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PROCULTHER-NET 2

PROTECTING CULTURAL HERITAGE FROM THE CONSEQUENCES OF DISASTERS - NETWORK

TECHNICAL BULLETIN

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2

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THE PROJECT

PROCULTHER-NET 2

PROTECTING CULTURAL HERITAGE
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PROCULTHER-NET 2 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 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), the University of Porto - UPORTO (Portugal) and the Suor Orsola Benincasa University - UNISOB (Italy).

Building on the experience and lessons learnt by the previous PROCULTHER EU-funded initiatives implemented under the framework of the Union Civil Protection Knowledge Network- UCPKN, PROCULTHER-NET 2 aims at implementing the pathway mapped out by the PROCULTHER-NET project to consolidate the inclusion of the protection of cultural heritage at risk in the Union Civil Protection Mechanism - UCPM processes and structures, so as to increase disaster preparedness capacities and knowledge at European and national levels.

The ongoing phase, running from January 2024 to December 2025, moves forward to consolidate and further expand the thematic community on the protection of cultural heritage at risk established within the UCPKN, namely for defining elements for its sustainable governance and functioning.

*Join the KN and find out more on **PROCULTHER-NET**!*

FOREWORD

By Krista Pikkat, Director, Culture and Emergencies Entity, Culture Sector, UNESCO

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Whether movable, immovable or intangible, cultural heritage is a major element of community identity and a critical factor in post-disaster resilience. It provides a connection between the past, present and future generations and has a unique and irreplaceable nature, which, when destroyed, has an impact not only on the culture sector, but also, on socio-economic development indicators in the areas affected. The inclusion of cultural heritage in disaster risk management plans enables preventive measures to be put in place, thereby reducing the long-term costs that could be incurred by its loss, replacement, restoration or recovery as a result of a disaster. Integrating cultural heritage into civil protection mechanisms enables the actors at the forefront of disaster response to better coordinate and more efficiently make use of their resources, avoiding duplication of effort and guaranteeing a more coherent and stronger response in the event of a disaster.

UNESCO is committed to the preservation and protection of cultural heritage, in all its forms, in emergency situations such as conflicts and disasters resulting from natural or human-induced hazards. UNESCO supports its Member States in better preparing for, responding to and recovering from emergencies that affect culture and heritage. As such, the PROCULTHER-NET 2 project is an excellent initiative, which will enable critical stakeholders in the European Union to come together in a community of practice, share their knowledge, experiences and innovations in order to strengthen the knowledge management process related to this field within the UCPKN. Thanks to this initiative, cultural heritage will be fully integrated into civil protection mechanisms and disaster risk management at European and national levels.

I trust that you will find this Technical Bulletin insightful with its articles that focus on the prevention, preparation and response for cultural heritage in disaster and crisis situations. Additionally, the “Focus On” section provides an in-depth exploration of key issues related to these themes.

INTRODUCTION

By Editorial Committee

Welcome to the fourth edition of the Technical Bulletin. At the beginning of 2024, a new format was designed to make this publication even more accessible to a wide community dedicated to the protection of cultural heritage in times of crisis. The Technical Bulletins have now reached their cruising speed, involving a growing number of experts from the UCPM States and beyond. Among the countries participating in the initiative, alongside the Consortium partners from France, Italy, Germany, Portugal, Spain, and Türkiye, we are delighted to welcome authors from Switzerland, as well as reviewers from Albania, Austria, Hungary, and the United Kingdom, whose expertise has significantly enriched this issue. We thank the authors for sharing their insights, case studies and expertise with the PROCULTHER-NET community.

Securing the dome of the Anime Sante Church in L'Aquila
© Corpo Nazionale Vigili del Fuoco

The year 2024 has seen new developments in the field of cultural heritage protection in times of crisis, especially in the wake of the 70th Anniversary of the Hague Convention for the Protection of Cultural Heritage in the event of Armed Conflicts. This is especially important in the current historical context, where multiple conflicts have placed cultural heritage at significant risk; indeed, several events and conferences have put this issue in the spotlight, focusing on the continued need for integration not only with the military field but also with the civil protection, humanitarian and more globally first-aiders community. With a focus on the stakes at international and European level, and with the aim of sharing cutting-edge knowledge on cultural heritage at risk, these technical bulletins approach the topic in a transversal and interdisciplinary manner, fostering dialogue among experts from the earliest stages of prevention and preparedness, to ensure more effective responses in the field.

This edition opens with an article from Türkiye in the **PREVENTION** section, which provides a blueprint on how cultural heritage can be directly embedded into Disaster Risk Reduction Plans, at national and regional levels, thus laying the foundations for an integrated approach. The **PREPAREDNESS** section includes good practices aimed at enabling and strengthening operational capacities. Articles in this sec-

tion deal with issues such as building a robust IT infrastructure to support response missions, with an example from Germany, and the importance of developing strong cooperation and common strategies between all actors involved. Testing capacities and processes within a realistic scenario can be seen as the culmination of the preparedness activities. This section thus brings us two valuable illustrations of the central role of exercises to ensure the operationality of disaster planning and management. Within the broader context of the protection of cultural heritage in Switzerland, the first article focuses on concrete applications in the City of Geneva, and more particularly on an exercise conducted in March 2024 at the Bibliothèque de Genève. The second article presents the two exercise phases organized in the Campi Flegrei area, in Italy, to face the bradyseism phenomenon and volcanic risk. Both articles emphasize the importance of cross-sectoral cooperation in emergencies, providing examples of exercises where various actors are involved in the protection of cultural heritage. In the **RESPONSE** section, experiences from the earthquake that struck central Italy in 2016 are presented through two parallel contributions: the second part of the article on debris of cultural interest that was presented by the Italian Ministry of Culture in the third Technical Bulletin. Using examples from the 2016 earthquake in Central Italy, the article follows the different steps of debris management, from the emergency phase, to storage and restoration. The other contribution from Italy explores the expertise developed by the National Fire and Rescue Service in stabilizing and shoring up damaged, at-risk buildings, highlighting their role in protecting cultural heritage during emergencies.

In this edition, the **FOCUS ON** section particularly concentrates on remote sensing, with two complementary case studies from Italy and Germany, exploring how these technologies can assist in protecting cultural heritage sites through different phases of the Disaster Risk Management Cycle, from monitoring to assisting in response operations. Finally, in this anniversary year of the 1954 Hague Convention, an article from France focuses on the interdisciplinary dialogue between military and civilian organisations.

We hope you enjoy reading this Technical Bulletin and that it will spark ideas, discussions and new collaborations.

Focus on cultural heritage in the context of disaster risk reduction activities in Türkiye

Erkan Doğanay, Disaster and Emergency Management Specialist, Ministry of Interior Disaster and Emergency Management Presidency - AFAD, Türkiye

Introduction

The 7.8 magnitude earthquake that struck Nepal on 25 April 2015, killing 8,844 people and injuring more than 22,000, not only caused loss of life and property, but also resulted in the destruction of 190 buildings and damage to 663 buildings in the World Heritage-listed Kathmandu Valley. The earthquake was followed by a second earthquake on 12 May, which added to the state of devastation.[1] The Nepal earthquake has once again globally highlighted the need to take precautions in disaster-prone areas to protect cultural heritage, as well as to make significant risk reduction efforts in disaster preparedness and post-disaster response.

As a result of the earthquake that occurred on 6 February 2023, particularly in Kahramanmaraş Pazarcık, Türkiye, more than 50,000 people lost their lives, more than 100,000 were injured, destruction occurred in an area of more than 120,000 square kilometers inhabited by 14 million people, and the general life of society was disrupted.[2] In addition to the structural damage to buildings, the disaster impacted strongly on cultural heritage many times causing collapses and destruction.

Although almost two years have passed since the earthquake, post-emergency work in the affected region is still ongoing, and although the restoration of the damaged cultural heritage assets involves, at most, structural interventions and improvements conforming to the original as far as possible, the lost or damaged cultural heritage elements can never be fully replaced. These disasters have clearly demonstrated the importance of an increased cooperation between disaster and cultural heritage institutions in protecting cultural heritage assets from the effects of disasters.

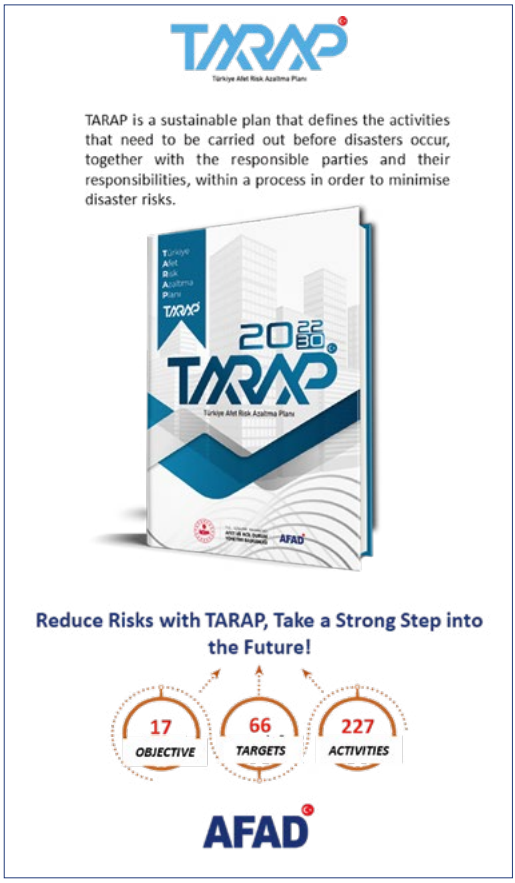
In this contribution, disaster risk reduction activities carried out at national and local levels in Türkiye, a country with high disaster risk, are evaluated at the strategic and operational levels, and the risk reduction activities carried out in the field of cultural heritage will be discussed at the end of this paper.

Approach to risk reduction activities at strategic and operational levels in Türkiye: the Turkish Disaster Risk Reduction Plan (TARAP)

Especially in recent years, the increasing impact of disasters at global and national levels has led to the development of an important and positive approach, such

[1] Kai W., 2015.
[2] AFAD Press Release, 2023.

as the increased importance given to risk reduction efforts in Türkiye. The most important step in risk reduction work for Türkiye has been the Turkish Disaster Risk Reduction Plan (TARAP) as a strategic approach. The TARAP was developed as a result of a study that aimed to align Türkiye's priorities, outlined in various national disaster risk reduction documents, with strategic goals and objectives. It identifies actions to achieve these targets while incorporating the priorities of the Sendai Framework for Disaster Risk Reduction and considering international developments and commitments.



1. TARAP Brochure, TARAP Document, 2024 (AFAD)

TARAP is a roadmap to prevent or minimise disaster-related losses by creating resilient societies and safe living spaces and was prepared under the coordination of the Disaster and Emergency Management Presidency (AFAD). TARAP is a national plan of action in place from 2022 to 2030 that identifies the actions to be carried out with all responsible stakeholders before disasters occur in order to mitigate disaster risks. This plan covers public institutions and organisations, local governments, the private sector, non-governmental organisations, universities and individuals who will carry out risk reduction activities for all types and scales of disasters that may occur. Considering the priorities of the Sendai Framework, the strategic priorities and objectives that form the basis of TARAP are listed below:

- **Strategic Priority 1**: Understanding disaster risk
- **Strategic Priority 2**: Strengthening disaster risk governance for disaster risk management
- **Strategic Priority 3**: Investing in DRR for resilience
- **Strategic Priority 4**: Developing and improving disaster preparedness for effective response, "building back better than before" in the rehabilitation and reconstruction phases.

2. Eleven disaster types identified within the scope of TARAP (TARAP Document, 2024 - AFAD)

TARAP avoids duplication of investments in disaster risk reduction. Under the strategic priorities, general and disaster-specific objectives, targets and actions for disaster risk reduction have been identified. The TARAP process, which aims to contribute directly to sustainable development through disaster risk reduction, has conducted a survey of 3500 institutions, worked with 107 institutions and organisations and involved 1500 participants in the process. The survey that was conducted as part of the process used a participatory approach to assess institutions' awareness of disaster risk reduction revealed that a significant part of the institutions' main and primary tasks form the basis for disaster risk reduction activities. As a result of the assessments carried out during the studies, 11 different types of disasters were prioritised and identified. Within these 11 types of disasters, the objectives, targets and actions for disaster risk reduction studies were defined. This approach resulted in 17 objectives, 66 targets and 227 actions for 11 different types of disasters. In addition to general actions, the disaster types for which strategies are developed in the document are "Earthquake, Mass migration, Floods, Climate change, Forest fires, Infectious and epidemic diseases, Chemical-biological-radiological-nuclear threats (CBRN), Major industrial accidents (BIA), Transport of hazardous materials (TMT), Mining accidents, Mass migration, Other disasters". In the context of the work carried out by all stakeholders in 2022-2024, the completion rate of TARAP actions amounted to 36%.

The TARAP Plan defines the actions to be fulfilled by the Ministry of Culture and Tourism in order to protect cultural heritage elements from the hazards caused by disasters. Within the framework of the planned actions, the final aim is first of all to identify the hazards of cultural heritage elements caused by disasters with a participatory approach, and then to create a culture/framework with an inter-sectoral cooperation approach by identifying the stakeholders.

TARAP Plan, Examples of Actions, 2021			
Type	**Activity**	**Responsible**	**Support/Stakeholder**
Other	Preparation of Integrated Disaster Hazard Maps	AFAD	• Min. of Environment Urbanization and Climate Change • Min. of Culture and Tourism • DG of Mineral Research and Exploration • Local Authorities
Other	Adding the Disaster Risk Reduction Approach to the national education curriculum	Min. of National Education	• AFAD
Earthquake	Creating a tsunami hazard and risk model, making maps and developing loss scenarios	Kandilli Observatory and Earthquake Research Institute	• AFAD
Mass Movement	Preparing/Updating mass movement hazard maps	AFAD	• Min. of Environment Urbanization and Climate Change • Min. of Internal Affairs • Min. of Agriculture and Forestry • DG of Mineral Research and Exploration • Local Authorities
Flood	Creating and updating Basin Flood Management Plans	Min. of Agriculture and Forestry	• Min. of Energy and Natural Resources • Min. of Internal Affairs • Min. of Health • Min. of Science, Industry and Technology • Min. of National Education • Min. of Culture and Tourism • AFAD • Local Authorities
Flood	Taking necessary structural and non-structural measures within the framework of flood control and risk reduction approach in the upstream and downstream sections of river basins	Min. of Agriculture and Forestry	• AFAD • Local Authorities
Forest Fire	Development and establishment of early warning systems against forest fires	DG of Forestry	• Min. of Agriculture and Forestry • Scientific and Technological Research Council – TUBİTAK • NGO's
Earthquake	Inventorying cultural heritage and service structures, determining their risk, importance and priority levels	Min. of Culture and Tourism	• Min. of Internal Affairs • Local Authorities

Provincial Disaster Risk Reduction Plan (IRAP)

In addition to TARAP, where priorities are set at the central and national levels, Provincial Disaster Risk Reduction Plans have been drawn up according to a bottom-up approach at local level for all stakeholders.

The Provincial Disaster Risk Reduction Plans (IRAP) have been prepared with the aim of ensuring safe living conditions in the provinces by:

- reducing or preventing loss of life, property, and other damages caused by disasters,
- raising awareness of disaster risk reduction,
- increasing cooperation among stakeholders,
- minimizing expenditures for post-disaster intervention and rehabilitation,
- ensuring the effective use of resources.

While the provinces carried out the IRAP studies, 289 academics from 99 universities supported the studies. Each province held 2 separate information meetings for provincial leaders (governors, mayors, heads of institutions and organisations, etc.) and experts, 2 workshops with representatives of all institutions and organisations,

3. İRAP Brochure (AFAD, IRAP Document, 2024 - AFAD)

and many meetings within their own IRAP studies. A total of 148 workshops were held to carry out the studies effectively, and plans were developed as a result of face-to-face and online studies during the COVID 19 pandemic period.

Once the plans were in place, work was carried out to implement, monitor and update the actions. To this end, a monitoring and evaluation meeting was held twice a year in each province, chaired by the provincial governor (once as a monitoring meeting and once at the end of the year). The monitoring and evaluation meetings reviewed IRAP actions, updated and evaluated completed actions, and held expert meetings and workshops to identify new actions during the year.

Examples of İRAP Actions in Samsun Province, 2024 (www.irap.afad.gov.tr)

Type	Activity	Responsible	Support/Stakeholder
Flood	Monitoring of the bridge located at the intersection of Değirmendere, Atakum district, with Atatürk Boulevard, to pass the 500-year flood flow	Regional Directorate of Highways	• General Directorate of State Hydraulic Works – Regional Office • Samsun AFAD
Fire	Completion of the construction of 97 hydrants in Vezirköprü district	Samsun Metropolitan Municipality Presidency	• Samsun Water and Sewerage Administration General Directorate
Flood	Strengthening the rainwater drainage infrastructure of Canik district Ulus Street, BelediyeEvleri junction and Ankara Boulevard road routes	Samsun Water and Sewerage Administration General Directorate	• Samsun AFAD • Canik Municipality
Flood	In Dereköy District of 19 Mayıs district, starting from approximately 80 m downstream of the Sinop-Samsun highway of the Mahallesi - 2 Stream, 30 cm slope reducing blocks will be installed for a length of 300 m, with a bed slope of 0.02 m/m	Samsun Metropolitan Municipality Presidency	• General Directorate of State Hydraulic Works – Regional Office
Earthquake	Completion of the reinforcement or reconstruction works of 8 schools in Kavak district, which were seismically prioritized by the Provincial Directorate of National Education	Samsun Provincial Directorate of National Education	• Samsun Investment Monitoring and Coordination Directorate • Samsun AFAD

The actions included in IRAPs are evaluated by specialized personnel on the general situation of the province, its disaster, hazard and risk assessments, current situation analysis, disaster risk reduction objectives, targets and approaches and related technical issues and submitted to the Provincial IRAP Monitoring and Evaluation Board consisting of the Governor of the province, Deputy Governor, Municipality Representative, Director of Environment, Urbanization and Climate Change, Provincial AFAD Director and a representative, expert in disaster risk reduction from uni-

versities in the province, twice a year leading to the approval and acceptance of all actions deemed effective. Depending on the nature and urgency of the disaster risk, representatives from relevant institutions may also be included in these meetings.

The IRAPs identify responsible and supportive stakeholders for each action aimed at reducing disaster risk. A total of 221 objectives, 1290 targets and 18011 actions were identified in 81 provinces. 81 provinces prioritised their actions and identified 2155 actions as red (priority) actions. 36% of 18,011 risk reduction actions and 41% of 2,155 red actions have been completed.

When IRAP Actions are evaluated based on disaster type:

- 23% of 5,432 flood/overflow actions,
- 26% of 4,263 earthquake actions,
- 26% of 1,555 mass movement actions,
- 39% of 955 fire actions.

