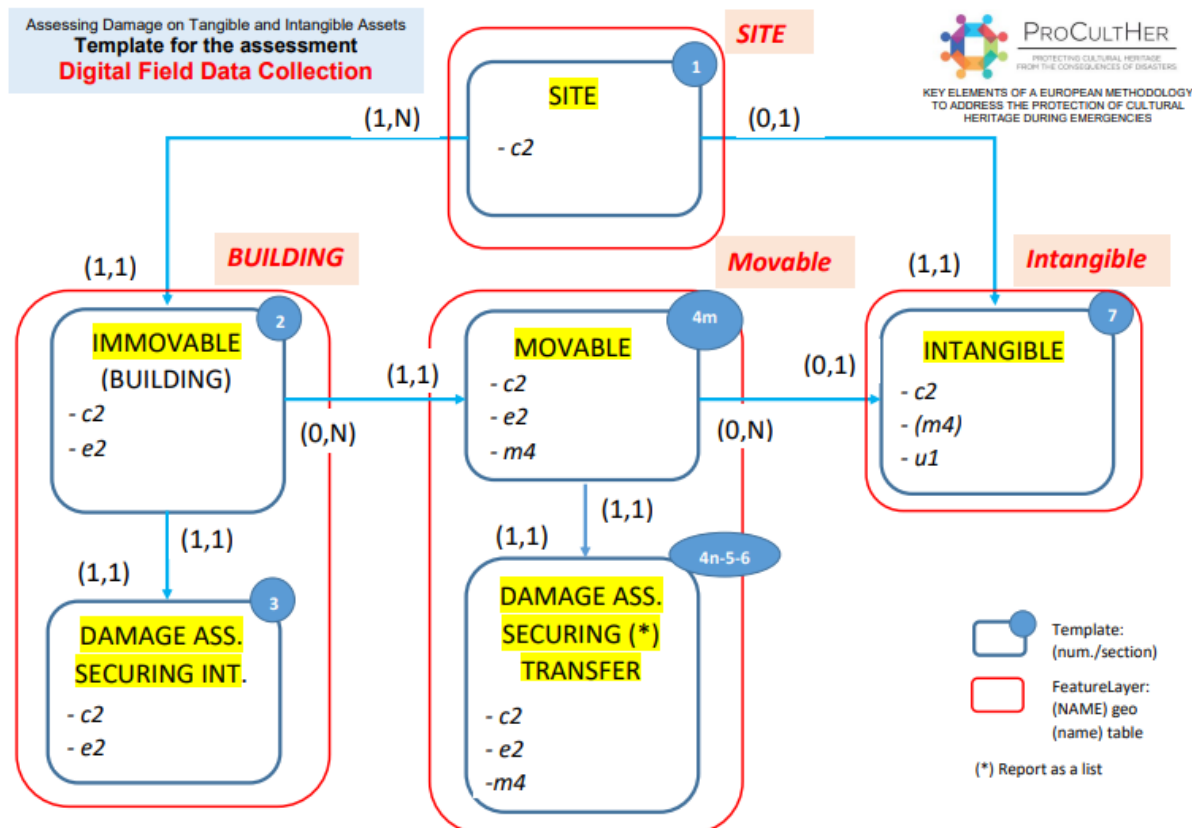


Fig. 2 Logical/conceptual diagram of automated data collection using Survey123 Source: author's concept note

<sup>13</sup> With the exception of the "intangible" asset which can also be detected regardless of its location in a specific building, as - more generally - associated with the "site", in which it occurs.



When implementing the Survey, it was decided to ensure compliance with the diagram of Figure 1. In this way, a unified compilation was created that could ensure the same compilation process for each of the three specific areas, according to the different type of asset.

The diagram of Figure 2, shows how the 7 elements -corresponding to the relevant sheets of the Methodology (PROCULTHER, 2021)-, give rise to a data structure consisting of 2 geographical Feature layers (related to Site and Building(s)) and two tables (related to movable assets and intangible assets).

From the applicant's user experience point of view, the correct orientation is established through the choice of particular "browsing" options enabling access to the sub-sections of which the various tabs are composed. Appropriate keys facilitate the orderly compilation of multiple cases of buildings within the same site and multiple ones of movable assets within the same building at a single site, as well as the compilation of multiple cases of intangible assets within the same site or referring to a movable asset contained in a specific building at a particular site.

From an operational point of view, the Survey123 app allows the selection of multiple languages both the compilation purposes, and the user, therefore, offers (in addition to English, indicated as the "default" language) 6 other languages, corresponding to the languages of the countries of each of the partners of the PROCULTHER-NET Project.

In addition, Report Templates were prepared - again through the general operability offered by the Survey123 app -, for printing reports related to the collected data referring, to the combination Site and Building(s), Site-Building - Movable Asset(s) and List of Movable Assets of a single Building within a Site. The choice in this case as well originates from the methodology (PROCULTHER, 2021), which precisely provides for appropriate documentation of the surveys made within the overall organization of activities and taking into account the different types of cultural heritage assets handled.

#### 4. The big change

The international course in Volterra was not only a success in itself for the wide and fruitful participation, but also the first actual application of the methodology proposed in PROCULTHER (2021), through the use in the two different exercise laboratories<sup>14</sup> of the Templates provided by the same methodology. The use of these Templates by the different teams consisted of both the compilation of the paper templates of the forms and the compilation via mobile devices of the survey prepared with the ArcGIS Survey123 app. Much remains to be done both on the side of the final development of the Templates themselves

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<sup>14</sup> For each edition of the course, two practical laboratories were carried out in the field, respectively on immovable and movable cultural heritage. The laboratory on immovable heritage took place in both editions of the course at the monumental complex of the Badia Camaldolese <https://abbazia-camaldolese.webnode.it> near Volterra. The workshop on movable cultural heritage, on the other hand, saw two different locations for the two editions. In the first edition, it took place in Piazza dei Priori ([https://www.comune.volterra.pi.it/Palazzo\\_dei\\_Priori](https://www.comune.volterra.pi.it/Palazzo_dei_Priori)), between Palazzo Pretorio and Palazzo dei Priori. In the second, instead, it took place in the Pinacoteca [https://www.comune.volterra.pi.it/Pinacoteca\\_civica](https://www.comune.volterra.pi.it/Pinacoteca_civica).

and on the side of their full experimentation. However, the revolution created by the possibility of conducting a survey through the use of a digital tool is undeniable. First of all, the various users, from a total of 24 countries were able to make the best use of the app through the possibility of having the interface in 6 other languages besides English. Second, all the data collected were centralized and displayed in real time in a summary dashboard. Finally, both the teams and the team of examiners were provided with data summary reports so that they could document and evaluate their work, including photographic and documentary material collected by the teams during the survey.

## Data acquisition and data management for the emergency rescue of cultural heritage

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*Authors: Elvira Iacono, Research Assistant, and Bernhard Fritsch, Data Manager, German Archaeological Institute - DAI*

Emergency rescue of built or movable cultural heritage in the event of a disaster involves the collection of potentially large amounts of information. In order to process this data, the KulturGutRetter project (KGR - Cultural Heritage Rescue Unit) is developing a workflow based on the use of mobile devices for data collection and an easy-to-use system for final data management during response operations. This concept not only takes into account the documentation of movable or immovable cultural heritage, but also the tracking of the processes carried out in the handling of cultural objects in the different rescue phases. In addition, once the fieldwork is completed, the information is then synchronized and processed for further use of the data.

### 1. Introduction

In the [KGR project](#)<sup>15</sup>, a cooperation between the German Archaeological Institute (DAI), the German Federal Agency for Technical Relief (THW) and the Leibniz Center for Archaeology (LEIZA), various fields of expertise are represented, covering all elements of an emergency response operation: from documenting the damage to the affected cultural heritage, to salvaging the objects, cleaning, restoring or shoring them, and sorting and storing the cultural heritage.

Each of these steps generates specific data. The guiding idea is to record all this data in a structured way so that it is possible, at any time, to reconstruct the current condition of an object as well as its condition at the time of salvage.

To achieve this goal, the 'QField' app is available to meet the needs of the various experts and to ensure the minimum standards required in the event of an emergency. Since QField is basically the mobile tool for the GIS system QGIS, it initially focuses on geodata. However, it is possible for anyone to create their own forms and data models for a specific project, so experts in different fields are satisfied with the possibilities to upload the objects through the app, including not only text-based information, but also photos, audio and video recordings. After the data is recorded on site, it becomes available in the digital documentation software 'Field Desktop' for all parties involved. This way, all the information collected during the mission can be handed over in one package or made available online if required.

### 2. Necessary conditions

The use of mobile devices in the field must meet certain requirements, both in terms of hardware and software. The mobile devices must be sturdy and yet light and easy to carry and operate, as well as reliable and able to process relatively large amounts of data quickly so that

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<sup>15</sup> See article "KulturGutRetter (KGR): technical characteristics of a cultural heritage response unit", in the [Technical Bulletin#1](#), March 2023

users can work consistently. To achieve this, the software must also be adapted accordingly, while meeting data entry requirements. Finally, also capable of synchronizing and combining all the data collected into a complete package.

The different work areas of the KGR project will take advantage of the opportunities presented by the use of QField in slightly different ways, or will focus on different aspects of the data entry app. Nonetheless, individual datasets will be linked by a common ID system, and in most cases by their geographic data. While linking geospatial data information is the basic function of QField, a specific ID system will be built in parallel, based on the use of UUIDs (Universally Unique Identifier), also including the use of QR codes.

As part of the project, a credit card-sized card was developed that can be attached to any movable cultural asset, thus enriching a photo with a (small) scale and a color table. Moreover, via the imprinted UUID - repeated once in plain text and once in the form of a QR code - the object is directly linked to the corresponding data set, which can be accessed by scanning the QR code in the app. In addition to the content designations, immovable cultural heritage is identified uniquely by UUIDs.



*Examples of movable heritage connected to a UUID via QR code © Eva Götting*

However, as soon as a conversion from immovable to movable cultural heritage takes place, for example when an architectural piece is recovered, this object is also tagged with a map and a QR code.

This system forms the basic framework for unambiguously assigning all objects and data with the help of QField and documenting them in a retrievable manner.

Finally, to store the huge amounts of data and make them easy to understand and use, the documentation system Field Desktop is used. This software was originally developed at the DAI for the documentation of excavations, but has already proven its worth for a wider range

of data collection. The system has also recently been used to teach culture professionals in Ukraine how to document endangered immovable heritage. In addition to a reduced view of spatial data, the advantage is good photo management and a clear interface that focuses only on what is necessary - even though much more would be technically possible, but of no greater value in an emergency.

### 3. Movable and immovable cultural heritage

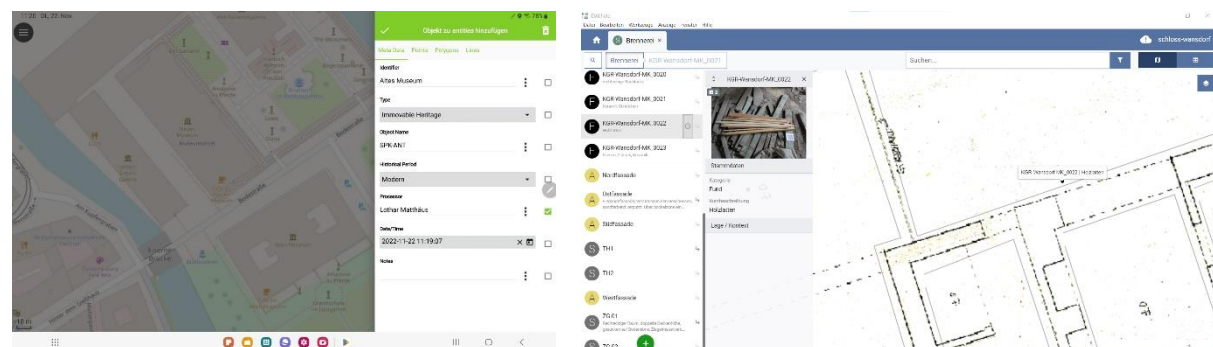
The main advantage of the app's use is the recording of the cultural heritage affected by a disaster. This part is handled by experts trained in different fields, who use different methods and terminologies accordingly. These different backgrounds need to join together and find a common ground in the QField data model, while the experts will also partly work in different forms and tabs, synchronizing each work unit's data.