When evaluated on the basis of the Institutions responsible for the actions:

- 27% of the 9,755 actions of the Metropolitan, Provincial and District Municipalities,
- 33% of the 2,056 actions of the General Directorate of State Hydraulic Works Field Organization,
- 52% of the 1,380 actions of the Provincial AFAD Directorates,
- 52% of the 734 actions of the Forestry Field Organization,
- 45% of the 367 actions of the General Directorate of Highways Field Organization have been completed.

4. Fire response in the historical mosque of Bartin © anadoluimages

A web-based online monitoring software has been developed to facilitate the monitoring and evaluation of IRAP actions. With the help of this software, approximately 5150 institutions responsible for IRAP are monitored by reporting their actions. The "IRAP Monitoring and Evaluation System" is a system through which the provinces can monitor and evaluate the actions for which they are responsible at the level of institutions and organisations.

The IRAP process has set the years 2021 - 2025 for this structural transformation to take place, in order to raise awareness within the planning activities and to incorporate it into local policies, and it aims to establish the concept of Disaster Risk Reduction with a structural perspective at the local level, with stakeholder studies to be carried out as part of the monitoring of the current process in 2025. As a result of this process, the protection of cultural heritage assets that are part of the rich legacy of our country and the development of risk reduction approaches will be implemented as political priorities and the participation of stakeholders will keep growing with increasing motivation with the synergy created after the Pazarcık earthquake.

Approach to the protection of cultural heritage elements in risk reduction plans

The General Directorate of Cultural Assets and Museums under the Ministry of Culture and Tourism is responsible for uncovering, protecting, evaluating and promoting the movable and immovable cultural assets that need to be protected in Türkiye through archaeological research and excavations, taking measures to prevent their destruction and smuggling, guiding and supporting the establishment of private museums and monitoring them according to appropriate principles and legislation. However, the protection of cultural heritage from the destructive effects of disasters is a process that requires inter-institutional and inter-sectoral coordination.

Within the framework of this approach, the aim of the actions included in the Provincial Disaster Risk Reduction Plans for the protection of cultural heritage elements from disasters is not only to protect the relevant elements but also to increase the cooperation activities among institutions at the local level and to create a culture of cooperation with a structural approach. In this direction, inter-sectoral cooperation is the main objective in the protection of cultural heritage elements as in all areas. As seen in the actions given as examples, organizations/institutions such as Provincial AFAD Directorate, Provincial Directorate of Culture and Tourism, Provincial Directorate of Environment, Urbanization and Climate, State Hydraulic Works, Provincial Directorate of Agriculture and Forestry, University and Governorship Investment Monitoring and Coordination Offices have various duties in this field and the ultimate goal is to create a culture/framework of cooperation among these organizations in the field of disaster risk reduction.

In provinces, the actions on cultural heritage included in the Provincial IRAP Plan are prioritized by stakeholder institutions under the coordination of the Provincial Directo-

rate of Culture and Tourism, and the actions that are urgent or require cooperation are submitted to the Board. The Board determines the appropriateness of the action within the framework of prioritization and includes it among the Provincial IRAP actions.

The main responsible points for the actions mobilize the financial mechanism, while operational activities are carried out by support units and stakeholders. In addition, the completion of the actions based on this cooperation will not only protect the cultural heritage assets at disaster risk, but also as a result of the cooperation activities of the institutions, knowledge transfer and finally a methodology will be developed for the protection of cultural heritage from the effects of disasters. As a matter of fact, both the methodology and the actions in the same direction will be updated as a result of the evaluation planned for the end of 2025. In the evaluation phase, the cultural heritage title will be handled separately and the distribution of tasks, authorities and responsibilities will be finalized in order to make new actions more effective and more efficient through methods such as SWOT and gap analysis in a participatory manner.

The devastating effects of disasters are seen especially in residential areas and cause great material and moral losses. Among these losses, the most important value that cannot be replaced after human life is cultural heritage.[3] Every year, cultural heritage is damaged and destroyed due to many disasters caused by natural and man-made risks. These risks can affect whole countries, regions or specific heritage sites, whether they are natural (earthquakes, floods, fires, landslides, tsunamis, etc.) or man-made (vandalism, wars, theft, etc.).[4]

Although it is not possible to prevent disasters in many cases, it is possible to reduce their impact. Disasters and the secondary disasters that may occur afterwards cause many losses of life and property in Türkiye as in the whole world . They cause great damage and losses to the economy, sociology, culture and cultural heritage of society.

Investing in preventive risk management planning before disasters occur will reduce the budget spent on rescue and rehabilitation efforts in the post-disaster phase resulting in significant economic savings.[5] In this context, it is worth mentioning that the UN Committee draws more attention to the pre-disaster rather than the post-disaster period in the protection of cultural heritage. The need and importance of taking precautionary measures against possible risks before, during and after the disaster has emerged.[6]

As part of this approach, especially in recent years, due to the increasing impact of disasters in Türkiye, there has been an increase and progress in disaster risk

[3] Ünal, G.Z.2014.
[4] Oktay, S., 2020, p. 306.
[5] UNESCO, 2010.
[6] Oktay, S., 2020.

reduction research with the establishment of the Disaster and Emergency Management Presidency. These studies have led to systematic developments at the strategic and operational levels with the TARAP and İRAP plans, which were drawn up under the coordination of AFAD. In light of these developments, measures have been increasingly taken at the central and local level to protect cultural heritage assets from the effects of disasters throughout the country. In particular, the ap-

5. Full-scale exercise after an earthquake, Bilecik © anadoluimages

6. Mosque restoration in Gaziantep © anadoluimages

proach created at the strategic level by identifying the stakeholders to reduce the impact of disasters with the TARAP plan at the central level has led to the implementation of important disaster risk reduction works with the IRAP plans at the local level.

Examples of cultural heritage protection actions in İRAP, 2024 (www.irap.afad.gov.tr)			
Type	**Activity**	**Responsible**	**Support/Stakeholder**
Mass Movement	Placing woven steel nets around the rocks to safeguard the historical castle in KorkutKarakale village to prevent them from falling into residential areas	Muş Provincial Directorate of Culture and Tourism	• MuşGovernorate • MuşAFAD • Bitlis Foundations Regional Directorate • Muş Special Provincial Administration
Meteorological	Determination of cultural assets that may be affected by meteorological events in the Phrygian Valley	Afyon Provincial Directorate of Culture and Tourism	• AfyonAFAD • Afyon Provincial Directorate of Environment, Urbanization and Climate Change
Mass Movement	Carrying out risk reduction studies for rockfall hazards in cultural areas with tourism potential, such as Nemrut Caldera and Adilcevaz Grand Mosque	Van Cultural Heritage Preservation Regional Board Directorate	• BitlisAFAD • Regional Directorate of the Ministry of Agriculture and Forestry
Earthquake	Restoring the Stone Arch Bridge in the Rabat Village of the Central District and ensuring its resistance against possible earthquake disasters	Tunceli Provincial Directorate of Culture and Tourism	• TunceliAFAD
Mass Movement	Remediation of landslides in the ancient city of Trapezapolis in Bekirler District of Babadağ District	Denizli Provincial Directorate of Culture and Tourism	• Babadağ Municipality • Pamukkale University • DenizliAFAD • Denizli Investment Monitoring Coordination Directorate
Earthquake	Determination of earthquake resistance of the ancient cities of Ephesus - Bergama - Torbalı - Agora - Smyrna - Urla, Birgi Çakırağa Mansion and St. John Church	Izmir Provincial Directorate of Culture and Tourism	• İzmir Metropolitan Municipality • DokuzEylül University • Ege University • Izmir Surveying and Monuments Directorate

Looking at the Provincial Disaster Risk Reduction Plans, a total of 147 disaster risk reduction activities are planned to be implemented by the local bodies of the Ministry of Culture and Tourism in 53 of the 81 provinces of the country. 13 of these actions have been fully completed and activities are ongoing in 63 actions. The number of actions that have not yet started is 71.

Risk reduction actions for cultural heritage protection in IRAP, 2024 (www.irap.afad.gov.tr)	
Disaster Type	**Number of Actions**
Infectious Diseases	1
Earthquake	70
Industrial Accidents	2
Landslides	1
Mass Movements	21
Meteorological and Climate Change-Related Disasters	8
Forest Fires	3
Floods	12
All/Other Disasters	21
Fires	8
Total	**147**

Among the 147 actions examined, several key risk reduction activities stand out, including:

- safeguarding historic sites with woven steel mesh,
- assessing and improving the seismic performance of historic structures,
- enhancing resilience to disasters such as rockfalls and landslides,
- mitigating the effects of meteorological disasters on historic sites and structures,
- evaluating fire risks and implementing reinforcement measures,
- conducting restoration activities that account for disaster risks,
- taking specific precautions against disasters, particularly fire, in museums, and
- increasing earthquake resilience.

These efforts collectively aim to protect historic sites and structures from various disaster risks

Conclusion

Recent developments in disaster risk reduction, driven by the lessons learned from past disasters, highlight the importance of planning at both central and local levels to implement structural measures before disasters occur. Türkiye advances its risk reduction efforts through the TARAP and IRAP plans, implemented under the leadership of AFAD in collaboration with multiple stakeholders. These efforts to protect cultural heritage not only foster disaster awareness and a culture of preparedness but also ensure the preservation of cultural heritage for future generations.

IT infrastructure for cultural heritage response missions

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Introduction

The Cultural Heritage Response Unit (CHRU) of the German project KulturGutRetter (implemented by the German Archaeological Institute – DAI, the Federal Agency for Technical Relief – THW, and the Leibniz Center for Archaeology – LEIZA), which is currently being set up, is implementing a digital documentation system with mobile devices that document both the objects themselves and the measures carried out during a mission. Once operational, the CHRU will be deployable worldwide, within the framework of international disaster relief, to protect cultural heritage in crises.

For this purpose, the unit is equipped with its own mobile IT infrastructure so that the documentation system can operate autonomously. A mobile server and a local network enable the data acquisition on several tablets or smartphones, which simultaneously and at the same frequency record data at different locations. At the heart of the system is a PostgreSQL database, which allows both the Movable Cultural Assets (MCA) and the Immovable Cultural Assets (ICA) departments to document processes and objects according to their respective requirements.

The system can operate effectively depending on the situation. On the one hand, the system can be extended to cover a larger area, with a backup option to a server in Germany via 5G, and on the other hand, in the event of a network or power failure, it can be used for offline data collection, which would then require manual synchronization of the data.

Documenting objects and work processes is an integral part of dealing with cultural heritage in research, and is equally important when carrying out cultural heritage response missions, after a disaster or crisis. This may involve a very large number of objects that need to be recorded in a very short time, or several buildings where damage needs to be documented quickly over a large area. The aim is always to collect information that is as accurate and error-free as possible, clearly structured and usable. All of these requirements can be met by using a digital documentation system.

In the case of cultural heritage response missions, in contrast to excavation projects lasting years with an established infrastructure on-site, there are additional challenges, such as granting power supply and/or Internet connection across the area of operation. In addition, it is not always possible to modify the system on a voluntary basis during an ongoing mission. The documentation system must therefore be flexible enough to work in both smaller and larger missions. In this respect too, a digital structure offers better conditions than, for example, documentation on paper.

In the course of setting up the CHRU, an IT architecture is also being developed that ideally enables the desired fast and accurate data recording, while also containing sufficient fallback levels so that it can continue to be used even under adverse conditions. The system described here is set up within a cooperation between the Field Tech Support Unit (FTS) of the THW and the Department of Scientific Computing of the German Archaeological Institute (DAI).

1. Workspace of the IT-Expert with boxes of mobile devices
© Bernhard Fritsch, DAI

Hardware

The central element of the entire system is a box in which a server (mini-PC / barebone) and a router are installed. The various teams (e.g. for movable cultural assets or immovable cultural assets) can use tablets or smartphones to enter data in predefined masks for the actual data collection work at the site. These devices can also be connected to the server via LAN or WLAN at a connected workstation or at stations where it is better to work with a notebook rather than a tablet. Additional SSD hard disks are plugged into the server, which can be quickly removed and backed up in an emergency.

Servers, routers and hard disks take up no more space than a standard PC tower and can also be easily transported. The space required by the devices for actual data collection depends on the number of devices used. In the case of the CHRU, the equipment currently consists of two tablet cases with 20 mobile devices each and two notebooks. In addition, there is a very small webcam for taking photos on an illuminated table[1] as well as a number of access points depending on the situation.

Access to all devices is secured by updated VPN tunnels and rigorous firewall rules. The system therefore meets all IT security requirements.

All of the hardware components mentioned are subject to constant updating and improvement, while being a currently operating infrastructure.

[1] At the CHRU, as part of the mobile emergency conservation laboratory. See also: Domenech de Cellès C., Jakubeit N., KulturGutRetter (KGR): technical characteristics of a cultural heritage response unit, in ***PROCULTHER-NET Project. Technical Bulletin N. 1, March 2023***. pp. 58-64. ISSN 2975-190X. Accessed 22 November 2024.

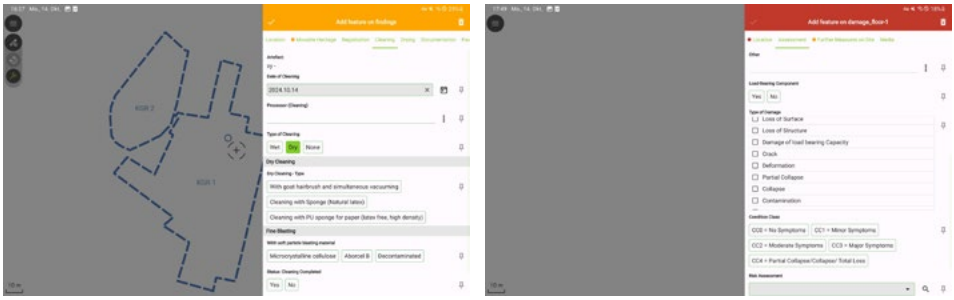
Software

Data collection in a CHRU deployment is carried out via mobile devices using the QField app.[2] QField is the mobile client of the QGIS geo-information system and was adapted to the needs of the CHRU mainly through the data model used. QGIS / QField are open-source programs and thus allow a great deal of control besides the integration of other devices in case additional people become involved in the data acquisition.

All data collected via QGIS / QField is stored in a PostgreSQL database, which is installed on the central (mini) server. Ideally, this makes it possible to synchronize the data live and thus track the progress of the work on all devices in use or to adapt the operation by quickly assessing the situation based on the current data.

Even if the program was originally for use in the geographical world, thus focused on geodata, a variety of data types can be recorded. This includes the possibility to add audio and video footage (that can be used also to document intangible heritage), and also photos and textual information as core elements. The predefined input masks reflect the requirements of the two groups ICA and MCA. This means that the ICA forms are designed for the documentation of buildings and damage to the building fabric, while the forms for MCA map a process chain following the rescue path of objects from salvage, cleaning and securing all the way to packaging and temporary storage. The joint ID system guarantees the connection of both areas in order to map the locations of mobile cultural assets in the buildings on the one hand, and to document the procedures carried out on the objects (MCA and ICA) independently of the geographical information.

The special challenges of operating in an emergency entail a great effort in balancing the mix between (academic) accuracy in the documentation of cultural



2. . Example of entry forms: (on the left) for movable cultural assets; (on the right) for immovable cultural assets © Bernhard Fritsch, DAI

[2] See Iacono E., Fritsch B., Data acquisition and data management for the emergency rescue of cultural heritage, ***PROCULTHER-NET Project. Technical Bulletin N. 2, June 2023***, pp.35-39. ISSN 2975-190X. Accessed 22 November 2024.

heritage property and minimal data to be recorded under pressure, also with regard to a final data transfer in the sense of FAIR (Findable, Accessible, Interoperable and Reusable) data principles. From a technical point of view, it is best to use the flexibility of a PostgreSQL database to be able to adapt the QField project depending on the situation without having to edit the database in the background.

The large number of images taken directly via the mobile devices or in the photo station via an external camera are also copied to the server after a few minutes with the help of the AutoSync app and can be accessed from there via the NginX web service by all other connected devices for viewing.

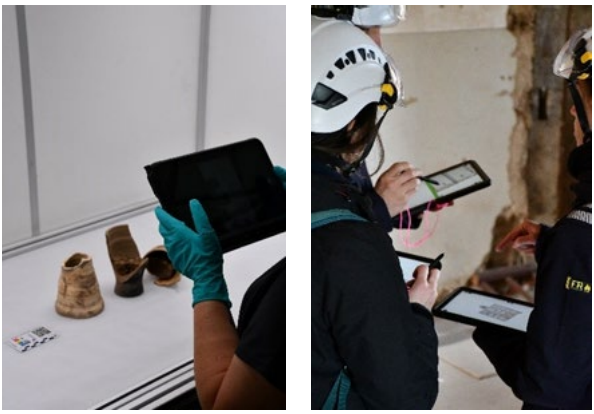
In addition, further external data, such as laser scan or Structure for Motion (SfM) data, can be stored and backed up in a Nextcloud instance installed on the server. Nextcloud Talk allows direct communication between the devices registered in the network.

For individual additional functions, apps can be installed on individual or all devices, such as apps for further image processing or for controlling GNSS devices.

Network and procedure

The use of the aforementioned hardware and software allows a multi-level data acquisition system to be established that can be adapted to the situation on site in terms of power supply and network connection.

The standard variant (variant A) provides for data recording in a local network without an Internet connection, but with a sufficient power supply.



3. Documenting movable cultural assets (left) with a tablet, documentation and data comparison in the area of immovable cultural assets © Marcel Pasternak, DAI

In this case, the router sets up a local network and all mobile devices located within this network save the data directly in the PostgreSQL database. To do this, the QField project must be set up for online recording. The decisive factor here is stable coverage of the deployment site with the local network. This can be achieved through the targeted installation of access points, whereby the access points can also be quickly relocated as required in order to cover a different area for data collection.

Variant A thus represents a closed system that enables parallel and fast data acquisition with a large number of mobile devices for one location within the local network. It is only necessary to ensure a constant power supply.

If it is possible to use an existing WLAN or to supply the router or a second router with an Internet connection via 5G. For example, the documentation system, which is always synchronized live, can also be extended to two or more remote locations (variant B). Communication and importing data to the server, which is then, not carried out via the local network, but (ideally) via a 5G data connection. Individual tablets, which in turn are in use at other, remote locations, could also directly connect with the overall project.

In this variant B, a connection could also be established to another server, e.g. in the operations center in Germany, and this second server could be used as a backup option. However, this data transfer can only occur upon authorization by the local host institution, and represents a safeguard for data preservation.

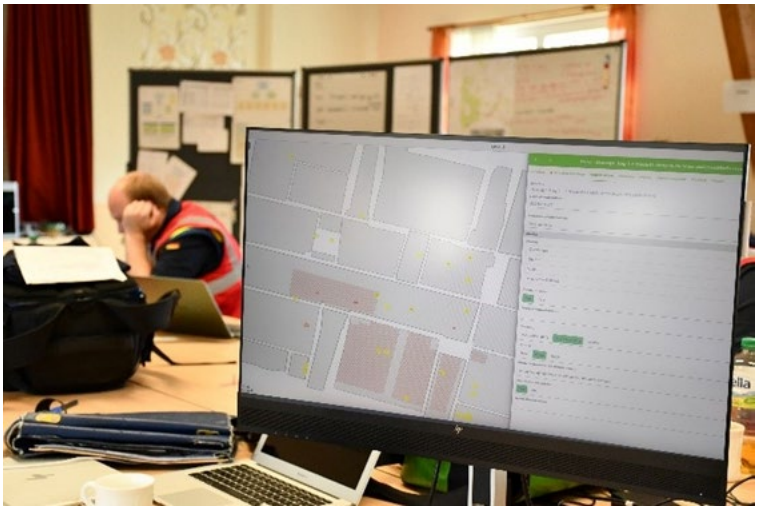
But the system can also be customized in the other direction. QField also offers the option of recording data in an offline mode (variant C). In this case, however, the data from the individual devices must be merged manually once data collection is complete. A project synchronized this way can then become accessible to all the individual mobile devices the next day, for example, so that all the devices used can access the same data again by then, at the latest. Variants C and A can also be combined so that individual mobile devices that are no longer within range of the local network due to their location can also be used to record data. The data from these devices can then be added manually to the central PostgreSQL database.

Finally, there is variant D, in which neither the Internet nor sufficient power is available for offline recording by the tablets. In this case, the data can be entered on paper forms that are absolutely identical to the input masks in QField. Photos can be created using external cameras. In this variant, data collation is of course very laborious and error-prone, so this variant is applicable only in extreme emergency states.

Data management

Most of the documentation from the field can therefore be stored in a central PostgreSQL database. As photos are another central element of data collection, the database was supplemented with a NginX web server allowing all photos to be taken by several different mobile devices visible to all devices. For this purpose, the photos can be uploaded at a central location and the path is automatically changed accordingly in the PostgreSQL database. In this way, each tablet can access the photos of the other devices via the link in the database.

In addition, a range of other data such as laser scans, inventory lists or photos from external cameras can be collected during a mission. This data is stored on external



4. Tracing the data documentation in the control room © Marcel Pasternak

hard drives connected to the server according to the usual data management rules so that the hard disks can be quickly removed and backed up in an emergency without having to pack up the entire system.

Summary

The above-described system for data acquisition in the field consists of a number of individual components, all of which are commercially available (or in the case of Software: Open Source) and readily available (both hardware and software). The configuration of the devices and the adaptation of the software can be carried out directly and independently by members of the project, so that the project itself can always exercise a high degree of control over the entire system. Adjustments can also be made quickly.

In September 2024, the IT architecture described above was tested during a full-scale CHRU exercise. In terms of the data recorded, the exercise was very successful and the digital documentation system basically fulfilled its purpose. The technical implementation in terms of setting up the local WLAN, secure access to the server and database and parallel data collection from several mobile devices with immediate synchronization could effectively work. However, the usage of the IT system revealed many issues, that could be improved. The shortcomings mainly referred to very practical matters such as the size and cabling of the devices in the Base of Operations (BoO), but above all the optimization of workflows and processes between the specific specialized departments (Immovable / Movable Cultural Heritage) and IT. For example, data was often recorded in an offline area, while the implementation of the access points had not been completed yet. This in turn led to additional work for the IT department, as data also had to be synchronized manually. Moreover, the

crucial importance of support by the IT personnel as part of the overall teams on the cultural heritage sites (outside the BoO) became clearly evident, as is intensive training of all personnel in the system to better automatize the handling with digital devices in such a scenarios.

However, the constant development and upgrade of hardware and software systems necessarily requires the system's constant support and monitoring, as even small changes to individual parts can have a major impact. For this reason, the CHRU team always includes several IT specialists.

Therefore, the next goal must be to make the entire setup even more robust and stable in order to minimize potential sources of error when non-IT experts are recording data. The focus here is on supplying the area of use with stable WLAN so that variant A of the system can be implemented without any problems and manual data synchronization is avoided as much as possible.

Only then will the advantages of digital documentation such as speed, accuracy and structure of the data or the low number of sources of error with regard to data quality become apparent.

Attachment – necessary equipment:

Hardware (Minimal version)

- Mini-PC / Server with PostgreSQL-database and internal cloud-service for data management
- Router/Modem for local, secured network, if necessary connections via 5G
- Access points to cover the area of application with WLAN
- Mobile devices – Tablets and/or Smartphones for data acquisition#

Software (Minimal version)

- QGIS - https://www.qgis.org/
- QField - https://www.qgis.org/
- PostgreSQL - https://www.postgresql.org/
- DBeaver - https://dbeaver.io / pgAdmin - https://www.pgadmin.org
- NginX - https://nginx.org/
- Nextcloud / Nextcloud Talk - https://nextcloud.com
- AutoSync - https://metactrl.com/

Cultural heritage sector planning in the Campi Flegrei area on bradyseismic[1] and volcanic risk: the National Civil Protection Exercise "EXE Campi Flegrei 2024"

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Introduction

In the framework of national civil protection exercises[2], Italy organized a drill activity in the Campi Flegrei area in 2024, called "Exe Flegrei 2024," structured in three phases. This activity aimed to test the emergency planning developed to deal with both the bradyseism phenomenon and volcanic risk in the Flegrei area. The first two exercise phases, in table top mode, took place in April and May 2024 and focused on the bradyseismic phenomenon. This phenomenon has triggered a new eruptive phase of activity since 2005 that further intensified in 2023. The third exercise phase, in full-scale mode,

1. Beginning of the EXE Campi Flegrei, October 2024 © DPC

[1] *Bradyseism*: is a deformation of the ground involving phases of slow subsidence alternating with phases of more rapid uplift, the latter generally accompanied by shallow, low-magnitude earthquakes.

[2] Piacentini V., Proietti G., architects, Italian Presidency of the Council of Ministers, Civil Protection Department DPC, *Training and exercise: an effective approach to build cultural heritage protection capacity,* in ***PROCULTHER-NET Project. Technical Bulletin N. 2, June 2023***, *pp. 15-24.* ISSN 2975-190X. Accessed 23 November 2024.

took place in October 2024 and focused on volcanic risk. All of the above exercises included specific activities on safeguarding cultural heritage in emergencies, as provided by the aforementioned planning. The overall plan, in fact, included a significant part dedicated to the protection of cultural heritage, as provided in the drafting of the "cultural heritage sector plan," adopted by the Ministry of Culture (MiC) on January 4, 2024.

"Cultural heritage" sector planning

The "Cultural Heritage Sector Plan" consists of the definition of operational strategies in relation to risk scenarios, as identified by the Department of Civil Protection of the Presidency of the Council of Ministers in relation to the seismic risk and volcanic risk emergency of the Campi Flegrei area.[3]

The National Relief Programme for seismic risk, as outlined in the Directive of the President of the Council of Ministers dated 14 January 2014[4] requires that the components and operational structures, particularly those involved in supporting the Civil Protection Operational Committee, develop sector-specific plans.

These plans should integrate their organizational intervention models for civil protection emergencies with national and territorial activation protocols while respecting their internal organization and chain of command. The plans must align with national legislation and be based on municipal, inter-municipal, and provincial civil protection emergency plans, as well as regional intervention models or, where applicable, regional civil protection plans.

[3] Regulatory References:
Decree of the Head of the Department of Civil Protection of the Presidency of the Council of Ministers, February 2, 2015 (Official Gazette no. 75, March 31, 2015): Guidelines for the components and operational structures of the National Civil Protection Service on updating emergency plans for the precautionary evacuation of the "Red Zone" population in the Vesuvian area. ***Decreto del Capo Dipartimento del 2 febbraio 2015 | Dipartimento della Protezione Civile***
Decree of the President of the Council of Ministers, June 24, 2016 (Official Gazette no. 193, August 19, 2016): Provisions for updating emergency planning for volcanic risks in the Campi Flegrei area. ***Dpcm del 24 giugno 2016: Disposizioni per l'aggiornamento della pianificazione di emergenza per il rischio vulcanico dei Campi Flegrei (all'interno la Mappa dei gemellaggi) | Dipartimento della Protezione Civile***
Decree Law no. 140, October 12, 2023 (Official Gazette General Series no. 239, October 12, 2023): Urgent measures for seismic risk prevention related to the bradyseismic phenomenon in the Campi Flegrei area and Conversion Law no. 183, December 7, 2023 (Official Gazette General Series no. 288, December 11, 2023). ***Decreto-legge n. 140 del 12 ottobre 2023 - Misure urgenti di prevenzione del rischio sismico connesso al fenomeno bradisismico nell'area dei Campi Flegrei | Dipartimento della Protezione Civile***
Directive of the Ministry of Cultural Heritage and Activities and Tourism, April 23, 2015: Update of the December 12, 2013 Directive on "Procedures for the management of securing and safeguarding cultural heritage in emergencies resulting from natural disasters."
[4] See in particular point 3 of the Directive. Accessed 5 December 2024 [***https://www.protezionecivile.gov.it/en/normativa/direttiva-del-presidente-del-consiglio-dei-ministri-del-14-gennaio-2014-relativa-al-programma-nazionale-di-soccorso-per-il-rischio-sismico/***]

The Plan defines emergency management procedures, conforming to the indications contained in the Rapid Emergency Planning for the bradyseismic area, issued by the same Department of Civil Protection on December 20, 2023.[5]

Moreover, the "Cultural Heritage" Sector Plan indicates the parties involved in the emergency and their contacts, the census tables/charts of the movable and immovable cultural heritage assets in consignment to the MiC in the seismic risk area, the safeguarding priorities, the protection measures in place and the recording tools to use to identify the assets. The removed works, as according to Plan were transported to the emergency storage facility identified at the Royal Palace of Caserta, where they were placed in environmentally safe conditions and guarded by appropriate surveillance equipment.

The Plan, which falls within the framework of the aforementioned national civil protection planning, as later implemented with data related to the restricted areas within the Red and Yellow Zones under national planning, and further supplemented by census tables of movable and immovable cultural heritage assets not in the hands of the MiC. The tables reporting the safeguard priorities and planned protection measures, as well as documentation of the identified security deposits, as entities, institutions, and owners/holders of cultural heritage assets, regardless of ownership title, provided documentation concerning the assets.

In the same way as the "Sisma dello Stretto" (Strait of Messina Earthquake) Exercise, held in 2022[6] and the previously organized National Civil Protection exercises, the drill activities represented the culmination of an extensive training path carried out under the 2019[7] "Minimum Requirements" document, i.e., a nationwide training standard shared between DPC, MiC and the regional civil protection structures, dedicated to training in cultural heritage protection and aimed at public administration officials - Ministry of Culture, National Fire and Rescue Department, Carabinieri Command for the Protection of Cultural Heritage (TPC), Campania Region-and organized civil protection volunteers.

The Civil Protection Plan for volcanic risk in the Campi Flegrei area of Campania, states that the orange alert level, which corresponds to the pre-alert operational phase, provides for the implementation of preventive measures for the safeguard of cultural heritage assets including removal and sheltering operations at previously identified storage facilities outside the red area. In this regard, according to the cul-

[5] See also ***https://rischi.protezionecivile.gov.it/en/volcanic/volcanoes-italy/phlegraen-fields/rapid-emergency-planning-bradyseism-phlegraean-fields/*** Accessed 5 December 2024.

[6] PROJECT PROCULTHER-NET STAFF, *Italy testing capacities for heritage protection*. Accessed 23 November 2024 [***https://civil-protection-knowledge-network.europa.eu/news/italy-testing-capacities-heritage-protection***].

[7] 'Minimum requirements for the training of civil protection volunteers and public administration officials in safeguarding cultural heritage in civil protection activities' of 29 April 2019, Prot. No. DPC/POST/22409

tural heritage sector plan, during the volcanic risk pre-alert operational phase, all removed assets must be secured by Ministry of Culture personnel with the support of appropriately trained volunteers specialized in cultural heritage protection and other Administrations involved.

Civil Protection Exercises

The first two exercise phases in tabletop mode held in April and May 2024, focused on the assessment of the elements contained in the Rapid Emergency Planning for the bradyseism area and particularly on the proper functioning of the communication flow between the coordination centers and their operability. Both exercises featured information sessions organized by the MiC for its officials to learn the main concepts of the plan. On the other hand, the third and final exercise phase, held on October 11, 2024, in full-scale mode, allowed for field-testing of the interaction between the various participating actors.

As per the third exercise, the Campania Region organised the 2019 'Minimum Requirements' Course (i.e., a national level training standard, shared between DPC, MiC and regional civil protection structures) for Officers and Volunteers involved in the exercise.

The simulation, in terms of the operational scenario related to cultural heritage assets, took place at the Baia Castle in the Municipality of Bacoli, which contains archaeological ruins discovered during excavation campaigns carried out in the neighboring areas of the Municipalities of Bacoli and Pozzuoli. In the event of an emergency, these CH assets with the exception of works that couldn't be moved due to their size and weight and needed to remain *in situ*, these were secured through the help of expert personnel trained in specific training courses.

The operational scenario involved about 150 expert cultural heritage professionals, including 10 officials from the Civil Protection Department, 30 officials from the MiC, 40 officials from the local administrations of the Campania region, 10 firefighters, 5 Carabinieri from the Carabinieri Command for the Protection of Cultural Heritage (TPC), and 50 specialized civil protection volunteers.

All exercise activities were carried out in a restricted timeframe compared to real emergency situations; MiC officers and specialized volunteers who took part in the exercise were divided in 8 teams of about 10 members each and worked in synergy. Each team was coordinated by a team leader, identified among the MiC officers, and a deputy team leader from the civil protection volunteers.

Officials of the National Fire Department technically supported the operations through their assessment of the work sites' safety, and Carabinieri Command for the Protection of Cultural Heritage (TPC), in addition to supporting the MiC in the removal and packing operations, provided for the security and safeguard of the CH assets.

2. Securing movable assets in the Baia Castle © DPC

The eight teams were carefully balanced in terms of size and professional expertise. Each team was assigned a designated location equipped with a gazebo and a work table to facilitate the exercise activities.

A briefing was held for the team leaders (MiC) and deputy team leaders (volunteers), during which site assignment cards and team badges were handed out. Following a preliminary inspection by the team leaders, the necessary materials for moving and packing the objects at the exercise sites were requested. Each team proceeded to collect, document, and pack the objects at their assigned site, completing the activity by organizing the transport of the items to a designated depot within the castle. At the depot, they submitted the list of objects along with the packed items.

Approximately 60 observers from various embassies visited the exercise site, along with a group of about 10 evaluators including regional and DPC officials, who were provided with an overview of the activities.

At the conclusion of the exercise, the evaluators provided feedback on the various scenarios, including the one involving cultural heritage, and expressed their appreciation for the activities observed. They highlighted the excellent level of integration and involvement among all institutional actors, as well as the high level of awareness demonstrated by all participating operators. This was seen as evidence of an effective and productive training that addressed not only the technical and specialist aspects relevant to each institutional component's sector planning but also fos-

tered integration and operational synergy through the joint experience. Supporting this assessment, a sample of interviewed operators voiced their satisfaction and positive feedback on the training program.

3. and 4. Documentation of movable cultural heritage assets during the exercise © DPC

Conclusions

The drills carried out on the Campi Flegrei territory made it possible to test the contents and validity of the Emergency Plan and, as far as cultural heritage protection activities, the related Sector Plan.

During the exercise, the activities tested were:

- Support to the MiC and its local structures through activation tests of sector-specific planning;
- Coordination and interoperability between the officials of the different local structures of the MiC and the Volunteer Organizations involved;
- Assessment of alerting and involvement procedures at the Campania Region's Regional Civil Protection Operations Room (SORU) and at the National Emergency Command and Control Center (DI.Coma.C) of MiC contact persons;
- Assessment of operational capacity and procedures for the removal and securing of assets.

At the end of the exercise, the final debriefing highlighted the lessons learned and critical issues that emerged during the course of activities, especially those related to the need to work more frequently under conditions of interoperability among the different actors and administrations involved. Also, what emerged was the need to better define the roles of the mixed teams' members operating in the cultural heritage safeguarding and securing operations for a faster and more orderly execution of activities.

In general, we can say that civil protection exercises, whether in table top or full-scale mode, are the most effective tool for testing, modifying and updating planning tools. Carrying out drills on a regular basis will ensure a fruitful exchange of knowledge and interaction among those involved at the local level even in the emergency preparation phase, thus making the civil protection system more prepared to face any potential disaster.[8]

[8] PROCULTHER-NET Project, Exercises, in: ***Key elements of a European Methodology to address the Protection of Cultural Heritage during emergencies***, 2021, pp. 167-200. Città di Castello: LuoghInteriori, 2021. ISBN 978-88-6864-370-6. Accessed 23 November 2024.

The intersectoral strategy for the protection of cultural property in Switzerland: an overview of the "Leonardo" exercise in the City of Geneva

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The Protection of Cultural Property in Switzerland

Switzerland has an exemplary legal framework for protecting cultural property (PCP)[1] by international standards. Under Switzerland's federal system[2], the federal government, cantons and the communes each have responsibilities in relation to PCP and cooperate closely in this field.[3] Switzerland's PCP inventory, which is available to the public as an interactive geo-referenced map, is unique worldwide.[4] However, the system for protecting cultural property could still be improved, especially when it comes to measures to protect cultural property in the event of disasters and emergencies. The city of Geneva is a leader in this area in Switzerland and serves as a model.

The example of Geneva

Sixteen years ago in Geneva, the Department of Culture and Digital Transition launched a wide-ranging PCP strategy based on the Federal Act on the Protection of Cultural Property during Armed Conflicts, Disasters and Emergencies. This included the creation of a PCP committee, which plays a key role in developing an emergency response system. The committee is both a strategic and an operational body, responsible for overseeing measures to protect Geneva's cultural heritage assets. It plays a key role in developing and implementing the PCP strategy approved by the City of Geneva's Executive Council. This strategy meets federal obligations, setting out detailed measures to protect cultural property in the event of armed conflict, a natural disaster or emergency.

** Member of the Cantonal Commission for the Protection of Cultural Property (PCP) in the Event of Armed Conflict, Co-President of the Swiss Society for the Protection of Cultural Property (PCP)*
*** Member of the Cantonal Commission for the Protection of Cultural Property (PCP) in the Event of Armed Conflict*

[1] In Switzerland, the term 'cultural property', in reference to the terminology of the Hague Convention, is more commonly used than 'cultural heritage'.
[2] The legislation is available in German, French and Italian: ***Fedlex***
[3] For more information on how PCP is organised in Switzerland, visit the website of the Federal Office for Civil Protection (FOCP). ***The protection of Cultural Property in Switzerland***.
[4] The map can be accessed here: ***PCP Inventory***.

The PCP Committee is also a joint emergency response structure, pooling resources and skills for responding effectively in times of crisis. Its main objectives are to promote synergies between heritage institutions and external partners such as the Fire and Rescue Service (FRS), civil protection agencies and the Built Heritage Directorate (Direction du Patrimoine Bâti). It also has the task of anticipating disasters and coordinating a rapid response to safeguard cultural heritage assets.