For the documentation of immovable heritage, it is first and foremost important to map the object under investigation and then to add information about it with further details about damage, condition and the measures that need to be taken to secure the object. Locating and uniquely naming the position at this stage is also critical, as this information will also be used within the app as the basis for locating the movable heritage.

The use of drop-down menus or radio buttons as widgets help to dynamically document the actions that are envisioned or have been performed in relation to these objects, and are also a very good tool to avoid spelling errors or number twists.

In addition to basic documentation, as per immovable heritage, the app must perform some additional tasks for movable heritage. The steps linked to the use of a field laboratory<sup>16</sup> for cleaning and, if necessary, restoring the objects on site must also be documented. Within this workflow, the objects go through different stages (documenting, dry- and/or wet-cleaning, stabilization measures, packing...) where they are treated by different experts. Therefore, the data from each station must be passed on to the next station. The use of QR codes and the establishment of a local network rely on the infrastructure needed to support the QField.

The textual information is entered into forms that are predefined by the various units. These forms are designed to meet standard requirements, but - if really necessary - it is also possible



*Left: interface of QField on a mobile device, right: interface of Field Desktop @ Bernhard Fritsch*

<sup>16</sup> See article "Providing first-aid to movable cultural heritage: a modular table system", in the [Technical Bulletin#1](#), March 2023

to add fields during the response operation itself, by editing the basic QGIS project, which is then distributed to the mobile devices. In cases where it is not possible to enter text information or when more space is needed, audio and video recordings can also be made and added to the respective record.

Overall, the single dataset contains the same data structure for both types of objects - movable and immovable heritage - and can be stored in a digital project for a response operation. Each object is uniquely identified by a UUID, which can also be displayed in the form of a QR code, and is linked to spatial information to record the closest possible location and track changes in location during the mission. This data structure can be easily exported to other software environments for further use or archiving.

#### 4. QField

The QField app can be considered as the mobile extension of the open- source geographic information system QGIS. This means that all settings and forms to be used in the field using mobile devices with QField installed must be prepared as a single project in QGIS. The project is then transferred to the mobile device where it can be populated with data. To merge all the information from different devices, the project from each device is transferred back to the same QGIS project and can then again be copied to the mobile device, including all the data from the other tablets or smartphones. This workflow can also be simplified by using a cloud solution to synchronize the projects on the different devices simultaneously, but this requires a somewhat more sophisticated infrastructure setup that probably cannot be guaranteed in the field - but should be used whenever possible.

Using a mobile workstation (on which QGIS is installed) as the centerpiece for digital documentation in the field provides an effective way to work with a range of mobile devices and the app QField.

In any case, it is possible to capture data in an offline environment. The main project file can be populated manually via wired connections between the mobile devices and the workstation. When possible, the use of a local network and the ability to synchronize all devices online (i.e., without connecting to the World Wide Web) help to work faster and more accurately, as there is less chance of errors.

#### 5. Field Desktop

For several years now, the Field Desktop software has been developed within the DAI as a digital documentation system for archaeological excavations. It has been found that Field Desktop also meets all the requirements to create a self-contained data package for safeguarding cultural heritage. The application has recently been translated into Ukrainian and is currently being used to train local experts in the documentation of endangered cultural heritage. The data structure used for field data collection (with QField) can be clearly mapped here, and the program provides strong photo management in conjunction with individual datasets and the corresponding basic spatial information. Like QField, the software is open source, so any third party who receives the data can open and edit it without needing knowledge of working with a complex GIS environment.

### 6. Conclusion

Digital tools are an essential part of the overall workflow currently being developed for cultural heritage emergency response as part of the KGR project. The advantages are clearly in the fast and accurate acquisition of a large amount of necessary data in a very structured way, so that this data can be easily used, even after the completion of the work in the field. So, the final goal besides obtaining all the necessary information while working on cultural heritage rescue is to have a final data package that can be handed over to the hosting institution and can be easily read and edited by others.

The QField app for field work and Field Desktop for data delivery were chosen to implement data collection and management not only because they meet all the technical requirements, but also because they are becoming increasingly popular in the archaeological community. There is thus a chance that the experts who will participate in the KGR project are already familiar with these apps or similar systems. This will also help to speed up procedures in an emergency situation and successfully complete a mission.

### 7. Comment

The workflow described here needs the software QGIS with version 3.30 as a minimum requirement in order to use the audio- and video recording functions. Likewise, QField version 2.8 offers new improvements to perform the tasks needed. For both programs an active community keeps constantly developing new versions which will also help to improve the work of the CHRU unit.

Field Desktop offers the Ukrainian language support from version 3.0 and is also been maintained. In order to take pictures with the tablet and an external camera, an extra app is needed for some devices to control the camera remotely since Android 11 due to security reasons by Google.

# RESPONSE

## Assessing damages and risks to heritage post emergencies - now enabled by a web and mobile-based app customized by ICCROM-FAR

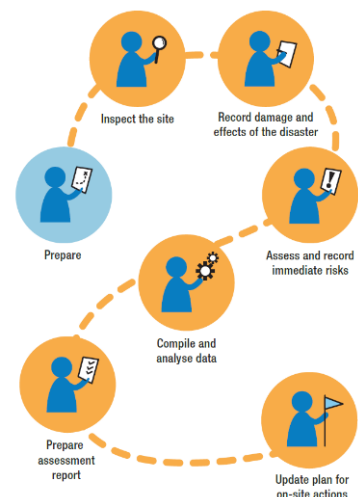
*Authors: Jui Ambani, Programme Assistant, and Aparna Tandon, Senior Programme Leader, First Aid and Resilience for Cultural Heritage in Times of Crisis (FAR) Programme, ICCROM*

What first steps can cultural heritage professionals take to safeguard heritage in the face of a devastating disaster?

Post-event on-site damage and risk assessment is among one of the first steps to secure endangered heritage following an emergency. It offers a wide lens for collecting site-specific heritage-based damage and risk data, identify and prioritise actions, estimate the funds, resources and supplies needed, as well as enhance preparedness by mitigating immediate risks.

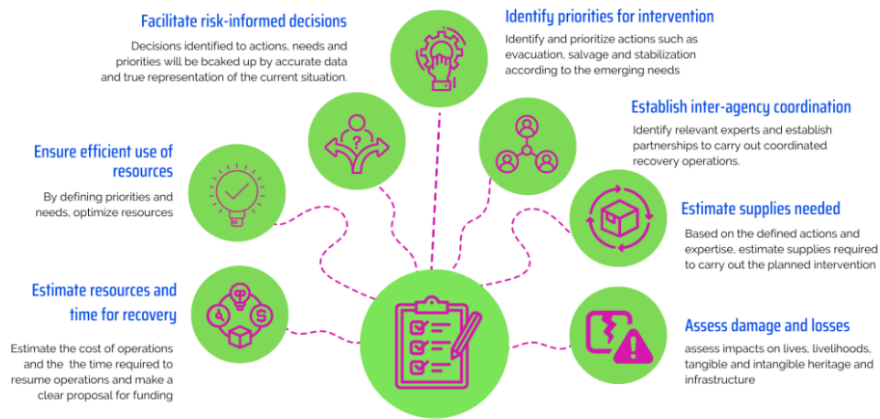
### What is Damage and Risk Assessment and when do we undertake it?

Often following an emergency, the responders rightly focus on saving lives and getting a better understanding of the scope of the emergency, as well as identify if there are associated secondary risks such as aftershocks or flash floods, fire, etc. Once the scope of emergency is established and immediate search and rescue is over, heritage professionals can begin to assess damage to heritage sites, collections and objects, as well as plan for recovery. This is a crucial point in emergency response, where based on a full picture view of the emergency, trained teams of multi-disciplinary heritage professionals can be deployed to assess damage and risk on-site, as well as verify the conditions on-the-ground.



Systematic post-event on-site damage and risk assessment is a necessary first step to ensure that efficient response mechanisms are in place, as well. In simple words, this methodology, through field-tested and contextualized forms, encourages a first-hand inspection, observation and verification of on-site damages, which feeds into the mass data provided by satellite imagery and drones. Additionally, on-site damage and risk assessment can be used to secure the necessary funds for cultural heritage first aid and recovery. Such an assessment can inform a Post-Disaster Needs Assessment (PDNA): a multi-sector assessment method, which helps affected governments to determine direct effects, long-term impacts and recovery needs in the aftermath of a large-scale disaster.





## WHY DAMAGE AND RISK ASSESSMENT?

### Preparation for on-site damage and risk assessment

**Situation Analysis:** A situation analysis is a necessary preparation for on-site damage and risk assessment. It involves a desk-based study of the size and scope of the emergency. It also helps to identify the geo-location of the affected heritage and its accessibility. Much of this information can be retrieved from local disaster management agencies, civil protection, municipality representatives, as well as local communities. Pre-event information on cultural heritage can be obtained from heritage institutions and agencies.

**Trained Teams:** It is important to have a trained team from multi-disciplinary backgrounds such as architecture, engineering, humanitarian aid, etc. as well as an estimation of adequate supplies and resources –transportation, food, water, accommodation, etc. – to deploy them on-field. Such mechanisms can feed into national, local and institutional disaster risk management plans to enhance overall preparedness to respond to a crisis.

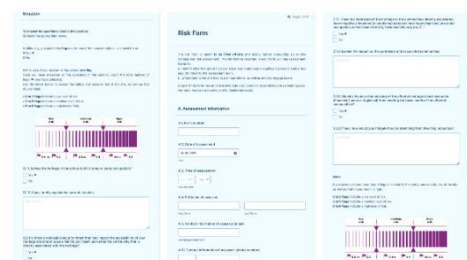
**Supplies, tools and gear:** Gather personal safety gear according to the nature of the hazard event such as helmets, torches, battery, etc. For e.g., for an on-site assessment in a flooded area, carry waterproof footwear and protective facemasks with microfilters to prevent infections. Make sure to bring pre-event reference photos, and plans.

**Forms:** Forms developed and contextualized for assessing damages and risks to heritage are divided based on hazards such as earthquakes, floods, hurricanes, wildfires, or conflicts and are tailored to the specific emergency scenarios.

The five types of forms are:

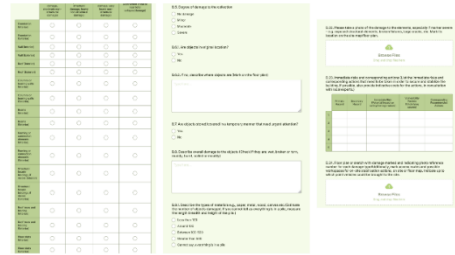
#### 1. Assessment Form for Immovable heritage

Observe, identify and record damages, as well as secondary potential secondary risks to structural and non-structural elements of a building (Stand-alone or part of a complex). You can also adapt these forms and create new categories based on types of heritage such as archaeological sites.



## 2. Assessment Form for Movable heritage

Observe, identify and record damages, as well as secondary potential secondary risks to objects or collections of objects in a museum, library, archives, etc. This form is always in coherence and reference to the immovable form.



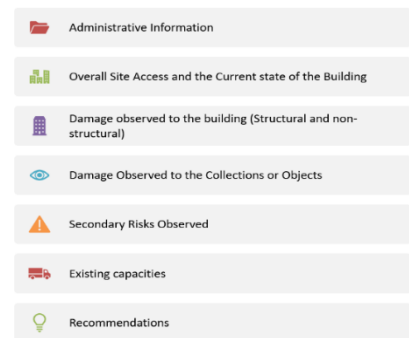
## 3. Assessment Form for Intangible heritage

Observe, identify and record damages to cultural practices, religious rituals and how the event affected the lives and livelihoods of people associated to the heritage.

## 4. Risk Form

(developed in cases of conflicts -to be filled off-line - to assess personal security and safety)

Collect risk flags and identify sites that are in high-risk areas and could pose a significant personal safety and security threat to the assessment team.



ICCROM-FAR specialises in this methodology and is experienced in helping governments to define priorities, estimate costs and recommend risk-informed interventions in the aftermath of large-scale emergencies. The Programme has a ready-to-deploy network of over 1000 cultural first aiders in more than 120 countries, as well as field-tested and published methodologies for securing and recovering endangered tangible and intangible heritage. It has trained teams on-the-ground to carry out a systematic on-site damage and risk assessment for all types of heritage, enabled by a newly customized mobile and web-based application.