The members of the PCP Committee offer a range of relevant skills: they include representatives of heritage institutions, specialists in conservation and restoration, safety engineers, building and information systems experts. They meet several times a year to discuss best practices and devise training events for museum, library and archive teams on crisis management and saving collections, with the help of experts from the Federal Office for Civil Protection (FOCP), the Civil Protection Organisation and the fire service. The Committee also conceived the BERCE PCP in 2013, a mobile container deployed for PCP operations, which at the time was a worldwide first example.

Finally, the Committee plans full scale exercises to keep improving PCP measures. In recent years, almost twenty exercises were carried out in Geneva's museums and libraries, including fifteen involving all the stakeholders, simulating a major incident.

1. The deployed BERCE PCP, used during the Leonardo exercise ©Ville de Genève

The 'Leonardo' Exercise was the most recent one conducted by the Geneva Public Library (Bibliothèque de Genève).

A look back at the Geneva Public Library's Leonardo exercise

An emergency strategy is not limited to drawing up an emergency plan and providing theoretical and practical training. It needs to evolve, and requires an operational assessment of emergency plans and their benefits. This assessment necessarily involves regular exercises to ensure that emergency plans are familiar and effective, and can be improved or even replaced. Assessment is a recurring process, adapted to staff turnover and feedback on experiences.

The aim of the exercises is to detect faults, identify inconsistencies and correct shortcomings with a view to refining emergency plans. They are also essential from a human point of view, to improve staff training and make the consequences of a disaster more tangible. They allow teams to share emotions and feelings, including those linked to the handling of damaged items, to alleviate the shock or any traumatic reactions in the event of a real disaster.

These full-scale simulations offer clear insights that only hands-on field experience can provide: how do you test a crisis team's ability to keep its cool, assess the responsiveness of those involved, or check the coordination between the emergency services, civil protection members and the staff of cultural institutions? How do you know what difficulties a fire engine might encounter on the ground, whether its ladder is long enough for the height of the building, for example? Is the communication by phone between the institution and the emergency teams reliable? How do you manage inaccessibility of data and inventories essential to rescue operations if the IT system is down? How can you deal with the shock, fatigue and despair of teams faced with damaged, burned or sodden with water cultural heritage documents or artefacts, making evacuation complex and challenging, without ever having experienced such a situation?

Aspects such as how the chain of command operates, understanding the problems, providing command support, using fire extinguishers, evacuating people, accessing digital data via the network, using emergency lighting in dark corridors, handling and transporting cultural goods, laying protective sheeting, stabilising humidity, assessing the damage and health measures to be taken, urgently triaging items, performing computer back-ups: all of these operations need to be tested under realistic, life-size conditions.

That's why, on 4 March 2024, the alarm sounded at the Geneva Public Library, marking the start of a full-scale exercise designed to test and optimise strategies for the protection of cultural heritage assets at risk. The event, known as the 'Leonardo' exercise in reference to a manuscript attributed to Leonardo Da Vinci, present in the institution's collection, involved 173 people from various organisations over two days. Participants included library staff, emergency services, and representatives of inter-

national institutions on site with the role of observers. Although the exercise lasted 48 hours[5], it required a year of preparation. It was organised jointly by the Geneva Public Library and the FOCP, with support from the other participant organisations.

Organising a simulation exercise: the preliminary operations

There are several key stages in organising an exercise simulating the rescue of cultural heritage collections:

1. **Defining objectives**: This crucial stage enables us to target what will be assessed and tested. The objectives must be set by all the parties involved, i.e., the institution, the fire service, civil protection officers, architects and other partners. For the Leonardo exercise, the objectives were as follows: to test the emergency plan in the event of a disaster involving cultural heritage collections by simulating a fire in the Library's basement; to test the training and readiness of those involved in a full-scale emergency situation by assessing the coordination between the various bodies involved in crisis management: fire, police and ambulance services and other partners. Finally, the exercise aimed to identify the adjustments needed to improve the responsiveness and efficiency of the teams in the event of a real incident.
2. **Devising a realistic scenario**: Once the objectives are defined, a credible scenario needs to be devised. To do this, it is useful to draw on existing risk assessments or known vulnerabilities that may affect a cultural institution, so as to simulate an incident with a low to medium risk of occurrence and a high impact.
3. **Coordinating the participants**: The preliminary stages also include coordinating the various participants: an in-house team from the institution involved in the exercise and external partners (fire brigade, civil protection, etc.).
4. **Appointing an exercise management team**: This stage involves setting up an exercise management team that is responsible for operations on the actual day of the exercise. This stage deals with coordination of the various phases of the exercise, ensures that everything runs smoothly, and triggers events to disrupt or improve the situation. The management team thus plays a key role in the real-time adjustment and assessment of procedures.
5. **Appointing referees**: The referees observe the exercise neutrally. Their role is to assess each stage objectively and to identify strengths and shortcomings. Thanks to their expertise, they provide critical feedback so that operational methods can be improved.

[5] The night was used to simulate a period when the police would have sealed off the building for investigation purposes. This enabled the crisis unit to practise resuming operations following a period in which the police had 'locked down' the building. From now on, every exercise carried out by the City of Geneva will systematically include this police procedural aspect, often neglected in institutional scenarios, despite its significant impact on PCP operations. This includes the time required for the investigation or the collection of evidence by the forensic police. Contrary to conventional belief, this type of procedure is not only required in cases of injury or suspected crime. A police investigation can also be launched for insurance reasons.

The Leonardo exercise implementation day

One crucial precondition of Geneva's PCP strategy since 2022 was that neither the staff nor the management of the institution concerned were informed in advance of the exercise date. This surprise element made it possible to measure the real indicators, such as the time taken to activate the crisis unit and the number of present employees on a normal workday. Only a selected number of people had been secretly informed of the date, to facilitate the coordination of certain phases of the scenario.

The Leonardo exercise began at 4pm when the alarm was set off due to a fire in the Library's basement. The simulated flames and smoke quickly spread upstairs, threatening both the collections and the historic building. Staff and members of the public were immediately evacuated, while the emergency services, including the Geneva Fire and Rescue Service (FRS), arrived on site to contain the fire, evacuate casualties and monitor the situation. At the same time, the Library's crisis unit was mobilised to coordinate the rescue of priority cultural heritage assets. The next step was the activation of a key component of Geneva's cultural heritage protection system, that is the Crisis Unit called to intervene in case of major incidents, such as the one simulated by the Leonardo exercise. This special unit plays a key role in conducting rescue operations, providing management, coordination, logistics and strategic communications.

2. The scene of the damage in the library. Hundreds of items designated for destruction were prepared for the exercise to simulate realistic fire, smoke and water damage ©Ville de Genève

Nevertheless, several complications arose. The lack of badges for firefighters temporarily restricted access to sensitive areas, while the absence of vertical compartmentalisation caused smoke to spread throughout the building, complicating the protection of collections on the lower levels. In addition, initial confusion regarding the assignment of roles within the Crisis Unit members occasionally delayed decision-making, requiring adjustments during the exercise to ensure a more efficient distribution of tasks. Interdepartmental cooperation was effective overall, though some difficulties in communication and the management of shared responsibilities persisted. In addition, insurance companies introduced additional restrictions for collections deposited by third parties, necessitating real-time adjustments, particularly for alternative storage locations of loaned artworks.[6]

The mission of this operational task force is to ensure a rapid and effective response to crisis by:

1. coordinating operations on the ground, gathering and providing information centrally and managing the teams responsible for protecting and evacuating collections;
2. applying the crisis management strategies defined in the emergency plans, while adapting measures to the realities on the ground;
3. supervising the logistics of the measures taken, in close collaboration with external partners such as the FRS, civil protection units and architects at the Built Heritage Directorate.

The crisis unit comprises directors of institutions, conservation and restoration experts, security and safety officers and collection curators. It also includes civil protection officers and applies rigorous crisis management methods. The primary missions of the crisis unit include assessing the situation, coordinating interventions, and quickly adapting strategies as the crisis unfolds. Managing human and material resources is also part of its responsibilities, as well as facilitating communication—crucial for centralising exchanges with on-site teams and external partners, such as insurers of valuable collections. The crisis unit's clearly defined hierarchical structure ensures optimal responsiveness.[7] Continuous evaluation

[6] A key challenge was managing artworks on loan from third parties and coordinating with insurance companies. These often highly valuable pieces presented specific difficulties. For some collections, the insurers demanded alternative storage locations that strictly complied with their security and conservation standards. For example, one collection's insurer refused to accept the City of Geneva's initial plan to relocate the collection, requiring the rapid identification of a more appropriate alternative. This change led to delays, as every location needed individual validation by each insurer to minimise the risk of uncovered damage. All in all, the exercise underlined the need for smoother procedures and prior agreements with insurers to ensure greater responsiveness in the event of a crisis.

[7] For instance, a security manager oversees the protection of works of art, while a logistics manager ensures the availability of evacuation equipment. The station manager centralises strategic decisions to maintain a comprehensive overview.

3. A unit of PCP specialists from the civil protection organisation preparing for their operation during the exercise ©Ville de Genève

procedures allow the unit to adjust its priorities and systematically document each decision. Compulsory training for its members is the key to the unit's effectiveness: all its members, including their deputies, receive specialized crisis management training – provided for several years by FOCP experts – enabling them to act quickly and in a coordinated manner in case of emergency. Roles and responsibilities are clearly defined upstream in the emergency plans, ensuring that tasks are carried out smoothly and efficiently. The crisis unit was one of the key elements evaluated during the exercise.

Results of the exercise

A total of 15 partner services, including the cantonal police, the civil protection organisation and fire service, contributed their expertise and 14 vehicles were deployed (front command post, fire engine, etc.) to ensure that the simulation ran smoothly.

At the end of two intense days, the teams successfully evacuated and dealt with the entire 70 linear metres of collections affected, stabilising the damaged areas on two floors (300m^2). Thanks to specialised equipment, in particular from the BERCE, the crisis unit container, but above all, thanks to the dedication of the staff, the teams were able to carry out their mission successfully. The feedback provided highlighted the areas and issues that need to be improved, particularly in terms of managing emergency equipment, adapting equipment to the specific architectural features of the building, and ensuring the safety of collections during rescue operations.

For example, after 10 years of existence, the effectiveness of the *BERCE PCP* is beyond question. However, this exercise confirmed the need of additional equipment for the City of Geneva. This new project, which will see the light in 2025, consists of a container or vehicle that can be mobilised rapidly. It will be fitted with additional equipment dedicated to handling heavy loads. Designed, once again, with the support of the fire and civil protection services, the vehicle will contain specialised equipment for handling cultural heritage property.

In addition, although the City of Geneva has in recent years been working on acquiring the digital technology necessary for emergency situations, for example by digitising documents containing crucial information regarding the rescue of prioritised cultural assets, feedback during exercises and disasters that have occurred has confirmed the need to maintain these documents in hard copy format.

Furthermore, in real-life situations, first responders need immediate access to the essential information available in these documents. It was therefore decided to install high-security safes in each institution, outside the buildings and close to the fire stations. These safes, accessible only to firefighters and security services, contain all necessary documents. This system, comprising 30 safes, will be deployed in 2025. It will enable firefighters to intervene more quickly and autonomously, thus strengthening their ability to respond effectively in the event of an emergency.

The strategy's effectiveness is largely based on the solidity and pooling of the organisational structures put in place by the City of Geneva, as well as on a close collaboration with the FOCP. The PCP Committee and the crisis units provide an essential framework for the protection of cultural heritage assets, ensuring the best possible response in the event of an incident. Through their role in planning, coordination and execution, these bodies play a key role in guaranteeing the preservation of Geneva's heritage and serve as a model for other institutions around the world.

The Leonardo exercise not only improved coordination and cooperation between the various local and international players involved in the protection of cultural assets, but also proved the fact that collective intelligence and collaboration are crucial in anticipating and managing cultural heritage crises effectively. In light of this experience and the actual incidents dealt with in the past, Geneva continues to assert its active role in safeguarding the city's heritage.

The next major exercise will take place in 2025 at the Geneva Museum of Art and History (*Musée d'Art et d'Histoire de Genève*). In order to be as realistic as possible, the scenario has been drawn up in consultation with all stakeholders, and will test the building's vulnerabilities, particularly in the exhibition halls, all of which feature monumental glass roofs.

Earthquake debris of cultural interest: the Italian methodology for their management, selection and reuse (Part b. Some examples after the Central Italy earthquake of 2016)

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Introduction

The article follows the first part[1] on the Italian methodology for the management, selection and reuse of debris of cultural interest and discusses several cases of debris management following the devastating Central Italy earthquake of 2016.

Italy is a country with a high seismic risk: in the last thousand years, at least 2,500 earthquakes with a magnitude greater than 5 have affected the country: of these, at least 15 have had catastrophic consequences, causing over 120,000 casualties.[2]

The high seismic risk of Italy depends not only, and not so much on the frequency and the intensity of earthquakes, but on the high population density of some areas; a built environment characterised primarily by historic buildings and their vulnerability due to their age, typological and constructive characteristics and poor state of repair.[3]

Over the years, the lack of adequate preventive measures has resulted in considerable damage to cultural heritage buildings, as well as enormous economic costs for the post-earthquake reconstruction.

2016 Central Italy earthquake

On August 24, 2016 a 6.2 magnitude earthquake hit Central Italy, involving 4 regions (Umbria, Lazio, Abruzzo and Marche), 140 municipalities and almost 100,000 inhabitants; among the most affected municipalities were the towns of Amatrice, Accumoli, Arquata del Tronto, Visso and Norcia, with 299 casualties and 400 injured.[4]

On 26 and 30 October, new severe quakes struck the same area, with a peak of 6.5 magnitude, stronger than the previous ones. Fortunately, this time there were no victims, due to the evacuation from damaged and vulnerable buildings after the previous seismic events. Many small towns and villages, that survived the first earth-

[1] ***PROCULTHER-NET 2 Project. Technical Bulletin, N. 3. July 2024***, p. 72-82. Accessed 12 November 2024. ISSN 2975-190X – ISBN 978-88-6864-548-9.
[2] Presidency of the Council of Ministers, Italian Civil Protection Department, ***National risk assessment***, 2018, 1, p. 5. Accessed 22 November 2024.
[3] In this regard, not only the natural deterioration of the materials, the changing environmental conditions and the poor state of maintenance are to blame, but also the numerous interventions that have succeeded one another over the centuries, which gradually altered the original construction plan, making buildings increasingly vulnerable to external actions.
[4] Fiorentino G., et al., 2018.

quake, suffered significant damage and losses on this second round of quakes. Other shocks with a higher magnitude than 5 occurred in January 2017.[5]

The epicentres spread partially overlapping with the one of the 1997 Umbria-Marche and 2009 L'Aquila earthquakes.[6]

Residential and public offices buildings, schools, hospitals, cultural heritage, livestock farms, and roads were severely affected, with considerable social and economic impacts; many consequent landslides and rockfalls were in part responsible for disruptions of the transportation system.

On 25 August 2016 the Council of Ministers declared the state of emergency, entrusting to the Civil Protection Department the coordination of the first emergency phase activities, which was managed by the National Emergency Command and Control Center (Di.Coma.C), established in Rieti. In accordance with the 2015 Directive[7], The Ministry of Culture activated the National Coordination Unit (UCCN-MiC) coordinated by the Directorate General for Cultural Heritage Security. UCCN in turn activated the Regional Crisis and Coordination Units (UCCR-MiC) in the four Regions involved, that ensures the operative procedures concerning cultural heritage, including damage assessment, cataloguing, securing movable assets, temporary storage management, site security measures, debris management, relocation of movable assets, on-site restoration interventions.[8]

Concerning the management, selection and reuse of debris of cultural interest, in the next paragraphs we will focus on two cases: the historic centre of Amatrice, a complex context with Type A, B, C debris, and the Church of San Salvatore in Campi (Norcia), an isolated single case with Type A debris.

The recovery of type A and type B debris in the historic centre of Amatrice

Amatrice, a small medieval town located on the border between the Lazio, Abruzzo, Umbria and Marche regions, suffered the most extensive damages caused by the 2016 Central Italy earthquake, both in terms of human losses and damage to constructions.

The results of the first survey indicated the total collapse of 40% of the buildings in the historical centre and partial collapse or a high level of damage to the other

[5] See note 4; for more details see also ***https://www.ingv.it/***.

[6] Presidency of the Council of Ministers, Italian Civil Protection Department – ***Disaster risk management training Seminars***, Di Bucci D., Dolce M., 2020.

[7] Directive of the Minister of Cultural Heritage and Activities and Tourism (subsequently renamed Ministry of Culture), 12 December 2013 "Procedures for the management of activities for the safeguarding and protection of cultural heritage in the event of emergencies resulting from natural disasters" and subsequent update Directive of the Minister of Cultural Heritage and Activities and Tourism, 23 April 2015.

[8] For more details: ***PROCULTHER Project. Key elements of a European Methodology to Address the Protection of Cultural Heritage during Emergencies,*** Città di Castello: LuoghInteriori, 2021. ISBN 978-88-6864-370-6. Accessed 23 November 2024.

ones. Photos taken following the October 26 and 30 quakes depict a massive pile of rubble in the town centre leaving only a few structures still standing.

1. Amatrice, following the August 24 and October 30, 2016 earthquakes
© Corpo Nazionale dei Vigili del Fuoco

The elevated destruction level was mainly due to the high vulnerability of the buildings, mostly made of cobblestone masonry. The main monuments like San Francesco Church, Sant'Agostino Church, the "Cola Filotesio" Museum located inside the Sant'Emidio Church and the Civic Tower, suffered severe damage after the initial August 24 earthquake. Unfortunately, the continuing sequence of aftershocks did not allow a prompt implementation of the necessary safety measures, hence the level of damage progressively worsened until reaching a state of total collapse.

During the first emergency phase, the Fire Brigade, together with the Army, and under the Di.Coma.C control and coordination, removed the rubble from the main roads, freeing a central strip of about 5.00 m width, to secure the area and allow the circulation of emergency vehicles.

In this first phase, technical experts from the Ministry of Culture were not granted access to the areas of intervention for safety reasons, thus making it very difficult to balance quick results with correct methodological approaches. Thus,

2. Amatrice, rubble removal from the main roads (first phase)
© Corpo Nazionale dei Vigili del Fuoco

it was decided to urgently proceed with the identification, selection and management of cultural heritage debris, especially in the case of rubble relating to urban aggregates and mixed waste. UCCR-MiC immediately began the task of identifying all buildings of CH interest and architectural value on the Amatrice cadastral map. Then, by overlapping the cadastral map on a high-resolution aerial photograph of the piles of rubble, different types of rubble (A, B and C) were identified.[9] Due to the seismic swarm, it was necessary to update the map with the piles of rubble classified after each aftershock. At the same time, some initial general operational instructions were planned.[10] The outcomes of this activity were shared regularly with the Civil Protection during coordination meetings held in the Di.Coma.C.

3. Amatrice, Sant'Agostino Church, recover of movable assets of cultural interest (9 sept. 2016); portal securing and facade debris covering with temporary tarpaulins (9 nov. 2016) - Ministry of Culture with the Fire Brigade operative support © Corpo Nazionale dei Vigili del Fuoco

As soon as it became possible to access the historic centre of Amatrice, all movable assets of cultural heritage interest, in particular, within the local museum, the Church of San Francesco and the Church of Sant'Agostino, were collected and transferred to the nearest temporary storage site located in Cittaducale (Rieti).[11] At the same time, with the support of the Fire Brigade, some temporary structural securing works were carried out as well as the covering of type A debris with temporary tarpaulins to protect the debris from adverse weather elements.

[9] See ***PROCULTHER-NET 2 Project. Technical Bulletin, N. 3. July 2024***, p. 77-78 and fig. 5 and 6; furthermore pp. 76-77 for the classification of cultural heritage debris and pp. 79-81 for the procedures. ISSN 2975-190X – ISBN 978-88-6864-548-9. Accessed 12 November 2024.

[10] Ministry of Culture, Directive of the Directorate General for Archaeology, Fine Arts and Landscape, 12 September 2016, n. 11087, "*Procedures for removing and recovering debris from assets of cultural interest and historic buildings*". See ***PROCULTHER-NET 2 Project. Technical Bulletin, N. 3. July 2024***, pp. 74-75. ISSN 2975-190X – ISBN 978-88-6864-548-9. Accessed 12 November 2024.

[11] For further details on cultural heritage assets security depots in emergencies, see Mercalli M., "*Security depots for the storage of movable cultural heritage assets in emergencies*", in ***PROCULTHER-NET Project. Technical Bulletin, N 1. March 2023***, p. 30-35. ISSN 2975-190X. Accessed 12 November 2024.

Once the initial emergency intervention phase was completed[12], a systematic plan for the removal of the rubble was drawn up, giving way to the second phase. The Lazio Region, through the Special Offices for Reconstruction (USR), was entrusted with the rubble removal and their placement in dedicated storage sites. The focus was on the debris within the perimeters of buildings and in particular within privately owned areas.[13] The activities were therefore carried out by dividing the historic centre area into "lots" and "quadrants".[14] For each lot, the unsafe and non-recoverable wall structures demolition and rubble removal were carried out

4. Amatrice, rubble removal within building perimeters (second phase)
© Corpo Nazionale dei Vigili del Fuoco

[12] First emergency phase lasted from Sept. 2016 to May 2017. At the end of the emergency phase, Di.Coma.C. was deactivated, and an *Extraordinary Commissioner of Government* was appointed to manage the reconstruction. At the same time, *Special Offices for Reconstruction* (USR) were established within the regional administrations. Within the Ministry of Culture, the Regional Crisis and Coordination Units were deactivated and the *Office of the Special Superintendent for the areas affected by the earthquake of 24 August 2016*, was created to coordinate and support the territorial Superintendencies.

[13] Due to the high level of devastation in the historic centre of Amatrice, as in many other municipalities, it was necessary to define specific provisions to reconcile the public interest in proceeding quickly with reconstruction with private property rights. According to Italian law, the latter are in fact owners of the area of the buildings and the related rubble, even if it was impossible, in most cases, to separate it from that of the surrounding buildings. In addition, there was also the question of the presence under the rubble of privately owned objects of considerable economic as well as emotional value. Specific indications in this regard have therefore been introduced in the Legislative Decree 17 Oct. 2016, n. 189, *Urgent interventions in favour of the populations affected by the seismic events of 2016*: art. 28 "*Provisions regarding the treatment and transport of material resulting from the partial or total collapse of buildings*".

[14] The division into lots facilitated the tender procedures, while the division into quadrants of each lot helped the operational aspects in reducing the risk of interference between the various executors, especially in the movement of heavy vehicles.

5. Amatrice, Ministry of Culture officials attending debris removal operations
© Corpo Nazionale dei Vigili del Fuoco

at the same time, applying the procedures envisaged for type A, B and C debris, as well as by other authorities for specific aspects (hazardous waste, asbestos, etc.).[15]

The start of the activities for each individual lot and the related timetable were communicated from time to time through public notices[16] issued by the municipality of Amatrice, to allow the competent authorities (Ministry of Culture if there were type A and/or B debris piles) or the owners to closely examine the material collected.

The type A rubble was managed directly by the Ministry of Culture[17]: when not feasible for the rubble to remain on site, it was transported to storages identified by the Ministry, who was responsible for selecting some outdoor areas or warehouses available by the Lazio Region or Municipality of Amatrice. The Region in agreement with the Municipality of Amatrice identified the storage sites for type B rubble. The sorting of this type of rubble took place partly on-site but mostly at the storage site. This phase lasted until March 2019.[18]

Management of the major monuments' rubble was particularly complex. For safety reasons, all recovery activities were carried out by specialized Ministry of Culture

[15] For more details on procedures, see ***PROCULTHER-NET 2 Project. Technical Bulletin, N. 3. July 2024***, pp. 79-81. ISSN 2975-190X – ISBN 978-88-6864-548-9.Accessed 12 November 2024.
[16] ***https://www.comune.amatrice.rieti.it/gestione-delle-macerie-di-amatrice/***
[17] Two officials from the Ministry of Culture (typically archaeologists, assisted by restorers and art historians) were consistently present during the removal operations. Private professionals also volunteered to support the Ministry's technicians. Civil Protection volunteers made a particularly valuable contribution, especially during the sorting phase at the storage sites. Under the coordination and instructions of the Ministry officials, they focused on identifying and selecting valuable elements—such as cornices, brackets, and capitals—from the piles of type B rubble removed.
[18] Second emergency phase lasted from July 2017 to March 2019.

technical experts, with the support of the Fire Brigade and the Carabinieri Command for the Protection of Cultural Heritage (TPC). While rubble removal operations were taking place, it was also necessary to secure the structural remains of the monumental or historic buildings. Moreover, rubble removal operations had to go hand in hand with the consolidation of the walls still standing.

6. Amatrice, San Francesco Church, rubble management and securing works. Type A debris were left on site protected in blue metal containers © Acaia 61 Studio Architecture ing. Stefano Podestà © Maria Agostiano

The recovery of the iconostasis fragments of San Salvatore Church in Campi (Norcia): a 'forerunner' site

The Church of San Salvatore in Campi, near Norcia in the Umbria region, has ancient origins dating back at least to the 12th century and has undergone significant transformations in the 15th and 16th centuries. Among the 15th-century interventions, the iconostasis stands out; it is an internal structure adorned with mural paintings and topped with a stone balustrade, which bears the engraved date of its construction, 1463.

*7. **San Salvatore Church, before 2016 Central Italy earthquake** © Silvio Sorcini – Wikipedia*

After the seismic event of August 24, 2016, which put the Church out of use, two strong earthquakes in October 2016, with their epicentre right in Norcia, further compromised the already precarious stability of the structure, causing significant collapses that raised concerns on the possibility of the complete collapse of the building.

8. San Salvatore Church, after Central Italy earthquake, 26 Oct. 2016. The aftershock on October 30, 2016, caused further collapse of the remaining left part of the facade and the wall between the two naves © Silvio Sorcini - Wikipedia

The morphological features of the Church and its conditions following the earthquake, immediately suggested that the case of San Salvatore Church and its peculiar and significant aspects could turn it into a "forerunner" site. In particular, the presence of many valuable elements (frescoes, stone and wooden features), the considerable amount of rubble that was hard to remove, without further compromising the structure, and the isolated site, with no accessibility ways, allowed for the drawing up of a standard intervention methodology that could be adapted for similar cases in the future.

A few days after the October 2016 earthquake, officials from the Ministry of Culture, in particular from the Central Institute for Restoration (ICR) and the Superintendence for Umbria intervened to secure the church and safeguard of its decorative elements. The primary objective was not to reconstruct it "where it was, as it was", but to gain an in-depth understanding of the work through a careful documentation phase.[19]

The adopted method, tested by the ICR, involves several phases[20]:

1. Protection of the building remains with a temporary steel cover and shoring of the right-side wall (Nov. 2016 - May 2017);
2. Securing still standing load-bearing structures and iconostasis[21]; recovery of frescoed blocks (June 2017 - April 2018);
3. Cataloging of the finds using a grid system[22]based on the area of discovery;
4. Transfer of the finds to a temporary depot near Spoleto;
5. Reassembly of iconostasis balustrade stone structure; reorganization, cataloguing and, if possible, reassembling of frescoed surface fragments.[23]

[19] Elements intended for future total or partial reassembly of the original decorative apparatus were chosen and recovered. These include decorative and sculpted fragments, stone blocks worked on at least one side, wooden furnishings and any other materials considered to have historical and aesthetic value. Surveys were conducted using various technologies, including drones and 3D laser scanners, to minimize the presence of operators in dangerous areas.

[20] This method was experimented starting after the Second World War and in particular in recent days after the San Francis Basilica vaults collapse during 1997 earthquake; see for more details G. Basile, 2007, pp. 100-108.

[21] The rubble entirely covered the building's ground area with an over 3 m height and extended beyond the external perimeter of the church. The removal activity, therefore, began from the external fringes in order to facilitate the securing operations.

[22] The selection of rubble was carried out, when possible, using the stratigraphic method of archaeological excavation. The ICR team identified, on a general orthophotographic map, sectors marked by different colours and labelled with letters and numbers. References to these sectors were noted on the non-valuable sections of the recovered objects, which bore the sector code made with the corresponding colour, thus making each element easily traceable to the extraction area. Fragments of particularly important architectural elements, such as the two portals, the two rose windows and the iconostasis, were promptly identified.

[23] The phase of organizing and cataloguing materials in the depot allowed for a clear identification of the elements that made up the *iconostasis*, separating them from others, and understanding the extent of the parts that could still be reconstructed. After separating the stone elements with sculptural decorations from those with fresco fragments, it was possible to reassemble the entire stone and painted balustrade of the architecture, recovered by 95%.

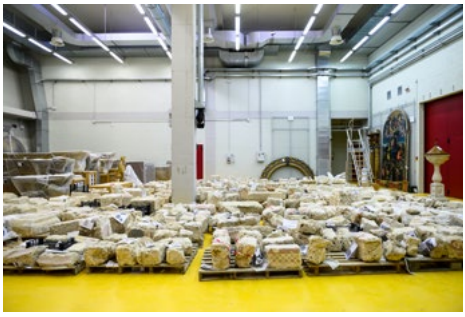
Issues and challenges

The complete collapse of the building and the compromise of the masonry presented a challenge in balancing the safety of the operators with the recovery and removal of the rubble. The interventions, coordinated progressively to avoid further col-

9. Covering walls and related debris with temporary tarpaulins, November 2016 © Silvio Sorcini/Wikimedia Commons

10. Securing lateral wall ruins with a temporary steel cover and bracing, April 2017 Wikimedia Commons

*11. **Securing works***



12. Sculptural and painting blocks selected and preliminarily classified in situ, then reclassified at the temporary depot near Spoleto © Maria Agostiano; © Umbria Superintendence

13. Cataloguing of painting blocks and reassembly of balustrade stones at the temporary depot © Umbria Superintendence

14. Reassembly of rose window stones at the temporary depot © Umbria Superintendence

lapses, included securing and disassembling the masonry, while restorers carried out pre-consolidation and protection operations for the decorations. An additional difficulty was identifying the provenance of the fragments from distinct decorative ensembles, compounded by the lack of photographic documentation and the poor visibility of distinguishing features on the varnished fragments.

How challenges were overcome

The deployment of a heterogeneous team composed of engineers, architects, restorers, art historians and surveyors, along with the synergistic work of specialists, enabled the recovery of almost all the authentic material bearing the historical and

aesthetic value of the Church's architecture.[24] The achieved result has allowed for a deep and thoughtful reflection on how and what can be relocated or reconstructed, providing a tangible sign of hope for the community affected by the earthquake. The project for the *in-situ* reconstruction of the *iconostasis* aims for a seismically resistant architecture that is structurally and statically independent from the rest of the Church, also thanks to the introduction of potentially reversible and distinguishable structural elements.[25]

Conclusions

Although expressly indicated for seismic events, the illustrated methodology can be used for any other emergency. Catastrophic events' debris management is a complex and time-consuming process, but essential for the reconstruction of the urban and social fabric.

The best solution would be to store selected rubble near the places it originally belonged to, as it maintains the connection with its relevant structures, facilitates reuse, and limits the costs of transportation and storage. Rubble management also requires specific ad hoc emergency storage facilities, which implies the need for large spaces, machinery for handling, as well as large costs for the personnel employed on a long-term basis.

The maintenance of debris *in-situ* is also crucial for the reconstruction and social aspects, since in small areas or towns the historical identity and legacy of communities is entrenched in the urban fabric, as well as in religious and monumental buildings.

In urban aggregates or entire historic centres, it is very important to preserve the memory of the pre-existing urban layout, by avoiding ground-level demolition and maintaining base wall parts as cornerstones for future reconstruction planning. Unfortunately, in Amatrice, the rush to provide a quick response to reconstruction expectations made these considerations appear negligible and today the historic centre looks like a desolate heath in which the main reference point remains the Civic Tower as the only standing symbol of the reconstruction process.

The restoration of the Civic Tower of Amatrice is also an example of reusing type B rubble. In the case of type A debris, the implementation of the strategies developed by the Ministry of Culture has allowed the recovery of many cultural heritage assets of great value, considered lost, as the case of San Salvatore Church demonstrates.

[24] Nearly 30,000 small fragments have been dusted, sorted and photographed, constituting 2 m^2 of painted surface that can be confidently reallocated. Almost 500 catalogued macro-fragments on blocks enabled the recovery and reassembly of 95% of the iconostasis.

[25] Thanks to the Central Institute for Restoration colleagues Stefania Argenti, Maria Elena Corrado, Serena Di Gaetano and Federica Giacomini, for the documentation and suggestions provided regarding their work on the Church of San Salvatore a Campi.

15. Amatrice, Civic Tower, before and after the 2016 Central Italy earthquake; reconstruction and restoration works (2022-2023). The stone blocks recovered from the rubble of surrounding buildings (Type B debris) were reused for wall reintegration and the masonry cladding of the new bell tower © Maria Agostiano © Corpo Nazionale dei Vigili del Fuoco

The steps forward compared to previous earthquakes are significant: rubble management has produced remarkable results in the cultural heritage recovery of affected communities, providing a fundamental contribution to their material reconstruction and preservation of their immaterial legacy.

The role of the Italian National Fire and Rescue Service for the protection of cultural heritage during emergency

Ciro Bolognese, Structural Engineer, Fire Chief - Alessandria Fire Brigade, National Fire and Rescue Service, Italy

Introduction

Following a disaster, Italy activates the national civil protection service to manage the emergency. The Italian National Fire and Rescue Service (NFRS) is the core component of the service and has a long tradition in interventions for the protection of cultural heritage. This paper describes the activities of the NFRS during an emergency, particularly the procedures applied for damaged buildings. In conclusion, the paper shows the results achieved by applying the procedures in place to a church damaged by the 2016 Central Italy earthquake.

Italy is the country with the largest number of UNESCO World Heritage Sites. Within the national cultural heritage framework, there are 55 World Heritage Sites and 12 included in the list of intangible cultural heritage sites. Unfortunately, however, Italian territory is also well-known for its high seismic and hydrogeological risks, as proven by the many severe earthquakes of the last century (e.g. Messina 1908, 7.2 Mw, 80,000 victims - Irpinia 1980, 6.9 Mw, 2,734 victims, Friuli 1976, 6.4 Mw, 965 victims, L'Aquila 2009, 6.1 Mw, 309 victims) and floods that hit the regions of Tuscany and Emilia Romagna in 2023, or other disasters (e.g. Piedmont flood in 2000). For these combined reasons, Italy's rich cultural heritage is constantly threatened by natural hazards and risks stemming from human activity. This complex scenario has led to a raised awareness and increasing efforts toward the development of the national civil protection service, which includes several organizations, both local and national, working in close cooperation also for the protection and safeguard of cultural heritage.

The NFRS is the fundamental component of the civil protection service, as established by Legislative Decree of 2nd January 2018, n. 1. The NFRS has since then been held responsible by law for the direction and responsibility of technical rescue operations and activities. The NFRS deals with the rescue of people in the immediate aftermath of emergency events, operating for the safeguard of assets at risk, including strategic infrastructures and cultural heritage sites. NFRS activities also aim at avoiding further damage caused by any emergency or disaster scenario's evolution, including seismic aftershocks or increasing water levels due to floods.

The first phase of emergency involves the intervention of USAR (Urban Search and Rescue) teams to rescue people trapped under the rubble or flood rescuers in case of floods and river overflows. All human resources involved in emergency relief op-

erations are coordinated by firefighting officers, including approximately 1.000 engineers and architects. During the rescue operations, immediate assessments are conducted based on reconnaissance of the affected area, guiding the allocation of necessary resources and the development of the most effective intervention strategy. These initial and critical operations involve structural assessments of endangered buildings affected by events such as earthquakes or floods, which may have caused significant damage, increasing the risk to both occupants and cultural heritage assets.

In this context, NFRS personnel work alongside those of the Ministry of Culture, the Department of Civil Protection and the Municipalities to operate inspections of sites classified as cultural heritage, to assess buildings' damage and to evaluate the necessary safeguard actions. These activities include, if possible, the removal of artworks and their relocation to safe areas or their onsite protection. The removal of the works very often concerns severely damaged buildings with partially collapsed roofs. In such cases, the NFRS intervenes with SAF (rope rescue specialists) personnel who recover the works by sliding down on ropes from above to reduce their exposure to the overall risk.

1. The recovery of an ancient painting from Sant'Agostino church (Amatrice, Italy 2016) © Corpo Nazionale Vigili del Fuoco

An additional and crucial activity of the NFRS concerns the implementation of short-term countermeasures including the identification of restricted areas, the removal of unsafe parts, shoring and other temporary support systems.

The goals of these interventions are to:

- support the damaged buildings
- prevent further damage due to the aftershocks
- avoid collapses on other buildings or roads

However, these operations do not include to:

- restore the loadbearing capacity
- return to the original position of damaged elements
- operate a final restoring action

Documents from the earthquakes of Avezzano (1915, Central Italy), Belice (1968, Southern Italy), Friuli Venezia Giulia (1976), prove that Italian firefighters have a long history in securing damaged buildings. The shoring interventions usually consisted of wooden supports, as this material was easily available and processed by the workers.

After the 1997 earthquake in Umbria (Central Italy), the first operational safety procedures were developed and new materials such as steel tubes were used for the first time.

The earthquake that struck L'Aquila in 2009 led to the establishment of a wide off limits "red zone" (a restricted access area due to unsafe buildings/structures conditions) including the entire historical city center. Most of the city's cultural heritage assets was lost or severely damaged, as was the highly compromised road system: the size of the scenario imposed a rapid response to simplify, standardize and accelerate emergency management processes.