### The contribution of technology enabled damage and risk assessment - ICCROM-FAR's app

For documenting damages at-scale, technologies such as satellite imagery and GIS-based tools are handy. At the same time, equipment-led technology such as 3D laser scanning and photogrammetry provide a site-by-site overview of damages. But on-site damage and risk assessment being a form-facilitated expert observation-based methodology for verification of damages, lags in scaling mass information, as well as risks losing or mismatching data due to human error.

Hence, to ensure efficient use of time and resources, as well as develop a uniform way of collecting data, employing technology-enabled tools in correspondence with expert knowledge becomes important.

ICCROM's First Aid and Resilience for Cultural Heritage in Times of Crisis (FAR) Programme's newly customized web and mobile-based app has facilitated a step-by-step rapidly implemented post-event damage and risk assessments in Ukraine, Philippines, Pakistan and Ecuador on-site and has been field-tested in over 120 sites. Hosted on a secure server, the multi-lingual app has customized damage and risk assessment forms for movable, immovable and intangible heritage and can be used both online and offline.

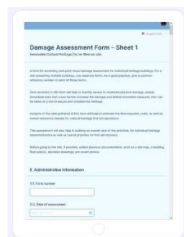
Through this app, which is now supported by a community of practitioners globally, ICCROM-FAR aims to address some gaps and ongoing challenges faced by the culture sector working in post-disaster recovery fields today. This includes helping to produce systematic, comparable and inter-operable data that can be readily, yet securely shared across sectors to aid recovery and secure damage and losses for impacted heritage. The results from the app can also facilitate visual charts, custom diagrams to support the analysis of the data collected, ensuring efficient use of experts and resources. Additionally, the data collected through these field-tested forms and the widely applicable methodology can help prioritize actions, cost interventions, as well as estimate supplies and the time required for a full recovery. Finally, the app can be customized and deployed in various contexts with their own secure server and controlled admin access.

Please note that while the app is open source, the methodology only allows trained professionals to be able to gather data. At the same time, data analysis is carried out by a pool of multi-disciplinary experts and the app simply facilitates the process.

The pilot report outlining results from damage and risk assessment done using the app at 4 heritage places in Ukraine is now available on ICCROM's official [website](#) here:

## DAMAGE AND RISK ASSESSMENT

*An Open-Source Web and Mobile-based app*



### KEY FEATURES

- Online and Offline
- Multi-lingual
- Easy-to-use
- Works on all devices
- Automates reporting

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*After a major injury, when one injures an arm, the doctors prioritize scanning of the injured section and fixing the fracture instead of performing a full body scan. By extension, this is the fundamental difference between mounting damage and risk assessment and conducting a full-fledged condition assessment.*

*Heritage professionals must arrest the damage incurred before intervening  
– to 'do no further harm'.*

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### What kind of assistance does ICCROM-FAR offer in an emergency?

In collaboration with local partner institutions working on- field, FAR has facilitated context-specific, post-event, on-site damage and risk assessments for movable, immovable and intangible heritage in the response to disaster events such as earthquakes, floods, wildfires, as well as conflicts. Through its decade-long interventions in large-scale disasters and complex emergency situations, the team has provided technical assistance in over 14 countries, including: Belgium, Brazil, Croatia, Germany, Haiti, India, Iraq, Lebanon, Myanmar, Nepal, the Philippines, South Sudan, Syria and Ukraine.

Upon specific request of the affected Member State or ICCROM partner institution, as well as for incidents involving substantive damage to cultural heritage far exceeding the capacity of the affected Member State, FAR provides:

- Context-specific rapid needs assessments and post-event damage and risk assessments for safeguarding cultural heritage.
- On-site or online training for emergency responders, civil defence personnel, heritage professionals, experts and volunteers to provide first aid to tangible and intangible heritage.
- Capacity building for planning and implementing post-disaster and post-conflict recovery and peacebuilding operations.
- Setting up interagency coordination mechanisms; and
- Sharing and translating relevant resources.

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*FAR actively seeks partners to field test the damage and risk assessment web and mobile-based applications in different emergency contexts. To learn more about our emergency response interventions, visit our [website](#) or write to the programme at [far\\_programme@iccrom.org](mailto:far_programme@iccrom.org)*

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## State-of-the-art and user-friendly technologies for assessing damages on heritage: a possible way forward

As described in this paper, the ICCROM-FAR application has been developed based on the more than 10-years on-field experience within the framework of ICCROM's Flagship programme, First Aid and Resilience for Cultural Heritage in Times of Crisis ([FAR](#)). With a network of over 1000 trained professionals across more than 120 countries, the FAR methodology aims to reduce disaster risk for tangible and intangible heritage, as well as associated communities. FAR specializes in the methodology that focuses on rapidly implementing post-event damage and risk assessments, whether conducted remotely or on-site. This app, which has been widely tested outside Europe, allows for assessments in multi-hazard contexts, while providing an on-the-ground field-tested framework to plan, design and implement first aid interventions, as well as help governments define priorities in the aftermath of large-scale emergencies and disasters.

The QField application adapted by DAI for the [KGR project](#) while drawing on its own methodology linked to the archaeological field, presents some very interesting solutions, such as additional features that allow the production of videos and detailed spatial data options through Lidar surveys. Other strengths include the availability of the "ID-cards" and QR code, which are of particular interest because of their usefulness and practicality, as well as easy replicability.

In fact, this app has more similarities with the PROCULTHER app with which it is compatible because they have similar technical features: they are both open applications that can simultaneously manage geographic and nongeographic data, online and offline data, and in which a mobile app and a centralized Web-based app for data sharing coexist.

Finally, the PROCULTHER app is the most recent one and was tested for the first time during the two editions of the first "Protecting Cultural Heritage Course-PCH" course conducted as part of the PROCULTHER-NET project in March and attended by 60 experts in risk management, civil protection and cultural heritage representing as many as 24 countries of the Union Civil Protection Mechanism, but also professionals belonging to the United Nations and nongovernmental and humanitarian organizations.<sup>17</sup>

Although there is still a need to adequately test the PROCULTHER app and train a large number of users, integrating the effective features currently available, seems to offer good potential for a comprehensive technical refinement of this tool.

In conclusion, with a view to proposing effective management of this multiplicity of tools so as to simplify and make data collection and sharing processes more efficient, it would be advisable to guarantee the interoperability and standardisation of data, i.e., to adopt common languages, shared formats, homogeneous digital data transmission protocols, according to the [FAIR principles](#) - Findability, Accessibility, Interoperability, Reusability - also mentioned in

<sup>17</sup> More on the PROCULTHER-NET Protecting Cultural Heritage Course-PCH <https://civil-protection-knowledge-network.europa.eu/news/european-training-cultural-heritage-protection-risk>

the new European Commission Implementing Regulation (EU) 2023/138 of 21 December 2022 laying down a list of specific high-value datasets and the arrangements for their publication and re-use.<sup>18</sup>

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<sup>18</sup> European Commission Implementing Regulation (EU) 2023/138 of 21 December 2022 laying down a list of specific high-value datasets and the arrangements for their publication and re-use. <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023R0138&from=EN>

# RESPONSE

## Post-seismic assessment of cultural heritage buildings: experimental and real case of use of the LiDAR

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*Authors: Stefano Marsella, Central Director for Logistics and Instrumental Resources, and Marcello Marzoli, LiDAR WG, Ministry of Interior, Italian National Fire and Rescue Service (CNVVF)*

Italy has an incredible wealth of historical and cultural heritage buildings and monuments scattered throughout the National territory. The same territory is subject to seismic risk, albeit with different levels of exposure. Therefore, the frequent earthquakes that affect the country, also concern historic buildings and structures of cultural interest, which has led the Italian National Fire and Rescue Service (CNVVF) over the years to progressively improve its operational capacity, in terms of personnel training, operating procedures and technological innovation.

Among the various activities that the civil protection system implements immediately after a seismic event, the most urgent is to rescue the people at risk and ensure their safety following which, operations to prevent the buildings of historical and cultural heritage from further damage and collapse caused by the aftershocks are carried out. These tasks are performed by the CNVVF which, in all areas where there is a danger to operators and citizens, is responsible for the necessary rescue and safety measures. Among these measures, the installation of provisional works, designed to prevent further damage to damaged but not collapsed structures, is particularly complex. Moreover, such provisional works are designed to ensure the buildings' stability in the short term, before further works are implemented to ensure long term stability; such installations remain quite often in place for a much longer period, and are also subject to aftershocks: circumstances which raise the need to ensure the effectiveness of provisional works over time vs. the residual stability of the targeted building. Considering that provisional works are carried out on damaged structures, the assessment of the provisional works' effectiveness over time cannot rely on the usual features of integrity, continuity and verticality of the structure, which were obviously lacking even at the time of the works design, but will have to leverage on the comparison between the actual condition of the structure vs. the condition of the same structure prior to the provisional works' installation.

Similarly, it is possible to make use of software applications licensed to CNVVF to reassess the stability of structures subject to the stress of aftershocks, facilitating the rapid comparison of damages on two 3D point clouds of the same structure acquired at different times.

The target use case foresees that the 3D point cloud acquired with the first assessment is stored in a dedicated cloud (presently available here: <https://pointclouds.vigilfuoco.it/welcome>). So that, while the seismic swarms strike the same structure, it is possible to rapidly reiterate the 3D point cloud acquisition and leverage on the functionalities, which allow quantitative measures (e.g., distances and angles), to compare the size of the damages on 3D point clouds acquired at different times. By implementing such a procedure, it is possible to assess the aftershocks' impact on the structure leveraging on

quantitative measures (e.g., ignoring the previous unaltered damages or measuring the increase of length of cracks, as demonstrated in the framework of the EU H2020 research and innovation action STORM (*Safeguarding Cultural Heritage through Technical and Organisational Resources Management*) trial staged into the Aula I of the Terme di Diocleziano in Rome (Fig. 1 and Fig. 2).



Fig. 1 Terme di Diocleziano (Rome): length of crack A at T0 © Vigili del Fuoco



Fig. 2 Terme di Diocleziano (Rome): length of crack A at T1 © Vigili del Fuoco

From the follow-up analysis of the trial, it became evident that the worst limitation to the comparison of point clouds acquired at different times is the actual and timely availability of a 3D point cloud acquired previously. Which, in turn, requires to adequately justify the effort spent to acquire point clouds when first assessing the stability of cultural heritage structures. This dilemma is solved at least in a few use cases: 1) when CNVVF and cultural heritage experts cooperate in designing and installing provisional works, 2) when CNVVF assess the safety of cultural heritage operators who need to access historical and cultural buildings located within the red areas, and 3) when provisional works have to be prioritised and their design requires accurate measurements by the surveyor experts.





The first case was triggered by the well-established civil protection cooperation with CNVVF and Ministry of Culture in designing and installing provisional works for historical and cultural buildings damaged by earthquakes (to leverage on both the cultural heritage experts' deep knowledge of the damaged buildings and the expertise of CNVVF in designing and installing provisional works). In the 2009 L'Aquila earthquake the design of the provisional works was agreed upon through the exchange of reference photos, which, although apparently a simple operation, supported the remote cooperation on installation of works very efficiently. (Fig. 3 and Fig. 4).

*Fig. 3 Church of San Domenico (L'Aquila): design of provisional works © Vigili del Fuoco*



*Fig. 4 Church of San Domenico (L'Aquila): Implemented provisional works © Vigili del Fuoco*

It was soon evident that such cooperation could be better supported by a CNVVF procedure, which foresaw to acquire 3D point clouds, to be uploaded and shared on a dedicated cloud-based server provided with web-based SW application, presenting functionalities for quantitative assessment (e.g., measurement of distances and angles), as well as shared annotations, so as to support cooperative remote design (Fig. 5).



Fig. 5 Terme di Diocleziano (Rome): remote cooperation between CNVVF and cultural heritage experts © Vigili del Fuoco

The second case is justified by the difficulty of reconciling the exclusive responsibility of the Ministry of Culture operators in the protection of cultural heritage, with the exclusive responsibility of the CNVVF to ensure the safety of rescuers and technicians operating in red areas, including those embedding historical and cultural buildings. Such use case found a suitable solution in the procedure proposed for the first use case.