In light of the high-value of the cultural heritage affected by the disaster, a specific and highly trained task force called NCP (Nucleo di coordinamento delle opere provvisionali – Special Unit for temporary countermeasures) was created within the NFRS in collaboration with the University of Udine. The NCP performed the following activities:

- Definition of standards and technical solutions for short-term countermeasures
- Development of technical and organizational procedures for the management of interventions in agreement and in collaboration with other institutions (local authorities, Ministry of Cultural Heritage and University)
- Monitoring of the interventions in progress
- Provision of technical advice, information and staff training for complex operations.

The NCP work and experience produced an outstanding outcome of operating procedures named STOP (Shoring Templates and Operating Procedures). The STOP handbook[1] includes several templates for the construction of different types of short-term countermeasures, including shoring or steel cables ties systems, and is an operational tool that provides pre-defined and designed solutions, without requiring any detailed calculation on site. The procedures are mainly focused on cultural heritage buildings but can be widely adopted for any kind of buildings including strategic infrastructures. The design is based on physical hypotheses presented in another NCP publication[2] and on structural calculations performed in compliance with the Italian National Technical Construction Regulation.

It is important to underline the key value of the STOP handbook for its application to historical buildings due to the complete removability of the adopted systems that is then compatible with the following and definitive restoration phase.

The fire officer responsible for operations, once the intervention scenario and the damage conditions of the building are defined, finds the proposed construction solutions and the sizing of the system components in the technical templates. These outcomes and technical decisions are based on the geometric dimensions of the building to be supported, which must be assessed and evaluated on site, within other critical aspects that can arise from the specific problem. The templates also report the field of application and the limits of use. In case of application of this plan, a specific design is required.

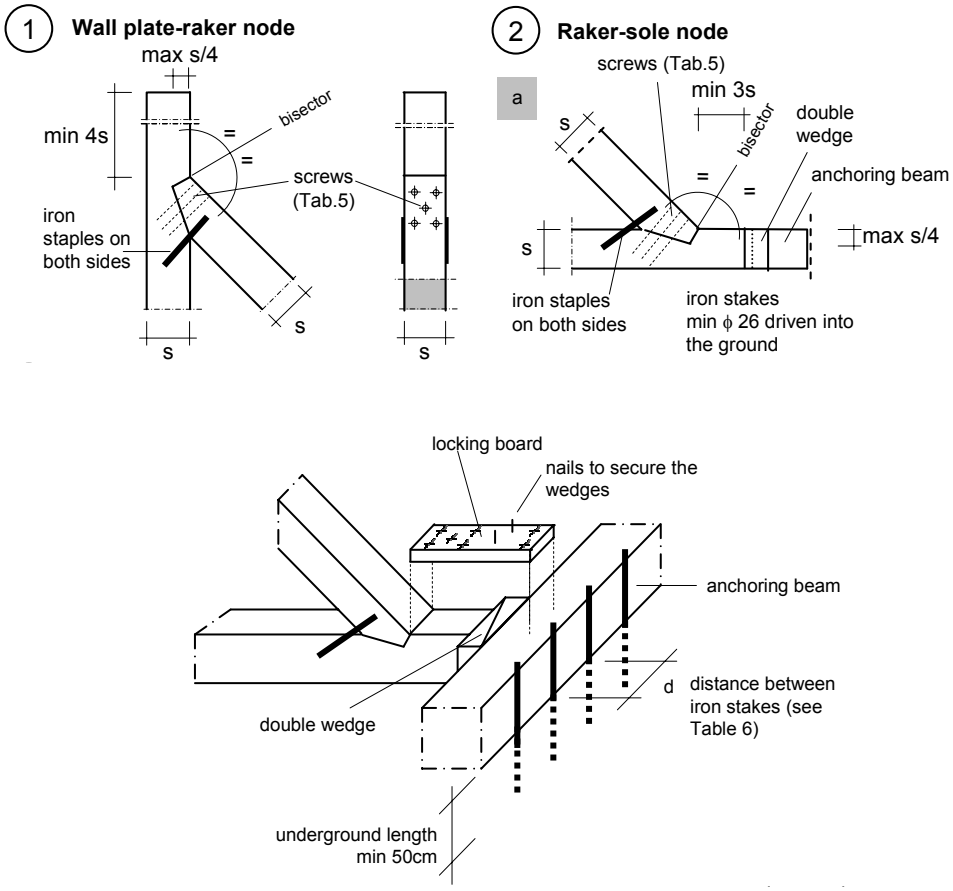
The STOP files present the construction details needed to avoid global and localized critical issues. One of these is related to the assembling of wooden shoring systems, normally performed only by nails. In this case, these operations must be performed through recesses and connections with screws or other metal elements for effective results.

A further crucial point of interest regards the safety of the personnel who carry out the interventions during a seismic emergency. During the operations, seismic aftershocks are frequent along with the risk of further collapses of structural or sec-

[1] Grimaz S., Cavriani M., Mannino E., Munaro L., Bellizzi M., Bolognese C., Caciolai M., D'Odorico A., Maiolo A., Ponticelli L., Barazza F., Malisan P. and Moretti A.; 2010: Schede tecniche delle opere provvisionali per la messa in sicurezza post-sisma da parte dei vigili del fuoco (Shoring templates and operating procedures for the support of buildings damaged by earthquakes). Corpo Nazionale dei Vigili del Fuoco, Roma, Italy, 128 pp., (in ***Italian***, ***English*** and ***French***). *Manuale e Vademecum STOP* Accessed 24 November 2024.

[2] Grimaz S., Cavriani M., Mannino E., Munaro L., Bellizzi M., Bolognese C., Caciolai M., D'Odorico A., Maiolo A., Ponticelli L., Barazza F., Malisan P. and Moretti A.; 2010: Manuale opere provvisionali. L'intervento tecnico urgente in emergenza sismica. Corpo Nazionale dei Vigili del Fuoco, Roma, Italy, 410 pp. (in Italian). ***Manuale e Vademecum STOP***. Accessed 24 November 2024.

Local solutions



2. Construction details for timber raker shores (ref. STOP-PR)

ondary elements. The intervention plan thus must consider the risk elements and is normally set in a progressive way as each step increases the level of safety and allows the execution of the following step. Therefore, the structures are built in a safe area and then moved on site, liaising with the construction team to reduce the personnel's risk exposure time.

It is important to remark that the structures shown in the STOP handbook are different from those used for USAR purposes, as they are intended to remain on site longer, with the possibility of being adjusted after construction to consider the withdrawal of materials and to ensure effective adhesion and support to the damaged building (i.e., they are not considered for short-term search-and-rescue goals).

3. Steel tubes shoring at Sant'Andrea church (Muccia, Italy 2016) © Corpo Nazionale Vigili del Fuoco

Case study

A particularly interesting example of intervention was adopted for the Basilica of San Benedetto in Norcia. The Church was severely damaged after the 2016 earthquake, leading to the almost total collapse of the building, except for the façade, which remained standing. The lack of supporting elements to the rear walls, however, made the façade particularly vulnerable to subsequent after-shocks with the risk of collapse involving the square and nearby buildings, where the rubble was located after being covered with sheets to protect it from weather conditions.

The scenario was very complex due to the proximity of another critically damaged building: the bell tower of Norcia.

In case of aftershocks and further collapses, the fire service working on site as well as the Basilica's facade would have been at risk. The first preliminary intervention was aimed at securing the bell tower through five steps:

1. application of polyester ratchet straps to temporarily brace the belfry
2. shoring of arches on three side
3. removal of bells
4. application of steel ropes replacing polyester straps
5. shoring of the fourth side

4. Application of polyester ratchet straps to temporarily brace the belfry (Norcia, Italy 2016)
© Corpo Nazionale Vigili del Fuoco

Once the bell tower was secured, the design team decided to adopt a short-term countermeasure for the Basilica, consisting of a steel tube structure (16 meters high and 22 meters wide with variable depth) to be put in place in the area in front of the church to avoid overturning towards the square.

The metal structure was built in cantilever and connected to the main one as no structures could be supported on the ground in the area behind the church due to the presence of a large amount of rubble.

Since the entire structure had to remain removable, it was not tied to the ground but fixed at the ground by big sandbags and concrete prisms. The entire structure was built far from the church in a safe area and subsequently moved to its final position using a crane from a private company. This way the façade was secured allowing the rubble to be removed and reconstruction work to begin.

Conclusion

The Italian National Fire and Rescue Service (NFRS) has a crucial and decisive role in safeguarding cultural heritage following disasters such as earthquakes and floods, in the framework of the civil protection service. Its commitment to preserving heritage sites underscores the importance of cultural identity and continuity in the face of adversity.

5. Installation of front steel tubes structure (Norcia, Italy 2016) © Corpo Nazionale Vigili del Fuoco

Through planning and training, the NFRS personnel are then prepared not only to face fires but also to protect invaluable artifacts and structures. The expertise in rapid response and recovery operations has proven vital in minimizing damage and facilitating restoration efforts following natural or human-caused disasters. The collaboration framework with cultural heritage organizations enhances their effectiveness, allowing for a more integrated, flexible and multidisciplinary approach to disaster management and recovery.

The operating procedures drawn up for the protection of damaged buildings have been widely applied during the seismic and flood emergencies that struck Italy and are available to other countries to be replicated. As Italy continues to face various risk-related challenges, the know-how of the NFRS remains a fundamental aspect for preserving the Nation's rich history.

In this context, the synergy between emergency services and cultural agencies is of vital importance to ensure that future generations can admire and learn from Italy's extraordinary cultural legacy.

The Metaponto model: the case study of CNR-IMAA as a high road in monitoring for the preservation of archaeological and natural areas

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Introduction

The concept of shared cultural assets originates from ancient civilizations. The Romans, for instance, regarded Egyptian antiquities as collective goods worthy of protection. Throughout history, there has been a consistent emphasis on preserving cultural heritage.

In the Middle Ages and the Renaissance, preservation efforts were motivated by religious and artistic reasons, such as those evident during the Grand Tour. G. Granata describes this period as "*almost a kind of secular pilgrimage to the roots of one's own culture*".[1]

In contemporary times, globalization and technological advancements have transformed cultural heritage into a central and dynamic issue. This shift has broadened preservation interests to include economic and commercial aspects. Consequently, the risk factors leading to the destruction of cultural heritage have changed significantly in recent years.

Case Study

The risk factors taken into consideration can be of a dual matrix: natural earthquakes, landslides, floods, tsunamis, and fires) or as in the dynamics of climate change on a global scale, and the anthropogenic (pollution, heavy agriculture and land use, urban sprawl, war or looting events, excessive tourism).[2]

Extremely innovative, and at this point essential in the history of cultural heritage prevention, is the approach taken by the CNR-IMAA in the case of the archaeological area of Metaponto[3]: the choice of this archaeological site located in southern Italy, precisely in Basilicata, in the Gulf of Taranto, overlooking the Ionian Sea, was

[1] Granata G., Presentazione, in Sabba F., *Viaggi tra i libri. Le biblioteche italiane nella letteratura del Grand Tour*, Pisa-Roma, Fabrizio Serra Editore, 2018, p. 15

[2] Pedersoli J. L., Antomarchi C., Michalski S., Aslan Z., Sabik A., *A Guide to Risk Management of Cultural Heritage*, Ottawa-Ontario-Canada, ICCROM - Canadian Conservation Institute, 2016.

[3] Fattore C., Abate N., Faridani F., Masini N., Lasaponara R., *Google Earth Engine as Multi-Sensor Open-Source Tool for Supporting the Preservation of Archaeological Areas: The Case Study of Flood and Fire Mapping in Metaponto, Italy*, Sensors 2021, 21, 1791.

motivated, as well expressed in the referenced article, by the elevated incidence, in recent years increasingly impactful, of risk factors due to natural and anthropogenic events (fires, floods, shoreline change).[4]

The National Research Council, particularly the Institute of Environmental Analysis Methodologies, has long been engaged on such issues with several projects, such as the FIRESAT project, useful for land management related to fire risk and the study of these events, in support of Italian Civil Protection activities.[5]

The FIRESAT project, supported by the Civil Protection of the Basilicata Region (see **FIRESAT** 2023-2024 - Sperimentazione Di Tecniche Eo Per La Ottimizzazione Dei Prodotti Copernicus Per Il Monitoraggio Incendi - Regione Basilicata. I Agosto 2023 - 31 Luglio 2024), aimed to develop a cost-effective method to monitor fire danger and estimate its effects using satellite-based Earth observation technologies. Specifically, the project used NASA's Moderate Resolution Imaging Spectroradiometer (MODIS), together with ASTER and Landsat TM data, and weather and topographic data, to monitor fires. The ARGON Laboratory of the CNR-IMAA experimented with new data processing techniques for this purpose. In particular, in this operational scenario, the CNR - IMAA is responsible for providing daily fire risk maps to the civil protection authorities, published on the organisation's website, as described in the "PIANO ANTINCENDIO REGIONALE (P.A.R.)".[6]

This focused on a model for estimating the fire risk, which has been effectively used from 2008 to the present. It served as a reliable tool to support and improve fire management strategies, from initial warning to resource allocation and direct firefighting efforts. The methodology involved daily updating of fire hazard levels, using freely available MODIS satellite images chosen for their spectral capabilities. This approach provided a systematic, daily and sustainable low-cost solution for monitoring large areas, enabling the Civil Protection Department to identify regional areas at greatest fire risk.

In recent years, using open-source technologies such as Google Earth Engine (GEE) and utilizing data made available by the European Space Agency (ESA) through the Copernicus programme, researchers using Sentinel-1 and Sentinel-2 and machine learning algorithms have focused on the analysis and characterization of fires such as: (i) automatic perimeter systems for burnt areas; (ii) identification and estimation of fire damage; and (iii) analysis of the recovery capacity of the vegetation involved.

[4] Fattore C., Abate N., Faridani F., Masini N., Lasaponara R., 2021, p. 1.
[5] Lanorte A., De Santis F., Aromando A., Lasaponara R., ***Low Cost Pre-operative Fire Monitoring from Fire Danger to Severity Estimation Based on Satellite MODIS, Landsat and ASTER Data: The Experience of FIRE-SAT Project in the Basilicata Region (Italy)***, in: B. Murgante *et al., Computational Science and Its Applications - ICCSA 2012. ICCSA 2012. Lecture Notes in Computer Science*, vol 7335. Berlin - Heidelberg, Springer, 2012. Accessed 26 November 2024.
[6] Regione Basilicata, ***Piano Antincendio Regionale (P.A.R.)***, Accessed 26 November 2024

From the experience, still active today, of the FIRESAT Project, CNR has developed other projects related to monitoring and prevention of damage and risk in areas of Cultural and Natural Heritage.

The CNR-IMAA team evaluated, as part of the COELUM[7] project and other activities, the use of open data and technologies to create an operational system useful for risk management and, in particular, post-event crisis management, when timely and up-to-date synoptic information is needed to better understand the spatial and temporal scale of damage and improve the mitigation strategy required immediately after events.

For the proper realization of a valid and exportable model at least at a national scale, extremely useful and at the same time innovative it turned out to include within the data package not only the archaeological site itself but the whole surrounding (naturalistic-environmental) context: it provided for the use of remote and earth observation technologies, which, connected with some satellite platforms that allow for constantly updated data, enabling those who coordinate post-event management to perform multitemporal and multisensory analyses hence to build a real model of intervention.

As expected, this approach has been recognized by the scientific community as a game changer, this time actually enabling the creation of models that are scalable and exportable to other similar contexts.

There is, however, an urgent need to simplify operations for the selection and analysis of the data provided through this process, so that it can be increasingly implemented in cultural heritage management systems.

In response to the complex articulation of information emerged through these technologies, the CNR-IMAA group[8] proposes the use of Google Earth Engine[9], which allows for streamlining data storage and calculation operations due to its very nature: Google provides, through a simple registration at no cost, a cloud for data storage, therefore facilitating the application of algorithms and analysis and eliminating the time-consuming steps of downloading and pre-processing data.[10] Above all, the approach to satellite data via GEE is completely free and open source and allows users to save a great deal of time and money by using Google's platform for both ingestion and processing of data and downloading of results.

The results of the analysis taken as a model here clearly highlighted the extreme usability of Google Earth Engine for the assessment and mapping of areas affected by fire and flood, due to the ability to integrate different datasets rather simply:

[7] ***http://www.coelum.cnr.it/***
[8] ***https://www.imaa.cnr.it/***
[9] ***https://earthengine.google.com/***
[10] Fattore C., Abate N., Faridani F., Masini N., Lasaponara R., 2021, p. 20.

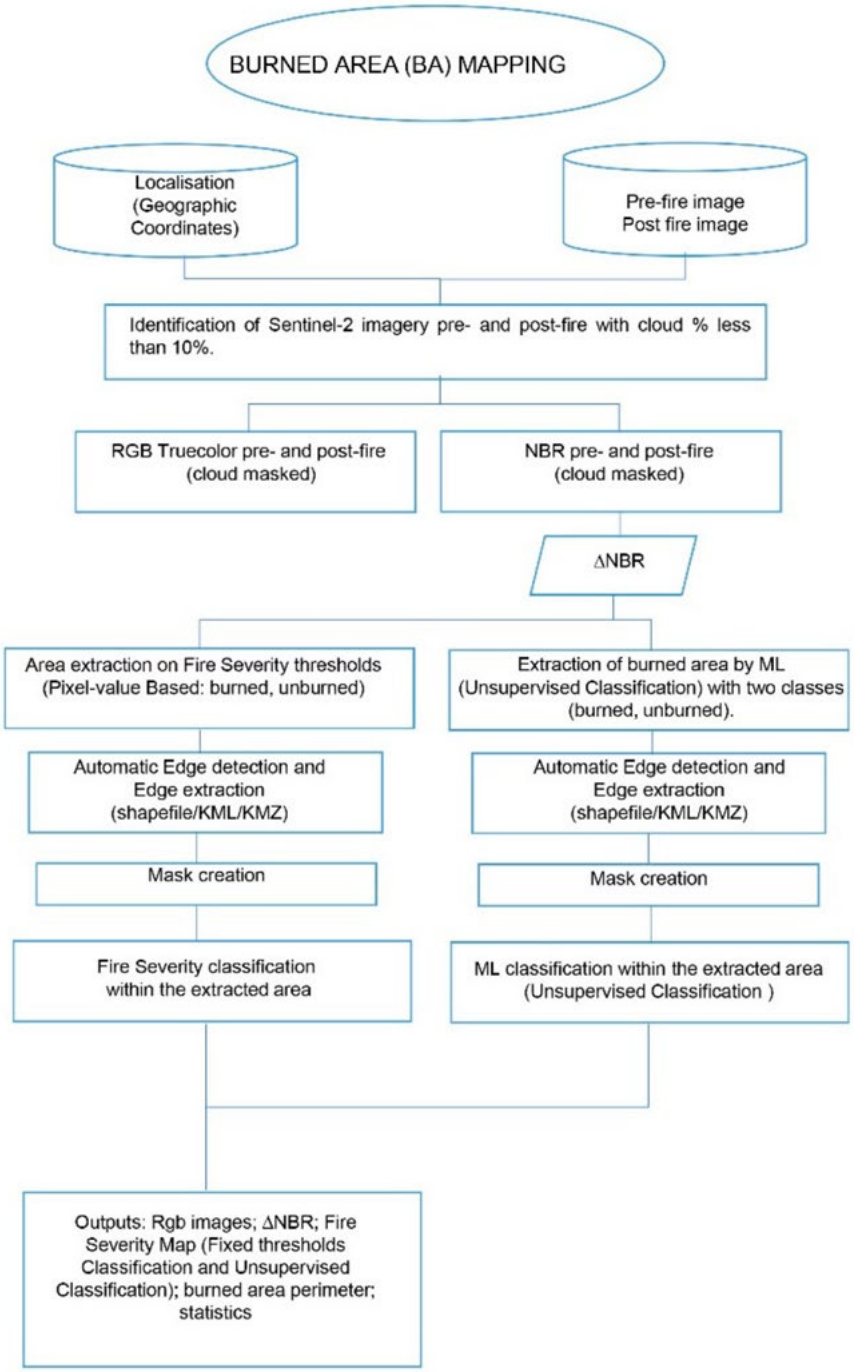
moreover, any code produced in this platform can be easily disseminated through official Google channels, allowing for easy situational scalability.