The third use case concerns the prioritisation of provisional works of cultural heritage and the need of accurate surveyor measurements of the cultural heritage (often not consistent) for their design. In fact, the acquisition of the 3D point cloud of a prospect (e.g., a church



Fig. 6 Santa Maria Argentea (Norcia): facade damages © Vigili del Fuoco

façade) could be a matter of half an hour, and could bring high-value outcomes, e.g., to quantitatively assess displacements of the verticality of large surfaces. This was clearly demonstrated in the framework of the trial at the Cathedral of Santa Maria Argentea in Norcia, heavily damaged by the earthquake of 30 October 2016 (see Fig. 6). In fact, notwithstanding the sturdy structures of the provisional works acting as obstacles, it was possible to acquire a single setup scan and process it to generate a colour-scale picture, which most clearly highlighted that the top of the façade jugged out of 20 cm circa, when compared with its base (Fig. 7).



Fig. 7 Santa Maria Argentea (Norcia): facade displacements © Vigili del Fuoco

Having completed a sequence of engaging trials, in 2020 the CNVVF launched two important initiatives to improve its operational capacity in the sector of 3D surveys supporting emergency assessments of buildings damaged by earthquakes:

- having signed the Memorandum of Understanding (MoU) with the *Soprintendenza Archeologia, Belle Arti e Paesaggio per la Città dell'Aquila e i Comuni del Cratere* (the Authority set up to ensure safety of cultural heritage damaged by the 2009 earthquake that devastated the city of L'Aquila and the surrounding area), the CNVVF delivered 3D surveys of three churches damaged by the 2009 earthquake. Then, in the framework of the agreement signed with the University of L'Aquila, further activities were kicked-off to validate the survey procedure adopted by the CNVVF. This agreement proved to be pivotal for the CNVVF capacity, since it was possible to stage trials in the red area of Fossa (L'Aquila), whose town centre is sadly still to be rebuilt and represents quite accurately the environment where rescuers have to operate in the very first phase of seismic emergencies. In the course of those trials, firemen and researches together carried out assessment activities rigorously designed according to the most realistic scenarios, whose first outcomes (documented in peer-reviewed scientific articles) constitute the sound basis over which the CNVVF operational procedures are being validated (Fig. 8).

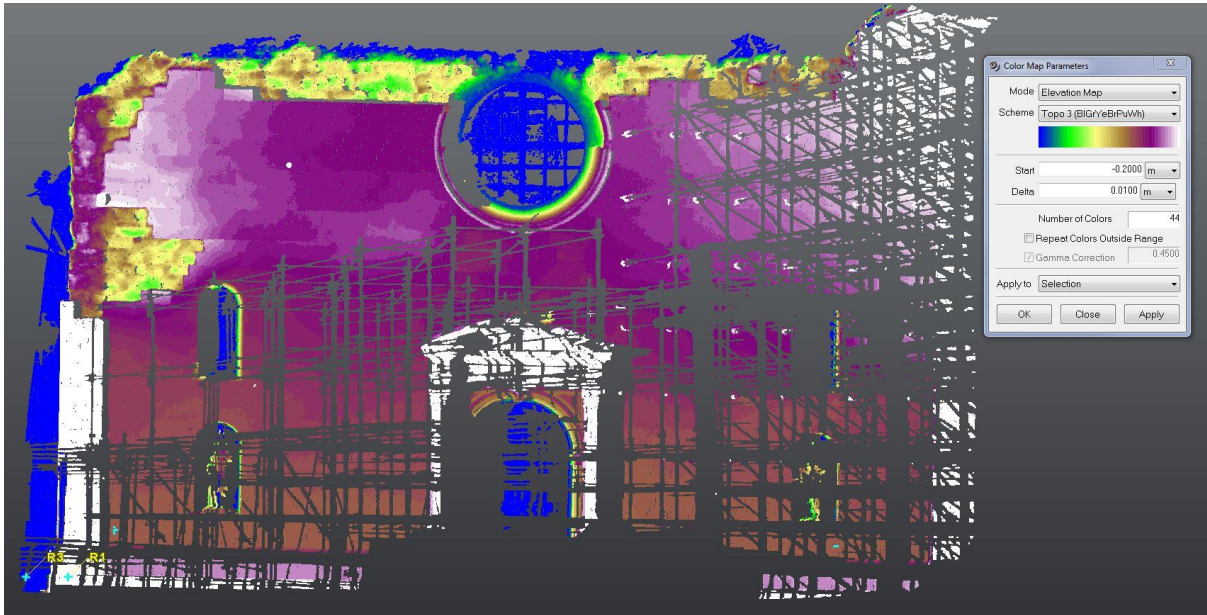


Fig. 8 Fossa (L'Aquila): validation outcomes © Vigili del Fuoco

- In 2020, a further MoU was agreed upon and signed by CNVVF and the *Sacro Convento* of Assisi, in the framework of which, CNVVF employed laser scanner instruments to acquire a complete and accurate georeferenced 3D point cloud of the compound. In fact, the *Sacro Convento* offered the opportunity to test the survey procedure in a set of buildings that virtually presents all the operative scenarios that the CNVVF can face when historical buildings are affected (e.g., underground and elevated environments, bearing structures in stone, brick and timber, frescoed surfaces, environments covered by vaults and roofs). The following figures can summarise the extent of the activities carried out: 2,300 set-up scans, more than 78 billion points recorded, 2.3 Tb of acquired data, 6.9 Tb of memory commitment for post-production storage, 90 scans per session, 270 person/days for scans, 50 person/days for post-production. Since Assisi's *Sacro Convento* has a unique structure of its kind, in terms of dimensions that find few equals, its survey will remain in all probability a "unicum", from which the CNVVF has gained an enormous experience in terms of ability to initially design the survey and awareness of its impact on the needed resources, hardware architecture design, adequate dimensioning of data storage systems and early identification of the most appropriate software to employ (Fig. 9).

The CNVVF increase of operational capacity became evident soon after the Mw 4.5 earthquake which stroke Umbertide (Umbria, Italy) on 9 March 2023. The seismic event heavily damaged the bell tower of the church of San Paterniano in Pierantonio so that, to ensure the safety of the surrounding area and to preserve the CH, CNVVF were entrusted with the required provisional works, whose design was greatly facilitated by the 3D point cloud of the structure acquired without delay by the CNVVF, so as to facilitate the immediate design and installation of the provisional works, as well as the restoration activities to come (Fig. 10).



*Fig. 9 Sacro Convento of Assisi: 3D point cloud perspective © Vigili del Fuoco*

The newly procured additional Laser Scanner systems, software licenses and the training of additional qualified operators will allow CNVVF to ensure timely deployment of the services depicted above overall the State territory within July 2023. As a consequence, the attention now is even more focused on the on-going initiatives to reinforce the National CNVVF IT infrastructure, so as to enable coherent storage and efficient sharing of cloud points: quite a challenging target, considering the massive data involved and the foreseeable impact in terms of needed data storage and increased bandwidth.



*Fig. 10 Acquisition of bell tower point cloud, Pierantonio (Perugia)  
© Vigili del Fuoco*

# RESPONSE

## Forest fires and cultural heritage: protection strategies in Castilla y León

*Author: Cristina Escudero, Coordinator of the Unit for Risk Management and Emergencies in Cultural Heritage (UGRECYL), Region Castilla y León - JCyL, General Directorate of Cultural Heritage and PROCULTHER-NET Focal Point for JCyL*

Forest fires are a growing risk, a catastrophe that destroys lives, property, natural heritage and cultural heritage... Is it all cultural heritage? No, this is a disaster, which affects, above all, the heritage of the rural world, which has different implications.

Its attention - or lack thereof - follows the same intricate dynamics that affect these territories. Perhaps we could point out that the situation of a cultural asset in a rural territory, unfortunately, makes it more vulnerable.

Faced with this problem, the Regional Ministry of Culture of the Junta de Castilla y León has established a series of strategies to face this challenge. The Risk and Emergency Management Unit for the Cultural Heritage of Castilla y León (UGRECYL) carries out this work. Much of its work focuses on the protection of cultural heritage in areas affected by forest fires.



*Castro of the iron age -Peña Valdemera- affected by the fire of Sierra de la Culebra, Zamora, 2022 © Román Rodríguez Calleja*

### **The Context- A formula to amplify the problem**

Large forest fires in the Mediterranean area in general, and in the Iberian Peninsula in particular, are a constantly growing problem, given the events we have been experiencing in recent years.

The scientific world has been announcing this trend derived from climate change for decades, noting that the number of days where the fire risk reaches extreme levels has increased

worldwide and has doubled in the Mediterranean basin in the last 40 years.<sup>19</sup> Therefore, although there are fewer fires, they increase in intensity, danger, and tend to affect large areas with their own dynamics, often overwhelming the capacities of the extinguishing means; these are the so-called Large Forest Fires (LFF).

However, focusing on the consequences of climate change as the only aggravating factor with regard to fires - at least in our country - is a simplistic vision; a self-interested approach that overlooks an entrenched reality. Forest fires are, above all, a problem of the rural world; a harsh reality that unfortunately, and at least in Spain, is rather far from being solved in the short or medium term.

The lack of adequate policies to reduce the existing gap between urban and rural areas translates, above all, into a lack of job opportunities and loss of quality public services in rural areas, which has led to a generalised phenomenon in our territory: the loss of population.

This neglect of the rural world and lack of generational replacement leads to the abandonment of crop fields, the cessation of livestock farming, the loss of the use of woodland, etc., which favours the uncontrolled expansion of the forest area and, therefore, a greater combustible biomass.

The increase in forest area - in continuity and extension - in a progressively disorganised territory, in which climate change-related disturbances are intensifying, are all factors that contribute to creating the ideal breeding ground for the development of large forest fires (LFFs).

LFFs are a major ecological, economic and social catastrophe with very serious and important consequences, including damage and destruction of cultural heritage.

### **Cultural Heritage in Forest Land**

The CH exposed to the destructive effects of flames belongs to all the categories contemplated, and to all the levels of protection established by law. Assets of Cultural Interest (BIC, the highest level of protection in Spain); assets that form part of the heritage inventory and, of course, World Heritage Sites declared by UNESCO -those assets or places of exceptional universal value, which transcend borders and have a special meaning and legacy in the history of humanity<sup>20</sup>-, many of which are located in forest enclaves.

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<sup>19</sup> <https://www.csic.es/es/actualidad-del-csic/el-cambio-climatico-aumenta-el-riesgo-de-incendios-forestales>

<sup>20</sup> <https://www.exteriores.gob.es/RepresentacionesPermanentes/unesco/es/UNESCO%20en%20Espana/Paginas/Inscripciones%20UNESCO/Patrimonio-Mundial.aspx#:~:text=El%20Patrimonio%20Mundial%20est%C3%A1%20integrado,la%20historia%20de%20la%20humanidad.>



*Vernacular architecture after the forest fire in Navalacruz, Avila, 2021 © Terra Levis/UGRECYL*

The typologies that may be affected are ethnographic heritage such as hermitages; traditional constructions and vernacular architecture; places of pilgrimage with associated intangible heritage (rituals, traditions or artisan production methods, among others). Architectural heritage including monasteries, castles and the collections they contain. Historical routes. Industrial heritage and, above all, archaeological heritage from all periods and cultures, both excavated and unexcavated, and especially rock art.<sup>21</sup>

However, these assets cannot be perceived in isolation; their value and importance must be considered within a broader, holistic vision, i.e., as part of a cultural landscape that has been shaped by the links and relationships established between natural heritage, cultural heritage and local communities, giving rise to an indivisible trinomial.

In this context, cultural assets are the testimonies -material and immaterial- that allow us to read and understand history; the occupation and planning of the territory, and the construction of memory by its inhabitants.

Despite its importance, and although much progress has been made in the protection of cultural heritage against threats such as earthquakes, floods, volcanoes, armed conflicts, etc., its protection against the risk of forest fires has not been sufficiently defined at a European level.<sup>22</sup>

<sup>21</sup> [https://www.fs.usda.gov/rm/pubs/rmrs\\_gtr042\\_3/rmrs\\_gtr042\\_3\\_113\\_130.pdf](https://www.fs.usda.gov/rm/pubs/rmrs_gtr042_3/rmrs_gtr042_3_113_130.pdf)  
[https://www.fs.usda.gov/rm/pubs\\_other/rmrs\\_2010\\_ryan\\_k004.pdf](https://www.fs.usda.gov/rm/pubs_other/rmrs_2010_ryan_k004.pdf)  
<https://www.theguardian.com/artanddesign/2020/feb/02/grave-fears-held-for-thousands-of-rock-art-sites-after-bushfires-lay-bare-irrevocable-damage>  
<https://www.abc.net.au/news/2020-01-08/ancient-rock-art-lost-after-plastic-walkway-explodes-in-bushfire/11848938>

<sup>22</sup> In the North American sphere, and given the willingness to protect the cultural patrimony of the Indian nations and the property right of these communities have and exercise over it, the protection of the CH against forest fires has developed more, contributing to the coordination of all the actors  
<https://www.nps.gov/articles/000/managing-cultural-resources-during-wildfires.htm>

In response to the increase and severity of the problem, many countries have begun to address strategies for the protection of heritage against forest fires, such as Australia  
[https://www.academia.edu/527953/Protecting\\_cultural\\_heritage\\_in\\_bushfire\\_prone\\_areas](https://www.academia.edu/527953/Protecting_cultural_heritage_in_bushfire_prone_areas) ;  
<https://blueshieldaustralia.org.au/news/bushfire-crisis-in-australia-update-20-january-2020/>  
<https://img1.wsimg.com/blobby/go/53760e0b-0154-4c7d-b318-b3fe5c5d4d90/downloads/Rapid-Assessment-%E2%80%93-Bushfire-Damage-to-Heritage.pdf?ver=1617237283594> country that even recovers the cultural



This is due to the lack of information and data (especially scientific) on damage and/or destruction of cultural heritage during forest fires.<sup>23</sup> Adding errors such as that the damage cannot be mitigated once it has been produced; that the archaeological sites, despite having suffered several fires throughout their history, have resisted or that the fires are beneficial since they allow the discovery of new cultural testimonies... In addition, their location in rural areas is not of media interest.



*Archaeological structures. Navalacruz forest fire Avila 2021 © Terra Levis/UGRECYL*

It finally seems that this gap can be bridged as a reaction to the severe fires we are suffering and their consequences in CH; and it should serve to answer a fundamental question: Are we prepared to respond and mitigate the vulnerability of our cultural assets to forest fires?

A forest fire is a catastrophic event of a magnitude similar to an earthquake, flood or other unforeseen disaster, for which there can and should be a planned response. Planning is the logical solution for the protection of cultural resources; but this dynamic is hampered by various factors, undoubtedly of great complexity, and requires a wide space of debate, although we can highlight the following:

- Minimization and lack of visibility of cultural heritage within the regulations of civil protection and emergencies -apart from the mere mention-; as well as in Special Plans against the risk and fight against forest fires.<sup>24</sup>
- The disassociation of the institutions responsible for the protection of cultural heritage from risk management policies.
- Lack of intersectoral collaboration and coordination.

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use of fire and the knowledge of native communities to carry out controlled burning

[https://www.nespthreatenedspecies.edu.au/media/bs4abb5v/8-2-1-empowering-indigenous-leadership-and-participation-in-bushfire-recovery-cultural-burning-and-land-management-report\\_v6.pdf](https://www.nespthreatenedspecies.edu.au/media/bs4abb5v/8-2-1-empowering-indigenous-leadership-and-participation-in-bushfire-recovery-cultural-burning-and-land-management-report_v6.pdf)

<sup>23</sup> Rui Figueiredo et al., *Understanding the Impacts of the October 2017 Portugal Wildfires on CH*

[https://www.researchgate.net/publication/354793204\\_Understanding\\_the\\_Impacts\\_of\\_the\\_October\\_2017\\_Portugal\\_Wildfires\\_on\\_Cultural\\_Heritage](https://www.researchgate.net/publication/354793204_Understanding_the_Impacts_of_the_October_2017_Portugal_Wildfires_on_Cultural_Heritage)

<sup>24</sup> In various regional Plans, we find an interesting paradox, since sometimes the need to preserve the natural heritage is highlighted, while the cultural heritage does not appear, being encompassed in assets or community assets; when the natural heritage is also part of these community assets.

### Damages and consequences: What happens to Cultural Heritage in a fire?

Damage to cultural heritage in a forest environment during the occurrence of a fire is classified into three categories, based on the work of Ryan et al. (2012)<sup>25</sup>, introducing aspects to highlight the importance of the damages generated by the extinction operations themselves in the course of emergency response activities.

Fire also affects and destroys educational structures and tourist resources associated with these heritage settings, so it is important to consider them when proposing guidelines for the recovery of the affected area.

- Direct damage or primary damage: those produced directly by high temperatures and the products and by-products of combustion. These are effects that can be observed immediately (either with the naked eye or through analytical procedures), such as the total or partial destruction of organic matter or the physicochemical transformations (thermoclasticism, reddening...) produced by the lithic materials of the architectural, archaeological structures or that support rock art.



*Damage to granite rock due to high temperatures, forest fire in archaeological area. Cerro del Berrueco, Salamanca, 2017 © UGRECYL*

- Indirect damage or secondary damage: those that take place once the fire is extinguished and can start or accelerate over time:
  - o Due to an increase in the level of alteration/erosion over time: the modification of the physical-chemical characteristics of the materials themselves during the fire, make them more susceptible to atmospheric and biological agents, etc., accelerating the weathering processes, decomposition, etc.
  - o By modification of the environment: the loss of vegetation cover followed by rainfall, generates an increase in surface runoff and more or less pronounced erosive episodes that cause the loss and removal of archaeological strata. In extreme cases, they can give rise to floods of mud that can destabilize or collapse architectural structures.

Due to anthropic action on the affected territory: looters who take advantage of the situation to remove objects from archaeological sites or damage caused during restoration work in the area, such as the removal of burnt wood, reforestation, etc.

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<sup>25</sup> Ryan, K.C.; Jones, A.T.; Koerner, C.L.; Lee, K.M. Wildland Fire in Ecosystems: Effects of Fire on Cultural Resources and Archaeology. In Effects of Fire on Cultural Resources and Archaeology; Department of Agriculture Forest Service, Rocky Mountain Research Station: Washington, DC, USA, 2012; Volume 3.

- **Operational damage:** They can be both direct and indirect and are those produced by the operation itself and by the means in charge of resolving the emergency, such as the opening of firebreaks with heavy machinery that can damage elements that are part of the cultural heritage.

As indicated by the National Defence Office - Ministry of Culture of Peru<sup>26</sup> -: "*The most severe impacts on cultural resources occur during the fight against Forest Fires and rehabilitation activities*" (...) therefore, "*It is important that firefighting operators are well informed about combat actions that may affect Cultural Heritage and become familiar with cultural resources and the methods to protect them*".



*Supervision and collection of materials in the firebreak area carried out to extinguish the fire. Archaeological zone of Los Tejares, Salamanca 2017, Salamanca 2017 © Manuel Carlos Jiménez*

It is necessary to highlight that these operational damages in the cultural heritage; unless they imply a conflict with other emergency priorities, such as the safeguarding of human life; they can be avoided. Coordination between the different organizations and sectors is essential, as well as integrating the georeferencing bases of cultural heritage in the cartographic viewers used for analysis and emergency planning.

### **Forest Fires and Cultural Heritage: Protection Strategies in Castilla y León**

Castilla y León is a vast territory divided into nine provinces with an area of 94,223 km<sup>2</sup>, which makes it not only the largest region in Spain, but also in Europe and, on the contrary, the problems indicated in rural territory are more accentuated; with a population density well below the Spanish average.

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<sup>26</sup> CARTILLA DE PROTECCION Y PREVENCIÓN CONTRA INCENDIOS FORESTALES. Ministerio de Cultural de Perú (pgg. 14-15)

[http://www.agritacna.gob.pe/gestores/presenta/comunicados/archivos/3471975475\\_4213851690.pdf](http://www.agritacna.gob.pe/gestores/presenta/comunicados/archivos/3471975475_4213851690.pdf)

In other words, our context of action is a vast rural territory, very depopulated and complex. But it concentrates an important volume of cultural heritage, with more than 2,500 BICs and 11 world heritage sites, some in forest contexts: The archaeological sites of Atapuerca (Burgos); the cultural landscape of Las Medulas (León); the rock art station of Siega Verde (Salamanca) or the Camino de Santiago, with wide sections that pass through natural spaces.



*UGRECYL on the ground, assessing damage at the Navasangil archaeological site, Avila 2021 © UGRECYL*

To address risk and emergency management of the community's cultural heritage, a specific unit was created in 2016: UGRECYL.<sup>27</sup> Unfortunately, and forced by circumstances, much of their work is focused on protecting cultural heritage at risk from forest fires, carrying out Disaster Risk Reduction (DRR) and Disaster Risk Management (DRM) strategies.<sup>28</sup>

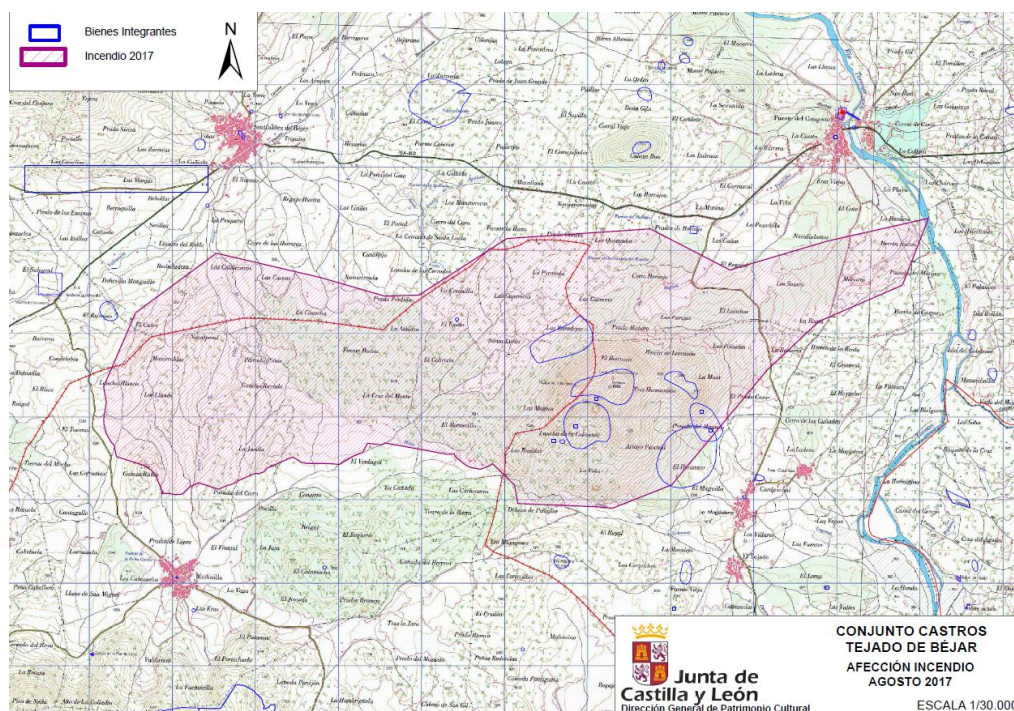
To meet these objectives, working with the CH's georeferenced databases is key, as it allows us to:

- Establish risk maps based on the history of forest fires in the region and the cultural heritage most exposed to this danger.
- Define the degree of vulnerability; establish priorities and plan preventive programs and/or carry out specific Safeguarding plans.
- Make sure you have an accurate list of cultural heritage assets affected during a fire: their typology, geometry, protection category, or the inventory of contained assets in the case of buildings in use, etc. Essential information when making decisions by the Operational Coordination Centre.<sup>29</sup>
- Carry out monitoring and assessment activities of the cultural heritage assets during forest fires.
- Assess the activation of our capabilities based on the needs detected during the emergency.
- Plan damage assessment and response operations.

<sup>27</sup> <https://patrimoniocultural.jcyl.es/web/es/proyectos-intervenciones/gestion-riesgos-emergencias-ugrecyl.html>

<sup>28</sup> Conference "Disaster risk reduction in cultural heritage: from theory to practice". Cristina Escudero Remírez, coordinator of the Risk and Emergency Management Unit in Cultural Heritage of Castilla y León (UGRECYL). <https://www.youtube.com/watch?v=J6oJat8fxh0>

<sup>29</sup> Although it is necessary to continue promoting collaboration and inter-sectoral coordination.