This project evaluated the capability of a methodology based on Sentinel-2 images to map both burnt areas and burn severity (i.e., fire damage to vegetation) near the archaeological area of Metaponto. The methodology herein proposed was optimized through the use of the Google Earth Engine cloud computing platform. The Google Earth Engine platform was essential at all steps of the processing, starting from the image visualization obtained in a few seconds, useful to select the most suitable pre- and post-fire images, without having to download or request them through the Copernicus Hub, provided by the European Space Agency (ESA). Moreover, the results achieved showed that the process of burnt area identification and fire severity calculation, in different ways, can be done very quickly thanks to the computational power of the Google Earth Engine platform. Similarly, in addition to the processes on satellite data of supervised or rule-based classification, machine learning and deep learning classification processes can also be integrated, with remarkable results, allowing the system to identify burnt areas and fire damage, as well as the assessment of preventive risk parameters, in a completely autonomous way. Burnt area mapping allows the visualization of fragile areas that are sensitive to fire damage, especially if these are conditioned by several elements such as the morphology of the territory, natural components of combustion (vegetation, soil moisture), and meteorological characteristics.[11] Above all, the results showed the great potential of the Google Earth Engine tool and its useful role in risk and damage management and monitoring. The methodology, as illustrated in the workflow (Figure 1), also demonstrated promising results for burnt area mapping, showing its potential to support further assessment of the environmental impacts of burnt area at regional, national, and global levels, and to support fire risk management.

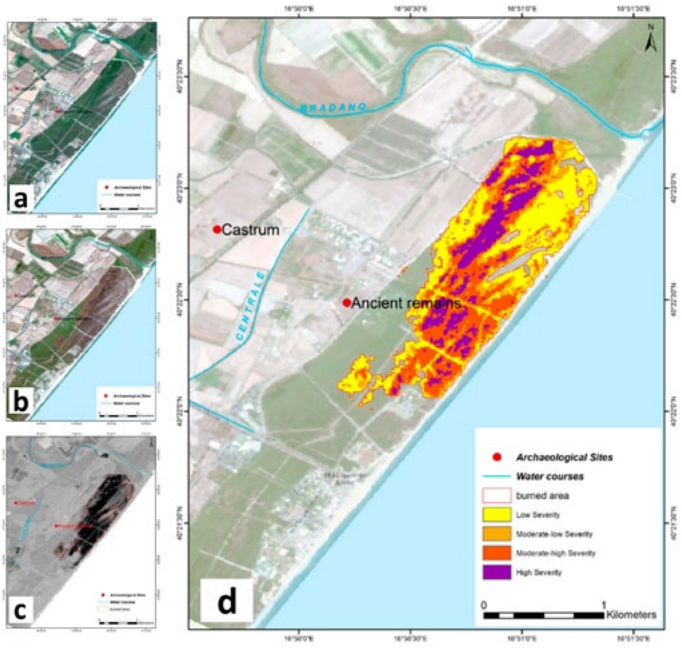
This is particularly relevant for the preservation of high-value heritage as natural and cultural properties and archaeological areas, that are unique and cannot be replaced if lost. Moreover, the impact of fire events affects the tourism sector and in turn, the local economy as occurred in the Ionian coast of the Basilicata region (Southern Italy) where the fire of 2017 also impacted the camping area which was evacuated for security reasons as well as to facilitate fire extinguishing operations

This simplicity in situational scalability makes this approach innovative, but even more impactful. Using combined data, as in the case of Metaponto, it is possible to overcome the limitations associated with a single range of information by matching these together and obtaining, through the Google platform, decidedly new and ready-to-use results.

[11] Oakley N. S., Cannon F., Munroe R., Lancaster J. T., Gomberg D., Ralph F. M., ***Brief communication: Meteorological and climatological conditions associated with the 9 January 2018 post-fire debris flows in Montecito and Carpinteria, California, USA***, Nat. Hazards Earth Syst. Sci., 18, 2018, 3037–3043, Accessed 26 November 2024.



1. Flowchart of automatic fire area extraction operations and effects on vegetation (from Fattore et. al. 2021, fig. 6)



e

Classification Type	High Severity	Moderate – High Severity	Moderate-Low Severity	Low Severity
Unsupervised	39.23 ha	47.8 ha	31.96 ha	52.7 ha

2. a) Sentinel-2 pre-event image; (b) Sentinel-2 post-event image; (c) deltaNBR to improve visiblity of the event; (d) automatic extraction of fire severity and fire perimeter; (e) statistics of the impact of the event on vegetation (from Fattore et. al. 2021, edited by the authors)

The geospatial situation of the archaeological area of Metaponto relates in pattern to other realities of archaeological parks particularly across southern Italy, but even throughout the Italian peninsula and beyond.

In this regard, therefore, the hypothesis of a 'Metaponto model' in each similar reality is to be able to structure and coordinate it as centrally as possible, a post-event response that is gradually more uniform and at the same time punctual.

This approach has been evaluated positively by the international scientific community so much so that it has been used abroad by the CNR IMAA itself, in a joint work with the CNR-Institute of Cultural Heritage Sciences (ISPC), to study fires in the archaeological area of Machu Picchu (Perù).[12]

[12] Lasaponara R., Abate N., Fattore C., Masini N., Open Big Earth Observation Data and Artificial Intelligence for the Study and Preservation of UNESCO Natural and Cultural Heritage: The Case of Machu Picchu, in: Ziółkowski M., Masini N., Bastante J. M. (Ed.), *Machu Picchu in Context: Interdisciplinary Approaches to the Study of Human Past*, 2022, 239-264.

Conclusion

The document presents an innovative approach developed by CNR-IMAA for monitoring and preserving archaeological areas, using the Metaponto area as an emblematic case study. This model, which we could refer to as the "Metaponto Model", innovatively integrates remote sensing technologies, Earth observation, and satellite platforms to conduct multitemporal and multisensory analyses.

The "Metaponto Model" has proven its effectiveness in mapping burned areas and assessing fire severity, offering a powerful tool for risk management and damage monitoring. Its flexibility and adaptability make it potentially applicable to various archaeological sites, not only in Italy but also globally.

At present, this tool is twofold and allows us to report the areas at greatest fire risk on a day-to-day basis, using algorithms based on satellite data, topographical data and meteorological data, and to estimate the damage of the events that have occurred in terms of extension and damage to vegetation, useful for estimating factors such as: economic damage produced, risk to structures (including cultural heritage) present, and estimation of risks related to fire events (e.g. hydrogeological risk).

The success of this approach in Metaponto has already led to its application in other contexts, such as the archaeological area of Machu Picchu in Peru, demonstrating its versatility and international relevance. This model represents a significant step forward in the management and preservation of cultural and natural heritage, offering new possibilities for rapid and effective response to risk events.

In conclusion, the innovative approach of the "Metaponto Model" could revolutionize risk management and cultural heritage conservation. By providing more effective tools for the protection of unique and irreplaceable sites, this model opens new pathways for the safeguard of our cultural and natural heritage, stressing how the integration of advanced technologies can significantly contribute to preserving our history and environment for future generations. Today, thanks to the input of new, continuously updated open source datasets and increasingly high-performance computing resources, the GEE platform makes it possible to use various methodologies, including the one illustrated, to create monitoring systems that are increasingly useful for the protection of Cultural and Natural Heritage. There are many research experiences published by the scientific community in recent years involving more and more actors such as research organisations, national and international institutions, in particular, great developments are taking place in the monitoring of large nature reserves and archaeological park areas, which, especially in 'hot' areas such as places without adequate prevention and protection legislation or war zones, can hardly be monitored adequately.

Remote sensing responses to hazard and damage assessment over archaeological and cultural heritage sites at risk

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Introduction

Natural hazards and anthropogenic land-use pressure result in destructive events occurring at increasingly higher frequencies, causing severe damage to Archaeological and Cultural Heritage (ACH) sites. The German Archaeological Institute (DAI), together with its partner organizations, the Federal Agency for technical Relief (THW) and the Leibniz Institute for Archaeology (LEIZA), has initiated the project KulturGutRetter ("cultural heritage responders") to assist with cultural heritage disaster recovery around the globe. It will be able to deploy its Cultural Heritage Response Unit (CHRU) in the framework of International Disaster Relief. As part of this project, the remote sensing and monitoring unit has to provide cost-effective support based on multi-source satellite datasets to assess damages and planning on the ground. In order to do so, we categorize our studies into three main approaches: preventive measures, times-series analysis (or monitoring), and rapid response. This paper provides a general overview of each of them, the types of available data, methods and their application in case of emergencies. Furthermore, we also discuss how to access different datasets through our partner institutions or subscriptions.

Remote Sensing methods and techniques have a variety of applications in research and everyday life. Starting from ground-based to space-borne technologies and measurements, they help us to understand and monitor the environment around us. One of the most important applications of these methods is for monitoring changes, observing and measuring damages caused by various hazards to human lives as well as archaeological and cultural heritage sites. The general application of different remote sensing methods on various levels has been discussed before including potentials of historical imagery and that of modern programmes such as Copernicus.[1]

Applications such as detection of Roman roads using multi- and hyperspectral drone imagery together with statistical analysis and unsupervised classification have been investigated.[2] Space-borne Very High Resolution (VHR) imagery can be used to monitor changes or damages to archaeological sites in case of hazards

[1] See articles: Luo et al., 2019 and Schreier, 2020.
[2] Atzberger et al., 2014 and Luo et al., 2019.

or human derived activities.[3] Also, an overview on disaster and risk management for cultural heritage utilizing different remote sensing method has been discussed before.[4] Previous studies have used VHR for monitoring archaeological and cultural heritage sites in order to assess damages in Syria.[5]

In this study, we explore different available satellite technologies and their digital products, with a focus on defining approaches for cultural heritage protection. We focus on the applications of these technologies in crisis situations, and on how the CHRU can utilize them in order to respond to risks and inspect archaeological and cultural heritage sites in danger. These crisis situations can be due to natural hazards, climate or human impact.

Data and Framework

For the satellite imagery, we (the remote sensing and monitoring unit) rely on several sources, such as the European Space Agency (ESA), the United States Geological Survey (USGS) and the National Aeronautics and Space Administration (NASA), which provide their data free of charge. These datasets can be accessed by anyone through their respective data portals. These satellites produce imagery with different spatial, spectral and temporal resolutions. To name a few, there are Sentinel-1, Sentinel-2 and Landsat-8 & 9. The products from these can help us gain an overall understanding of impact but cannot offer too much detail, since the spatial resolutions are limited to 10-15m at best. However, commercial satellites that can provide us with spatial resolution down to 30 cm, can potentially fill this gap, albeit at substantial cost. Besides, the temporal resolution of each of these satellites can differ from days to weeks. Therefore, it is important that we discuss the use of freely available datasets in combination with commercial VHR data to provide an economical baseline for remote sensing with applications in cultural heritage.

Another goal of our unit is to identify free and easy-to-use analytical toolboxes that will enable archaeologists, cultural heritage and civil protection specialists to work with these datasets. Specifically, we aim to investigate the usability and practicability of remote sensing and Geographical Information Systems (GIS) in case of crisis and of a possible CHRU mission.

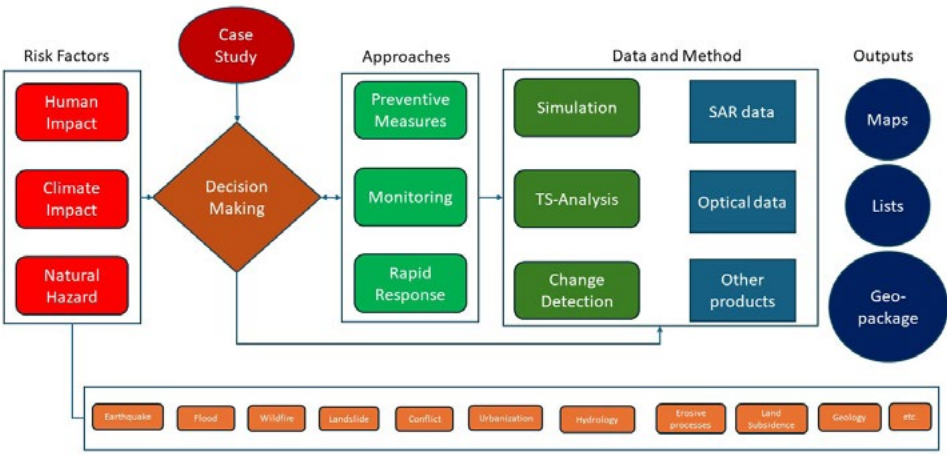
In our scenario, remote sensing has a key role in the preparation of a CHRU mission. In that phase, it is necessary to create maps and plans of the destination area with a strong focus on cultural heritage and archaeological sites. If possible, damages should be mapped remotely, so that a joint team of cultural heritage and civil protection experts is provided with as much information as possible on the situation on-site, before it actually starts operating on the field. This includes information on

[3] Tapete and Cigna, 2018.
[4] Rayne et al., 2023.
[5] e.g. Cerra et al., 2016, Cerra & Plank 2019, Masini & Lasaponara, 2020.

the cultural heritage sites in the affected area (position, numbers, access roads) as well as visible changes or damages to the sites.

Depending on the nature of the crisis and the local circumstances, there might not be enough time to collect much information on-site. Furthermore, it might not be clear how the infrastructure on the ground is affected and how much useful information could be retrieved from Internet once the team is on location. The same is true about the use of Unmanned Aerial Vehicles (UAVs), which in many cases would unlikely be activated.

In our unit, we identified risk factors, approaches and different data and methods that can be made use of in case of a new study area (Fig. 1) or in an emergency situation. The risk factors are defined based on the source of risk but they are not completely independent of each other, and every case study might involve more than one factor. After receiving a request regarding an area of interest, depending on the geographic extent of the area and the number of site(s), we explore the potential risks that could be present. Thereafter, based on the knowledge from various previously selected and tested scenarios (for example, a single site affected or a wide area), we decide on the best possible approaches and start collecting datasets available from different sources. These sources can be either freely available ones (as mentioned above) or from our institutional partners such as the BKG (German Federal Agency for Cartography and Geodesy), who provide us both with data and consultation on different products. Furthermore, we also have a subscription with the owner provider Planet Labs, that provides immediate access to VHR satellite imagery from their SkySat, RapidEye and PlanetScope Dove satellites. This grants us access to archive datasets



1. General workflow of the remote sensing and monitoring unit (SAR stands for Synthetic Aperture Radar and TS-Analysis for Time-Series Analysis) © Pouria Marzban, DAI

which we can then order immediately and receive within few hours, as well as tasking capability which can provide updated VHR images within a few days or more, depending on the study area. Moreover, the PlanetScope Doves provides images with a spatial resolution of 3m on a daily basis. In addition, the open data programs from different sources such as Maxar can be helpful, especially in case of an emergency.

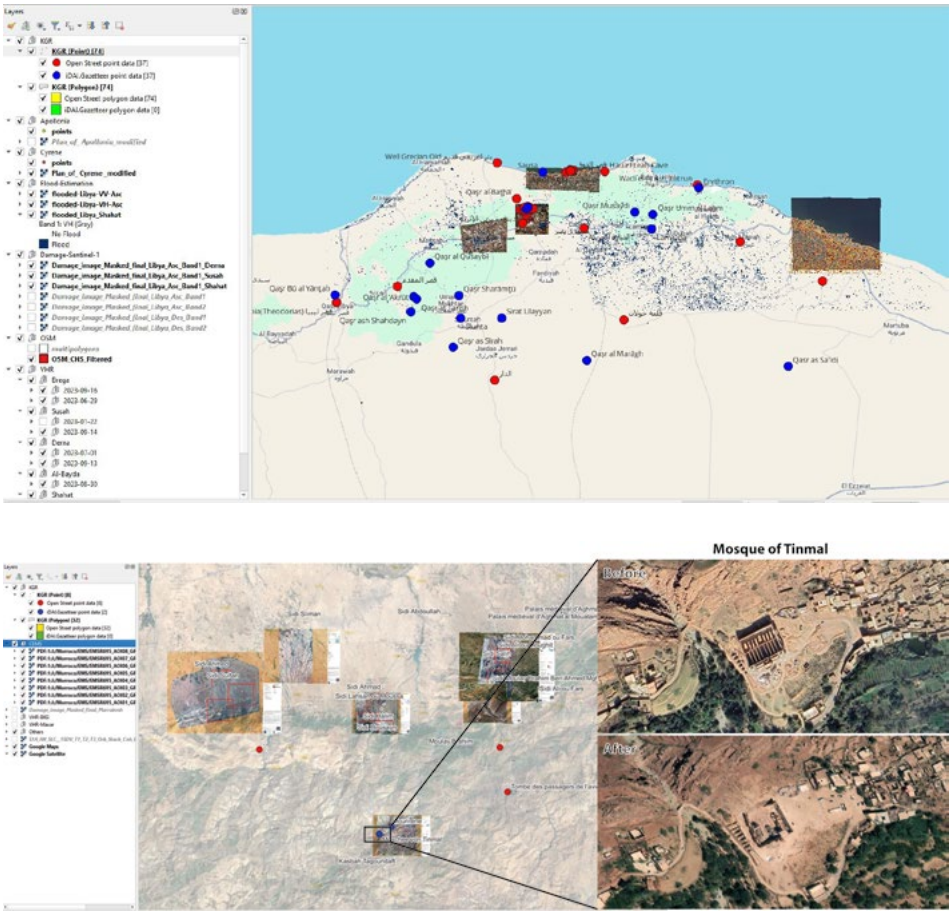
For each case study, there can be several different types of data and methods available. For example, in the case of a **rapid response**, we begin by checking the activation list of the EU's Copernicus Emergency Management System (CEMS), to verify if they already have analytical products for our area of interest. Otherwise, we start our own data acquisition and procurement processes. Accordingly, it is important to be flexible in terms of choosing data processing and analysis methods. Based on post-event data availability and capacities, we decide on the type of method we are going to use to detect potentially affected sites. For instance, if we have access to radar data, we can use change detection (damage assessment) methods based on amplitude and phase information, and if we have optical data we can use feature-based change detection methods.[6] In case we have both types of data, then a combination of these methods will lead to more accurate outcomes. This is the advantage of having access to several sources of data and a multi-sensor analysis framework.