*Area of the fire in Tejado de Bejar, Salamanca and identification of the heritage in the affected area, specifically a group of forts from the Bronze Age (blue) © UGRECYL*

**A practical example: Navalacruz forest fire, Ávila (August 2021)**

The fire started on August 14, 2021, with more than 22,000 burned hectares. Affecting 13 municipalities and evacuating 5 towns.

The area is protected in the Natura 2000 Network: ZEC “Sierra de la Paramera y Serrota” and an important heritage complex, in which the sites of the unpopulated area of Ulaca stand out. It is the most impressive of the vettone *castros* and, due to its characteristics, one of the most interesting oppida or Celtic fortified cities in all of Europe. The sum of this natural and cultural heritage was a prime attraction for tourism.

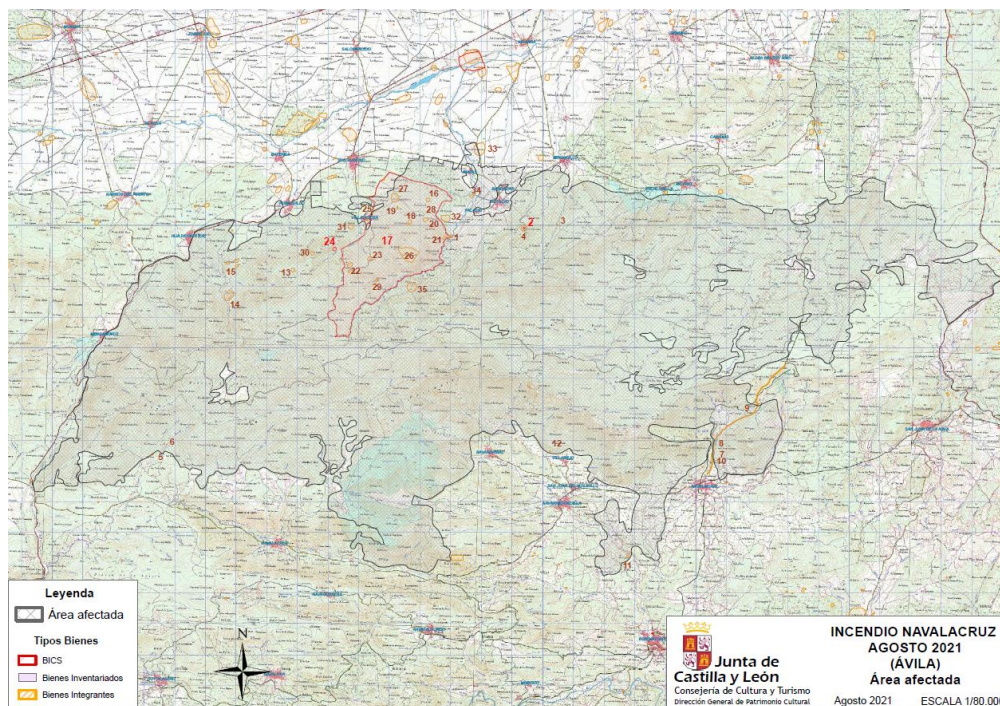
The fire caused an unprecedented crisis for the economic resources of the area, based on extensive cattle farming (after the fire there was neither water nor food available for the cattle); and rural tourism suffered the cancellation of reservations after the fire.

**Procedure:**

From the moment UGRECYL becomes aware of the incident, it activates a fire monitoring and control protocol, based on satellite information provided by the European Forest Fire Information System (EFFIS); and on the one that overlaps our CH database. Several elements at risk of great relevance to the territory were detected.

The data was updated thanks to the referenced data from Copernicus – Rapid Mapping.<sup>30</sup>

<sup>30</sup> In cases where this service has not been activated, the Forest Fire Fighting Services of the Ministry of the Environment of the Junta de Castilla y León are requested.



*Navalacruz fire, Ávila 2021. Based on data from Copernicus Emergency Management Service - Mapping Rapid Mapping: [EMSR538] Avila: Delineation Product, Monitoring 1, version 1, release 1, RTP Map #01): A database of the heritage of Castilla y León has been superimposed, detecting elements of cultural interest*

In the case of the Navalacruz fire, 35 cultural assets were located in the area of the 22,000 burned Hz; 3 of them with the protection of goods of cultural interest: The castle of Malqueospese, an example of rock art: Las Chorreras and the Despoblado de Ulaca, made up of 11 archaeological sites that occupy an area greater than 1,000 Hz.

Once the fire was declared extinguished, the UGRECYL, the analysis and assessment of the situation followed, focusing on the sites in the uninhabited area of Ulaca.<sup>31</sup> Various condition levels were detected, after which two actions had to be urgently carried out:

- Notify the Civil Guard of the danger of looting of archaeological sites by poachers and seekers with metal detectors in order to intensify control over the area.
- Proceed with a detailed evaluation of the cultural heritage in the area of the fire.

The assessment was supported by the Terra Levis group.<sup>32</sup> The systematic collection of data was done through the UGRECYL rapid assessment form, in which the significance of the assessed good was established; safety hazards; the primary conditions (whether direct or operational damages); the vulnerability of the asset after the fire depending on the secondary damage that may be triggered; and the prioritization of protection and recovery efforts.

<sup>31</sup> <https://servicios.jcyl.es/pweb/datosGIS.do?tipo=inmueble&numero=1210>

<sup>32</sup> "Terra Levis" is an archaeology group whose fundamental objective is the development of the rural environment and the conservation of cultural landscapes.



*Field damage assessment © Terra Levis/UGRECYL*

This assessment was extended to elements of an ethnographic nature that were not inventoried, such as the so-called “Cantos de los Responsos”; an intangible tradition of a folkloric nature, which some authors relate to the Christianization of rituals in the Celtic world, and which consists of throwing stones over a great song to free a soul from purgatory.<sup>33</sup>

In total, the assessment was carried out in 56 archaeological, ethnological and historically important sites. The damage suffered by the tourist infrastructure was also provided, reporting the destruction of information panels in several of the archaeological sites visited.



*Cantos de los Responsos © Terra Levis/UGRECYL*

Nine elements did not suffer any type of damage, in thirty-six cases, the damage was slight; seven had moderate or severe damage; and three elements had serious damage, derived from a previous vulnerable situation or due to operational damage; and unfortunately, an ethnographic element –the Muñico bridge- had to be classified as a ruin. This bridge, although salvaged from the effects of the fire, collapsed just ten days later. The erosion caused by the

<sup>33</sup> <https://revistas.ucm.es/index.php/ILUR/article/view/ILUR0606110005A/26177>

torrential rains on the unprotected land of its vegetal cover, caused a significant flood of water and sediments that caused the collapse of the bridge.

The methodology developed is essential to obtain accurate and specific knowledge of the situation and to be able to enable recovery strategies. These have to be directed to meet two objectives.

- Address the new problems presented by the cultural heritage of the area based on the alterations derived from the fire.
- Ensure that the cultural heritage is part of the recovery of the affected area, enhancing its importance as a tourist resource. These actions must be carried out with the participation of the municipalities and in response to their concerns. In this case, a line of subsidies was enabled for the creation of a visitor reception centre for the Ulaca complex.<sup>34</sup>



Partially damaged signage © Terra Levis/UGRECYL

### SOME DATA FROM THE 2022 LFFS IN CASTILLA Y LEÓN

The year 2022 has ended with nearly 310,000 forest hectares burned in Spain, approximately 40% of the total burned in the European Union (EU). A large part of this devastated forest mass corresponds to fires in Castilla y León, with more than 80,000 hectares of forest burned. In the region, these large fires have caused unprecedented emergency situations: numerous fires beyond the extinguishing capacity; 4 deceased; evacuated towns; destruction of real estate; death of numerous heads of cattle and wild fauna; loss of agricultural and livestock resources and other resources from the forest (honey, chestnuts, mushrooms, pine wood, income from hunting grounds,..), drop in tourism; ecological damage in areas of great biological importance, etc.

Data to which must be added the CH in the affected area:

- 116 cultural assets in the fires that affected the Sierra de la Culebra (Zamora),
- 20 in Cebreros (Ávila),
- 7 in Figueruela (Zamora),
- 11 in Monsagro (Salamanca) among which the important Monastery of Santo Domingo de la Batuecas that was saved in extremis, thanks to the actions of the firefighting services<sup>35</sup>,
- 4 elements of cultural heritage in Losacio (Zamora),

<sup>34</sup> <https://www.diariodevila.es/Noticia/Z2871D7BA-0245-FEE6-4542809DB54A206C/202303/El-castro-de-Ulaca-tendra-su-centro-de-recepcion-de-visitantes>

<sup>35</sup> <https://www.lagacetadesalamanca.es/provincia/el-milagro-del-convento-del-desierto-de-san-jose-de-las-batuecas-MF11725955>



- 15 in Quintanilla del Coco (Burgos) among which the imposing monastery of Santo Domingo de Silos that had to be evacuated.<sup>36</sup>

One hundred and seventy-three Cultural Assets that are still being worked on.

All these data reveal that these fires are a disaster that strikes -sometimes to death- the rural areas directly affected by the fire, that affects society as a whole, and in which the protection of cultural resources should be taken into account.

### **By way of conclusion: Cultural Heritage Risk management in forest environments**

Cultural heritage is much more than a tourist resource with economic repercussions; it is something alive that is part of ourselves; our history; our identity.

Cultural heritage is the physical, psychological and symbolic space that constitutes the stage where our lives develop and have developed; configuring cultural landscapes of great emotional charge. We have to be able to overcome its limits, and reinforce the trinomial that they form with the natural heritage and with society.

Only in this way will we be able to develop synergies aimed at improving the quality of life, the environment, the fight against disasters in general and forest fires in particular, and thus preserve our cultural heritage and our collective memory.

For this, we will have to implement the DRM in the area of CH, highlighting some actions:

- GEOREFERENCING of cultural resources of interest and preparation of risk maps. BIC databases available to the organizations and institutions in charge of extinction work.
- Creation of Emergency Units for Cultural Heritage (UEPC) within the ministries of culture: expert technical teams in this field; capable of cooperating for the protection of heritage, providing accurate information and working under the coordination of the competent agents.
- Participation - real and effective<sup>37</sup> -, as established in the different plans, of the general directorates of cultural heritage in the Operations Coordination Centre (CECOP/CECOPI) through the advisory body; and to provide information on cultural heritage in the area of the fire and advise for relevant decision-making.
- If necessary, incorporation of the UEPC, in the Advanced Command Post (PMA), through the Technical Support Group.
- Common language and SOP definition among all sectors
- Preparation of specific PROTECTION PLANS for those cultural resources of greatest interest -such as world heritage-, based on the study of the risk of forest fire and the vulnerabilities detected, establishing:
  - o PREVENTION MEASURES: Reduction of vegetable fuel, etc.
  - o SPECIFIC MEASURES TO BE TAKEN INTO ACCOUNT DURING THE EXTINGUISHING OF FOREST FIRES so that the materials that make up the cultural heritage are not affected or minimize their effects.
  - o POST-FIRE MEASURES: Analysis and evaluation of the situation created, conservation measures and implementation of remediation measures to prevent soil erosion and landscape recovery.
- Promote scientific research

<sup>36</sup> <https://www.elnortedecastilla.es/burgos/bomberos-burgos-centran-20220724202805-nt.html>

<sup>37</sup> Only on a few occasions has the incorporation of these general directorates been put into practice

- Training, exchange of experiences of all the actors involved and dissemination and awareness at a social level.



*El Castrillán, fort from the Iron Age, after a fire in the Sierra de la Culebra 2022 © UGRECYL*

# RECOVERY

## Sorting and recovery of rubble from protected cultural heritage buildings as a prerequisite for proper reconstruction

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*Authors: Eng. Paolo Iannelli, Special Superintendent for the areas affected by the earthquake of 24 August 2016, and Arch. Anna Rutiloni, Office of the Special Superintendent for the areas affected by the earthquake of 24 August 2016, Italian Ministry of Culture – MIC*

In relation to the seismic events that have so frequently affected Italy in recent years and the experience gained in the management of the resulting restoration and reconstruction activities of properties of historical artistic and landscape heritage, the Ministry of Culture has developed a number of devices designed to direct the management of emergency activities. Among these of relevant interest is the Ministry of Culture's Directive of April 23, 2015, "*Procedures for the management of activities to secure and safeguard cultural heritage in the event of emergencies from natural disasters*," and specifically for the management of rubble from historic buildings, the Directive of September 15, 2016, "*Directive for procedures for the removal and recovery of rubble from protected properties and historic buildings*".

With regard to the activity of sorting and recovery of rubble these Directives are sprung from the legislative assumption that the rubble resulting from a collapse of a 'protected' building is also of cultural interest and therefore must be carefully screened to allow their proper sorting and adequate storage also in relation to future relocation and reuse in the restoration and reconstruction phase. The "Directive for the procedures for the removal and recovery of rubble of protected property and historic buildings" has identified two specific distinct paths: one for protected property and the other for historic buildings, which although not under direct protection are entitled to be safeguarded as historical property. The first operation is the mapping of rubble zoned according to three distinct types: "a" Rubble of protected property; "b" Rubble of historic buildings subject to selection to identify singular elements, "c" Rubble without cultural interest. Such mapping will be added to already available mapping systems or by acquisition of the photographic footage including by drones.

Prior to the removal of the rubble, the following operations should be carried out: definition of the rubble perimeters to select the different types with the use of stakes to separate the type of rubble or other forms of identification in the field useful for the subsequent removal plan of the rubble; subdivision into georeferenced quadrants of the photographic footage to be further subdivided according to the size of the buildings, the density of the rubble and the mode of stratification of them. The type "b" rubble will then be transported to suitable places for its storage and preservation in which the subsequent activity of selection of the identity elements will take place. The importance of the mapping activity of this rubble, which allows its immediate connection to the original factory and thus future relocation of the material itself, is clearly evident.

For type "a" material, preference should be given to keeping the selected rubble in situ, taking into account both the reasons for the preservation of the materials and those of a logistical

nature of the emergency areas that may also require the clearing of the rubble. The same, if they remain in situ, should be covered with tarpaulins, adopting all those precautions aimed at safeguarding the elements regarding especially the removal of rainwater particularly impacting in the case of rubble left out in the open. If the rubble cannot be kept in situ, it needs to be transported to storage areas, after having being inventoried, having assessed any needs in terms of emergency response and in such a way as not to cause further damage.

The earthquake that affected central Italy with shocks starting on August 24, 2016 was particularly destructive and involved a vast, heterogeneous, rich and extremely fragile cultural heritage area, unfortunately producing a large volume of rubble. The territory involved falls largely within the Monti Sibillini National Park and the Gran Sasso and Monti della Laga National Park and is therefore characterized by a high quality of landscape and historic built environment, also sustained by that combination of natural and human factors that over the centuries have defined the happy union between nature and architecture and that from the outset, imposed the need for careful and calibrated safeguarding of the same during reconstruction. Among the heritage that suffered the greatest damage is the ecclesiastical one; countless churches and convents have been damaged, some, unfortunately, even partially destroyed. Then, with regard to the architecture of the villages and historic nuclei, many were those partially or totally destroyed, characterized mostly by minute building consisting of "poor" sack-type masonry which, subjected to the very strong and repeated aftershocks, mostly crumbled, creating a huge amount of rubble.

The activities implemented, particularly those related to the management of cultural heritage rubble in all the centers affected by the earthquake were substantial both in terms of management and cost. In order to take into account the complexity in terms of both design and workmanship related to the reuse of identity elements recovered from the collapses, the Extraordinary Commissioner of Government with the support of the Technical Working Group including , in addition to some specialists, the Ministry of Culture and the Italian Episcopal Conference, drafted the Ordinance No. 116 of May 6, 2021: "Reorganization and rationalization of the current provisions on the repair, restoration, rehabilitation and reconstruction of buildings of cultural interest and landscape belonging to private entities".

This provides for an increase in the reconstruction grant for architectural rehabilitation and restoration work that considers the relocation and reuse of the recovered elements, disincentivizing the demolition and reconstruction solution, in order to ensure as a priority the preservation of the constituent elements of the historic landscape and, at the same time, encourage the achievement of high quality levels in the design and implementation of restoration, repair, rehabilitation and reconstruction with seismic improvement of damaged buildings that are of cultural or landscape heritage interest.

**TABLE 2b – PROTECTION AND CONSERVATION OF BUILDINGS, URBAN AND LANDSCAPE AREAS applicable for immovable heritage ex comma 1 point d) and point e), before 1945**

TYOLOGY OF GOOD <input type="checkbox"/> d <input type="checkbox"/> e	CONSERVATION OF EXISTING		RECONSTRUCTION	
Year of construction before 1945 <input type="checkbox"/> SI		%		%
<b>LANDSCAPE, URBAN AND ARCHITECTURAL ELEMENTS</b>				
Preservation of the morphological configuration characterising the urban area (alignments, heights, roads, distances, etc.			YES	3
Conservation of the roof/covering (course and geometry of pitches, type of covering, eaves lines)	YES	6	YES	2
Conservation of holes and façade geometry e/o (alignments, proportions, dimensions, etc.)	YES	3	YES	2
Conservation of porches, loggias, balconies, terraces, external stairs, etc.	YES	4	YES	2
Preservation of structural typology: materials, characteristics and external finishes	YES	6	YES	3
Conservation of external façade elements: stone or stucco lintels of doors and windows cantonments stringcourses, etc.	YES	3	YES	2
Reutilisation of recovered elements (If any)	YES	3		
<b>ELEMENTS OF HISTORICAL ARCHITECTURE</b>				
Conservation of interior staircases: structural typology, positioning and constituent materials	YES	2	SI	1
Conservation of the internal vertical load-bearing structure: typology, materials and characteristics	YES	3	SI	1
Preservation of the roof structure: type, materials and characteristics	YES	3	SI	1
Conservation of horizons and vaulted structures: types, materials and characteristics	YES	3	SI	1
Conservation of interior finishes, decorations and non-structural identity elements	YES	2	SI	1
Reutilisation of internal recovered elements	YES	2	SI	1
<b>% INCREASE CONTRIBUTION TABLE 2 (Max 40% for conservation and 20 % for reconstruction)</b>			..... %	

*Table of increases in the Ordinance of the Extraordinary Government Commissioner n. 116 of 6 May 2021 © MiC*

A practical example of the reuse of elements salvaged from the rubble is the restoration and reconstruction of the Basilica of St. Benedict in Norcia (Perugia, Italy). Rising where tradition reports that the home of Saints Benedict and Scholastica had existed, the Basilica is a highly stratified monument. In fact, the church presents numerous construction phases, partly evident from reading the wall apparatus, and partly hidden by the overlapping structures over the centuries detected with the collapses. Archival research, conducted during the drafting of the planning guidance document and the numerous findings of structures frescoes and materials following the collapse, have allowed to make further assumptions about the Basilica's oldest construction phases and to trace its history more precisely.

## Sorting and recovery of rubble from protected cultural heritage buildings as a prerequisite for proper reconstruction

With the October 30, 2016, quake, the Basilica, already damaged by the August 24 earthquake, suffered the collapse of nearly 80% of its structures. The collapse of the bell tower destroyed the roof and its blocks broke through the vault of the crypt, also damaging the ancient floor of the crypt itself. The wall along the portico almost totally collapsed, taking the entire structure of the portico with it. Miraculously, the facade and part of the transept and apse remained standing.



*Left: The Basilica of San Benedetto in Norcia before and after the seism of 30 October 2016; right: the rubble masonry literally crumbled, leaving inside the Basilica a four meters high rubble front © MiC*

During the rubble sorting activity at the Basilica, conducted under the scientific direction of the Superintendence for Cultural Heritage and Landscape of Umbria and the Central Institute for Restoration of this Ministry, filing of the materials was the first step, after which the rubble was put into pellets and transported to the depots according to the methodologies indicated in the aforementioned Directive, making sure that the accompanying form linked the stone elements to the specific discovery area according to a mapping of the collapsed area to facilitate their recognition. The rubble was then placed in the depot of the Superintendence of “Santa Scholastica” in Norcia, and the pieces in need of immediate restoration were transferred to the depot at Santo Chiodo of Spoleto.



*Internal view of the Basilica of San Benedetto in Norcia after the seism of 30 October 2016 © MiC*

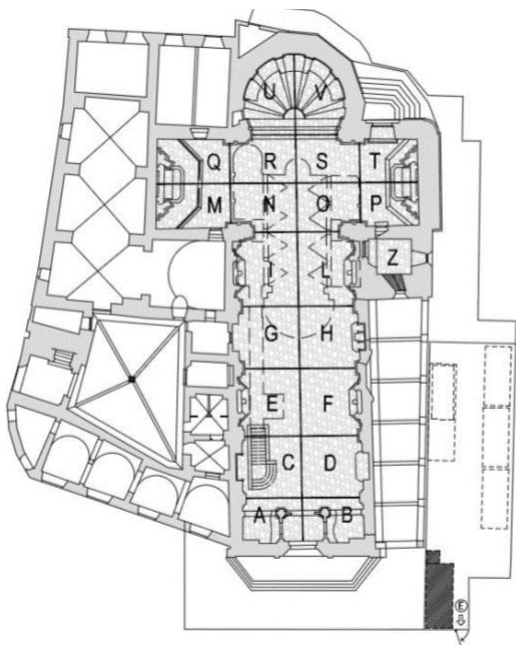
Material consisting essentially of pallets of squared ashlars, pallets of molded stones referable to architectural elements, pallets of stucco fragments, and the pallets of carved wood fragments referable to confessionals were taken to the Scholastica depot. Also catalogued and transported to the St. Scholastica depot were the ten constituent elements of the two facade pinnacles, previously removed from their locations and temporarily placed in

## Sorting and recovery of rubble from protected cultural heritage buildings as a prerequisite for proper reconstruction

the courtyard of the convent attached to the Basilica, and the two 16<sup>th</sup> century wings of the carved wooden doorway, removed and transported in the depot's hangar.



*Basilica of San Benedetto in Norcia after the debris removal © MiC*



*Left: Map of the debris recovery zones ; right: photo of zone 'A', by SABAP Umbria and the ICR, showing part of the entrance compass © MiC*

## Sorting and recovery of rubble from protected cultural heritage buildings as a prerequisite for proper reconstruction

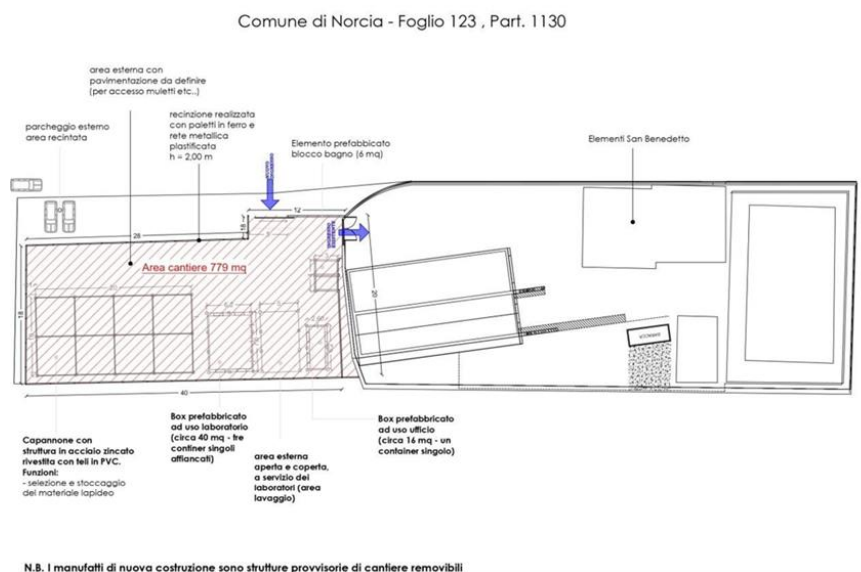


The area near the depot of Santa Scholastica in Norcia with the stone elements recovered from the rubble ©MiC

The St. Scholastica depot therefore appeared from the outset not only as a temporary storage area for the rubble while awaiting the restoration and reconstruction phase, but as a necessary place for the study and assessment of all the material in view of the project activity, which was not available in the areas of immediate proximity to the Basilica. For this purpose the Office of the Special Superintendent, within the framework of the technical sponsorship agreement of ENI

s.p.a. for the execution of the II lot of the works of the Basilica, proposed the setting up of the "St. Scholastica Worksite" where to carry out all the handling, selection and identification of the stone elements and any necessary preliminary work, in view of their relocation in the reconstructing phase, in connection and coordination with the progress of the project activity. ENI s.p.a. therefore designed and set up a large covered space outside to accommodate the pallets of stone elements that, in accordance with the work on site, were gradually being prepared, and two office spaces for the technicians and designers to carry out all the scientific activity of recognition and "design relocation" of the elements.

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The area nearby the depot of Santa Scholastica in Norcia ©MiC



## Sorting and recovery of rubble from protected cultural heritage buildings as a prerequisite for proper reconstruction

The work carried out in the depot allowed the relocation in the restoration and reconstruction work of the large stone elements that made up the wall of the Basilica along the *Portico delle Misure*, identified according to research studies, also confirmed by the propaedeutic design assessments made by the University of Padua, to belong to the Romanesque phase of the Basilica, as well as for those immediately above that differed in composition and type and the stone elements forming the Gothic arch that in ancient times provided access from this side as well. Likewise, it was possible to reconstruct with their own stones the pillars that supported the vault of the crypt and those of the portico of Measures with their own capitals and shutters. With this same purpose, it will also be possible to envisage the relocation of the surviving or recoverable elements that decorated the altars and facade and any other identity elements that once recovered will return, with their important legacy, to recompose the Basilica of St. Benedict.



*The Gothic arch reassembled at the St. Scholastica site with a view to its relocation © MiC*



*Pallet with ashlar of the Gothic arch © MiC*

Sorting and recovery of rubble from protected cultural heritage buildings as a prerequisite for proper reconstruction



*Left: Elements of the crypt pillars ready to be relocated; right: the interior of the ENI s.p.a. shed with pallets for the construction site ©MiC*



*Left: The Gothic arch repositioned in the wall of the Basilica; right: one of the pillars repositioned in the crypt © MiC*

## DALIH: a database for recording disaster damage and loss data for cultural heritage

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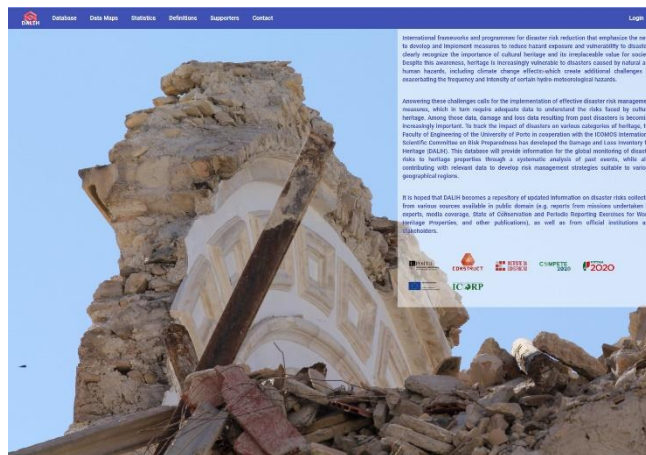
*Authors: Xavier Romão, Assistant Professor and Esmeralda Paupério, Senior Civil Engineer, Faculty of Engineering, University of Porto*

### Introduction

Existing international frameworks and programmes for disaster risk reduction (DRR) emphasize the need to develop and implement measures to reduce hazard exposure and vulnerability to disasters. Among other aspects, current DRR initiatives such as the Sendai Framework for Disaster Risk Reduction recognize the importance of cultural heritage and its irreplaceable value for society. Therefore, such initiatives clearly highlight the need to assess the impact that potential hazards may have on the built cultural heritage. Developing adequate risk assessment and management processes are crucial elements towards this end and it is a known fact that systematically collected and accurate damage and loss data are essential for such processes. The development of systems, models and methodologies to collect and handle such data should, therefore, become a worldwide priority.

Existing disaster loss data recording initiatives such as the EM-DAT/CRED, SIGMA/SwissRe, NATCAT/MünichRe or DesInventar/UNDRR databases are undoubtedly important sources of information in terms of the damage and losses that occurred in worldwide disasters. Moreover, recording such data is clearly useful for the purpose of loss accounting, forensic analysis of disasters and disaster risk modelling. For example, this data can provide an objective baseline for risk assessment as well as for mitigation priority setting and decision-making. However, the data recorded by these databases does not include damage and losses to cultural heritage. Therefore, without this important component, current loss estimation procedures cannot guarantee a sound and comprehensive quantification of disaster impacts.

In the cultural heritage sector, there is no systematic collection of data on the impacts of hazardous events involving cultural heritage properties. Existing data on damage and losses to cultural heritage are scattered among various agencies (national and international) without any coherence and coordination. Furthermore, no standardized methods and tools have been developed for cultural heritage disaster data collection until now. Given that specific approaches and methods are required to manage these issues, the [DALIH \(Damage and Loss Inventory for Heritage\)](#) database was created in order to collect worldwide data on immovable cultural heritage disaster losses and start addressing some of the limitations of existing systems.



*View of the initial page of the DALIH database*

## Overview of the DALIH database for cultural heritage

The DALIH database aims to provide a standard for loss and damage recording for immovable cultural heritage supported by international institutions such as UNESCO, ICOMOS, ICCROM or ICOM, as well as other organizations dealing with cultural heritage. DALIH records the occurrence of damage and losses in worldwide immovable cultural heritage properties caused by natural or human-made hazardous events. As such, DALIH is an efficient tool that will provide institutions managing and protecting cultural heritage with:

- a systematic and standardized recording of cultural heritage disaster-related data, from both natural and human-made hazards;
- a reliable accounting of cultural heritage losses;
- specific data for the analysis of disaster trends and risk mitigation needs in cultural heritage.

One of the key issues of the database development was the definition of a simple system of categories for the type of cultural heritage properties considered by DALIH. Although several classifications and definitions of cultural heritage categories can be found in literature<sup>38</sup>, none of these approaches is considered to be entirely satisfactory in order to classify different types of immovable cultural heritage assets in a simple, general and structured way. Therefore, the following system of Heritage Categories was established based on the importance of a certain immovable cultural heritage asset:

- UNESCO World Heritage Site
- Property Protected by the Hague Convention
- Listed National Heritage
- Listed Sub-National Heritage

<sup>38</sup> Blake, 2000; Vecco, 2010; Fernández-Freire et al., 2014; Prastakos and Gkadolou, 2015

- IUCN Protected Area
- Property of Local Significance

Given that some of these categories may overlap (e.g., a UNESCO World Heritage Sites can also be a Listed National Heritage), more than one Heritage Category may be assigned to a certain cultural heritage property. For each of these categories, an additional descriptor identifies the type of cultural heritage asset. This descriptor establishes that a given cultural heritage asset belongs to one of the following Unit Identification types:

- Single unit property: an individual monument or a natural landscape
- Multiple unit property: a group of monuments, an historic landscape, an historic town, an urban block of cultural significance

The hazardous events recorded by the database range from small-scale events that only affect a single cultural heritage property to large and widespread ones that affect a larger number of heritage assets. The database records basic identification and information about the main hazardous event (and secondary events that may have been triggered by the main event) such as the hazard type/subtype, the GLIDE number, geographical information (country, continent, location, latitude and longitude) and temporal information (start/end date, local time), (Figure 1). For each event, the database records information regarding the cultural heritage properties affected by the event. This includes basic descriptions about the cultural heritage properties before they were damaged along with a description of the damage and losses they suffered. The damage description can be illustrated using additional media such as photos, videos or reports uploaded on the database. Each cultural heritage property affected by an event is then associated to a Heritage Category and an Identification Type (according to the previously referred classifications), to one or more Property Classes (e.g., religious facility, archaeological site, residential facility, landmark, nature reserve, park, marine zone, rock formation, etc.), to a Value (qualitative) and to one or more Construction Materials (only for built properties). In terms of disaster data, the database records the (qualitative) damage level of each cultural heritage property, available information on economic losses and data regarding emergency procedures that may have been activated following the disaster.

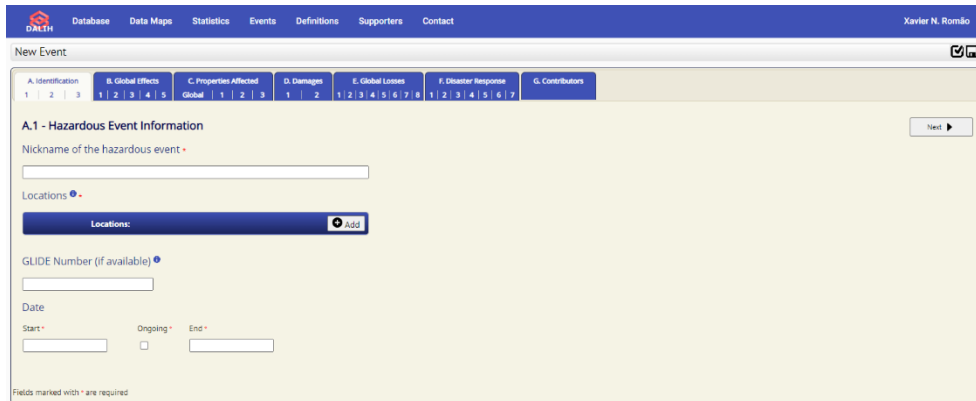


Fig. 1 First screen of the DALIH database where the main hazardous event is identified

The development of the DALIH database is particularly important given the possibility of using the data it collects in different steps of the cultural heritage risk management cycle. Performing a detailed risk assessment of cultural heritage properties is often a difficult task, given the complexity and the multidimensional value of cultural heritage. In these situations, using additional damage and loss data from past events recorded by disaster databases can be particularly helpful. Furthermore, the data collected by disaster databases is also relevant for the analysis and decision-making step, as well as for the risk mitigation and treatment step. Information on past experiences can provide valuable guidance for the definition of the approaches that are best suited to protect a certain cultural heritage asset or to create awareness regarding the need to develop new risk mitigation measures.

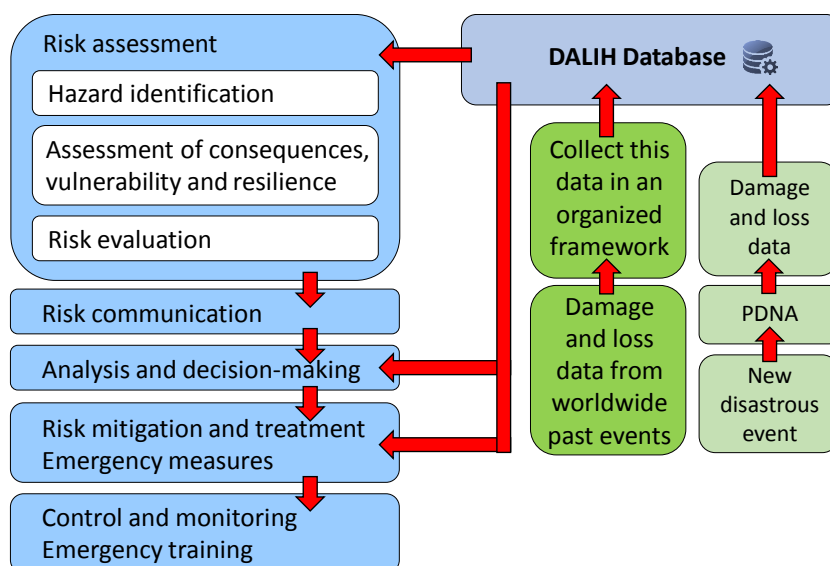


Fig. 2 The DALIH database within the risk management cycle for cultural heritage

### Final remarks

International frameworks and programs for DRR are clear in their objectives of reducing hazard exposure and vulnerability to disasters. Furthermore, the importance of cultural heritage and its irreplaceable value for society is also clearly acknowledged in these objectives. However, how can disaster loss reduction be measured in cultural heritage if there are no reliable loss data on the impacts that disasters have on this sector? Currently, it is clear that existing disaster loss accounting systems underestimate the true cost of disasters due to several factors. One of the factors is the inability to account for the disaster impacts on cultural heritage. Disaster loss databases are important tools to analyse patterns and trends of disaster losses and disaster risk based on past events. By understanding these patterns and trends, future losses can be mitigated by the implementation of efficient targeted measures. Furthermore, disaster loss data can also be used to determine if disaster risk management is actually effective in reducing risks as a result of DRR policies and investments. The development of a database specifically devised for the collection of cultural heritage disaster loss data such as the DALIH database is therefore fundamental and will provide important data for the development and preparation of better heritage-focused disaster mitigation strategies for the future.

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