Other sources such as shake maps from the USGS (produced in the aftermath of earthquakes) can be useful for us to define our focus areas. In any case, we use GIS sources such as OSM and ***iDAI.gazetteer*** to spot the locations of cultural heritage sites. To do so, the IT unit of the CHRU have developed an in-house open source QGIS plugin called ***"KGR finder"*** which can automatically connect to the above-mentioned sources and download matching archaeological and cultural heritage points based on the defined AoI. As examples, we show case studies in Figure 2 where we combined different analyses.

In case of **preventive measures**, approaches such as generating hazard maps over a specific area are possible using other products from satellite data, such as DEMs (digital elevation models) or land cover/use datasets. For example, hydrological or erosive processes can be simulated based on DEMs and can provide us with information on the possible scenarios in the future.[7] In general, these types of maps and products can be conceptualized based on previous analyses or events.

Long-term **monitoring** of ACH sites generally focuses on slow developing phenomena over longer time periods, often related to geological movements or climatic changes. For instance, we would employ InSAR (Interferometric Synthetic Aperture Radar) time-series analysis to monitor movements such as geological or land sub-

[6] Plank 2014, Canty et al., 2020.
[7] Marchetti et al., 2019.



2. Examples of spatial and remote sensing data on archaeological sites in QGIS. (Above) Case of Cyclone Daniel in Libya showing Flood estimation, damage assessment and datasets from different sources (VHR data from Maxar open data and Planet Labs SkySat), (Below) Case of Earthquake in Morocco (based on data provided publicly by CEMS and Maxar open data) © Pouria Marzban, DAI

sidence, look into current and past data and anticipate future trends. These types of studies can be done with the help of services such as LiCSAR and LiCSBAS[8] or commercial software such as ENVI SARscape or GAMMA. This can also be applied to large areas, on a state or country-wide scale to monitor (for example subsidence) hotspots.[9] For time-series analysis of satellite datasets, cloud-based technologies such as Google Earth Engine (GEE) are quite popular within the remote sensing community and can be utilized for ACH sites as well. For example, tracking changes

[8] Lazecký et al., 2020, Morishita et al., 2020.
[9] Nicholls & Shirzaei, 2024, Haghshenas Haghighi & Motagh, 2024, Cigna et al., 2024.

over time using continuous land change monitoring (CCDC) method[10] can help us in identifying potential hazards over time.

Conclusion

The aim of our unit is not only to build an infrastructure and new capabilities based on existing methods and tools, But also preparedness for any new scenario and further development of our workflow. There are other possibilities and potentially useful data sources besides remote sensing for the monitoring of cultural heritage sites and damage assessment. These include social media sites and the local network of archaeologists or volunteers who are willing to share information on the situation of ACH sites during or after a crisis situation. For further development of the project and our workflow, we constantly look for new types of sensors and methods to update our pool of instruments and data. The ultimate goal of our unit is to develop an automated monitoring system for ACH sites worldwide (at least for a selected number of globally representative sites). In order to achieve this, it is necessary that cultural heritage, civil protection and remote sensing experts work closely together. Further collaboration is also necessary in terms of using more recent technological developments such as data science and Artificial Intelligence (AI).

During our literature review and studies, we managed to identify several methods and approaches based on remote sensing data that can be useful in cultural heritage monitoring and damage assessment in case of emergency. We have conducted case studies and trial runs[11], in order to assess the validity and usefulness of a range of data and methods. Our multi-source approach can be applied to any case study around the world and can be further adapted. Utilizing satellite imagery, the remote sensing and monitoring unit can assess the condition and situation of cultural heritage sites without physical access to them.

[10] Arévalo et al., 2020.
[11] For example: Cyclone in Libya (2023), Earthquake in Morocco (2023), Flood in Pakistan (2022), Wildfires in Sicily (2016-2022).

70 years after the 1954 Hague Convention: joint strategies and future challenges for cultural property protection in armed conflict zones

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Introduction

In the current international context, where influence is asserting itself as a new strategic function, cultural property is gradually emerging as a field of confrontation. Damage to cultural property is irreversible and has political, societal and military repercussions. This growing awareness within Western armies and international organisations underlines the importance of this topic, not only as a witness to history, but also as a factor of operational and informational superiority. Indeed, attacks on cultural property often reveal the ideological or religious motivations of the opposing forces. So, in the field of information and in times of high intensity, cultural property protection (CPP) faces constant challenges. It is therefore necessary to take into account the protection of heritage in crises situations.

Since 1996, the Délégation au Patrimoine de l'Armée de Terre (DELPAT) has had its own dedicated team of conservation officers, who have been able to put their skills to good use in protecting the country's cultural property through exploratory missions (Central African Republic-2018, Mali-2019).[1] As a result of the preparatory work undertaken since these two missions and the guidelines issued by the CEMAT (Chief of French Army Staff) in 2020, DELPAT has developed and consolidated its expertise. In the face of growing threats, the employment of these specialists is proving its relevance and effectiveness.

More than ever, the protection of cultural property has become vital in the strategic thinking of our competitors and our allies. Cultural heritage assets, as sought-after objects of value, are now tools at the service of military strategies in times of armed conflict.

The year 2024, marked by the anniversary of the 1954 Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict[2], has provided France

[1] ***https://www.defense.gouv.fr/terre/mieux-nous-connaitre/delegation-au-patrimoine-larmee-terre-delpat/delegation-au-patrimoine-larmee-terre***

[2] See also ***https://www.unesco.org/en/70-years-culture-peace***. On the same topic, see also: O'Keefe R., Péron C., Musayev T., Ferrari G., ***Protection of Cultural Property – Military Manual***, UNESCO, 2016. ISBN 978-92-3-100184-0. Accessed 9 December 2024. Dunkley M., Mol L., Tulliach A., ***Heritage at war***, White Horse Press, 2024. Accessed 9 December 2024

with an opportunity to stimulate new strategic and political thinking, at the highest inter-ministerial levels, to meet the contemporary challenges of CPP.

Considering the historical and remarkable expertise in this field by the military forces, carried out both by the services for the protection of art works during the First World War and by the work of Rose Valland[3] during and after the Second World War, France can definitely boast a long-standing solid competence in the field, particularly within the armed forces. This year, particularly in view of such a special occasion, our country has taken the great opportunity to follow in the footsteps of history and memory of its legacy regarding the protection and preservation of endangered heritage, highlighting the work and efforts of all the players on the national scene, starting with the Blue Shield France, the French PROCULTHER network and the French army.

The work initiated will enable to identify a precise timeframe and set a clear course for taking better and more effective account of cultural property issues in war zones. So, if 2024 is the year of intellectual renewal, the years to come will be the markers of a concrete and practical translation of France's commitments to cultural heritage assets at risk.

A year marked by the anniversary of the Convention: has 2024 given rise to a new awareness?

The work initiated in the run-up to 2024 is part of an overall drive to strengthen cooperation between counterparts in different ministries. However, it is important to recall that cooperation between experts, particularly at military level, began long before this year.

Cooperation between the armed forces and Blue Shield France[4], for example, dates back a long time. Founded in 1996, the International Blue Shield (formerly the International Blue Shield Committee) works to protect the world's cultural property threatened by war and natural disasters. Since its creation, DELPAT has attended meetings of the association, and has maintained close relations with it, through training activities, for example. It distributes to museums the reference texts drawn up by the Ministry of Culture based on the conclusions of the French section of the International Council on Monuments and Sites (ICOMOS) at the Rennes symposium in December 1998.[5] These texts include references to the 1954 Hague Convention and

[3] Rose Valland, an art historian and resistance fighter, worked during and after the Second World War to recover looted works. See: Rose Valland, Le front de l'art : défense des collections françaises, 1939-1945, Réunion des Musées nationaux, 2014, 408 p. Available also in English : ***https://www.monumentsmenandwomenfnd.org/post/rose-valland-s-dream-realized-the-art-front***

[4] ***https://www.bouclier-bleu.fr***

[5] La sécurité du patrimoine : journées d'études internationales préparées par la Section française de l'ICOMOS, la Direction de l'architecture et du patrimoine et la Compagnie des architectes en chef des monuments historiques, Rennes, 10-11 décembre 1998, Bulletin de la Section française de l'ICOMOS, 1998, n° 42-43.

the Directive of May 2, 2000, on safeguarding plans for cultural property (movable assets and works of art) in case of damage to historic monuments. This directive complements the circular of January 19, 1998, which specifies safety measures to adopt in the event of fire.

Recent conflicts and the renaissance of CPP within the armed forces in 2019 have strengthened this evolving collaboration.

Although a dialogue has been established, it is often limited to bilateral exchanges. In this context, broader cooperation, involving all the relevant professionals, seems essential in view of the growing demand for support in terms of cultural property protection, thus encouraging the various experts to be ready to adapt to different contexts.

For the past three years, training has been provided by the DELPAT, with the aim of raising awareness among the military about the preservation of heritage in times of crisis. The "PROTPAT" training programme was further developed in 2024 by welcoming civilian members of the Blue Shield, stressing the will to share and collaborate.

The theoretical courses of this training are combined with a legal perspective and enriching feedback, particularly from Lebanese, Ukrainian and Dutch professionals. Practical exercises are also included, such as the use of new technologies. This year, for example, participants conducted aerial assessments of archaeological sites. A war game ends the week by offering the trainees the opportunity to put into practice, on the board, all the aspects covered during the training. A round table, opening the discussion on the management of museums in times of crisis with the intervention of the Director of ALIPH, a representative of ICOM and the Chief Curator of Cultural Heritage of Geneva, made it possible to end the training on a crucial note.

Elevated to inter-ministerial level for the first time, the issue of CPP is no longer the result of single players supposedly working to protect cultural property, but a collective problem.

This is a subject of common concern for the staff of specialized experts that has led to the launch of a number of projects at national level throughout the year, with the aim of continuing to capitalize on the experience and know-how of the bodies responsible for CPP, and subsequently to promote the spreading of information on the different skills of the organizations involved in the protection of cultural property.

This project approach aims to facilitate the organization and implementation of full-scale exercises, that will strengthen France's preparedness in real-life crisis scenarios.

1. Exercise on "Drone Handling and New Technologies" with civilian and military personnel during the 2024 "Heritage Protection in Operations" (PROTPAT) training © ADC Anthony/SIRPAT/Armée de Terre/Défense

2. Practical application of topics covered during the PROTPAT 2024 training week, conducted as a wargame. © ADC Anthony/SIRPAT/Armée de Terre/Défense

3. Lecture on the topic of "Civil-Military Cooperation" during the 2024 PROTPAT training.
© ADC Anthony/SIRPAT/Armée de Terre/Défense

Exhibitions, conferences and round tables, in France and abroad, have brought together all the different stakeholders worldwide to discuss this evolving issue, which requires progressive and transformative thinking, informed by the dynamic challenges of the contemporary world.

In France, the Ministries of Culture, Interior, Europe, Foreign Affairs and the Armed Forces have joined forces to protect the country's cultural property. At the first interministerial meeting held on 23 May 2024, these players agreed on the need for better national coordination, leading to the creation of a national advisory committee. At the heart of this meeting were discussions on the best practices achieved in several areas: emergency evacuation, the adoption of appropriate shelters, the marking of cultural assets with the international Blue Shield symbol, interdepartmental exercises, and ongoing training activities, as well as ad hoc and tailored training. All these issues, concerning the whole staff involved in this article, will be the focus of attention in 2025, the year in which the work carried out in recent months will come to fruition.

Thus, the expertise of France is the subject of many requests expected to be honoured in 2025.

Awareness, implementation and views

However, at a national level, despite the wide range of expertise available, there was a need to clarify the way in which responsibilities were shared. In order to respond more effectively to the new challenges posed by the protection of cultural property,

which has now become a new strategic and political function, and to meet the ever-increasing demand in this area, France wishes to make a firm commitment to a better coordination in this specific field.

Consequently, and particularly in light of Articles 3 and 25 of the Hague Convention and Resolution II of the Intergovernmental Conference also adopted on 14 May 1954, an inter-ministerial working group was set up to formalise and harmonise efforts to protect cultural property in the context of armed conflict.

This group, made up of experts from the various administrations concerned, aims to develop operational, technical, legal and administrative best practices, while strengthening international cooperation by sharing experiences with other States. Strong emphasis will be placed on the ongoing training of civilian and military personnel, both in France and abroad, to ensure that they are well prepared to meet the challenges of CPP, while continuing to disseminate the principles of the Hague Convention and its protocols, extending their reach within institutions and the armed forces. The Ministry of the Armed Forces, a key player, would play a central role by carrying on supporting its partners in the creation of specialised units dedicated to this mission. Finally, the main goal would be to consolidate civil-military collaboration, a real pillar for the effective and sustainable implementation of measures to protect cultural property, in synergy with all the international players.

As a form of continuity of the individual actions already undertaken, the National Advisory Committee, created by virtue of the obligations of the 1954 Hague Convention, is intended to justify all the ministerial procedures in terms of cultural property protection.

This non-binding working group, acting as a force multiplier, will, among other things, enable the introduction of multi-sectoral exercises, notably within French cultural institutions transformed into CPP emergency simulation scenarios.

Internationally, the various partnerships, initiated particularly by the French Army, will help promote this expertise. In 2024, France asserted its will in numerous countries and audiences, from the United States to Greece, via Lebanon, working with the various armed forces to ensure long-term collaboration and benefit from the know-how of its partners and allies.

Now more than ever, sharing resources and feedback is essential to effectively address the intentional and collateral destruction of valuable cultural assets during wartime, as part of efforts to protect France's cultural assets. Looking ahead, 2025 offers an opportunity to continue and enhance this long-standing collaboration, further reinforcing these critical efforts.

The need for action to deal with the growing threats

The need for this interministerial working group for the protection of cultural property in times of conflict is essential in view of the changing strategic stakes and increasing threats to it.

The widespread nature of attacks, often aimed at annihilation, underlines the urgent need of intervention for the safeguard of our cultural heritage today. In this context of urgency, it is essential to adopt a collective and coordinated approach, beyond the single initiatives of the relevant players.

Above all, this pooling of skills is an unprecedented strong point. Many countries have already set up similar groups, and their effectiveness is already visible.

The dialogue begun in 2024, that has led to the harmonization of operational, technical and legal practices, will keep growing in the coming years and will most likely promote international cooperation through the sharing of experience, as well as uniforming operational, technical and legal practices. It will indeed also produce best practices to be implemented more effectively, while guaranteeing ongoing training for civilian and military personnel.

This initiative will result in concrete actions, such as multi-sector exercises and emergency simulations, aimed at facing contemporary challenges at best, by strengthening civil-military collaboration.

Conclusion

The year 2024 will be one of historical and memorial continuity of military protection of cultural property in wartime.

This new year, marked by the anniversary of the 1954 Hague Convention, will be a wonderful opportunity to be part of a historical continuum of military CPP and to highlight the work and efforts spent by the French Army over the last few years.

They are part of an overall drive to strengthen cooperation with its counterparts, particularly at interministerial level. The protection of cultural assets is an area where synergies can be shared, providing the opportunity to launch projects at national level. The aim remains, as ever, to make the most of the solid experience and know-how built over time of the cultural property protection responsible bodies.

LIST OF REFERENCES

AFAD website

Agostiano M., Esposito S., Marrese G., Earthquakes debris of cultural interest. The Italian methodology for their management, selection and reuse (Part. A Regulatory provisions and operational indications), ***PROCULTHER-NET 2 Technical Bulletin N. 3, July 2024***, pp. 72-82. ISSN 2975-190X - ISBN 978-88-6864-548-9. Accessed 12 November 2024

Arévalo P., Bullock E. L., Woodcock C. E., Olofsson P., A suite of tools for continuous land change monitoring in google earth engine, Frontiers in Climate, 2020 (26)

Argenti S., Betori A., Corrado M.E., Crova C., Fazio G.M., La rimozione delle macerie nel post terremoto. L'approccio propedeutico alla fase della conservazione e del restauro dell'edilizia storica e del patrimonio culturale. In: Biscontin G. e Driussi G. (Ed.), Le nuove frontiere del restauro. Trasferimenti, contaminazioni, ibridazioni. Proceedings of the 33th International Conference "Scienza e Beni Culturali", Bressanone 27-30 June 2017. Venezia: Edizione Arcadia Ricerche, 2017, ISBN9788895409214, pp. 375-388

Argenti S., Corrado M.E., Frammenti crollati dell'iconostasi di San Salvatore in Campi di Norcia. In: Cassio G., Delogu G.L., Morriconi P., Restauravit, l'Art Bonus per i territori colpiti dal sisma del 2016. Roma: Gangemi Editore, 2024, ISBN 8849250312, pp, 223-227

Atzberger C., Wess M., Doneus M., Verhoeven G., ARCTIS—A MATLAB® Toolbox for archaeological imaging spectroscopy, Remote Sensing, 2014, 6(9), 8617-8638

Basile G., Il recupero dei frammenti: basilica superiore di S. Francesco in Assisi. In: M. Piccarreta (Ed.), Beni culturali in Umbria: dall'emergenza sismica alla ricostruzione. Città di Castello: Ed. Betagramma, 2007, pp. 100-108.

Canty M. J., Nielsen A. A., Skriver H., & Conradsen K., Wishart-based adaptive temporal filtering of polarimetric SAR imagery, Remote Sensing, 2020, 12(15), 2454

Cerra D., Plank S., Lysandrou V., Tian J., Cultural heritage sites in danger—towards automatic damage detection from space, Remote Sensing, 2016, 8(9), 781

Cerra D., Plank S., Towards Early Warning for Damages to Cultural Heritage Sites: The Case of Palmyra, Remote Sensing for Archaeology and Cultural Landscapes: Best Practices and Perspectives Across Europe and the Middle East, 2020, 221-239

Cigna F., Bonì R., Teatini P., Paranunzio R., Zoccarato C., Multi-Scale Assessment of Land Subsidence Risk in Major Urban Areas of Italy Using Satellite Insar, Hydrogeological And Climate Data. In IGARSS 2024-2024 IEEE International Geoscience and Remote Sensing Symposium 2024 Jul 7 (pp. 5394-5397). IEEE.

COELUM Project website

Corrado M.E., Perché un cantiere pilota nella Chiesa di San Salvatore a Campi, in: Garibaldi V., Delpriori A. (Ed.), Capolavori del Trecento. Il Cantiere di Giotto, Spoleto e l'Appennino. Perugia: Ed. Quattroemme, 2018. ISBN 9788894971026.

Decree of the Head of the Department of Civil Protection of the Presidency of the Council of Ministers, February 2, 2015 (Official Gazette no. 75, March 31, 2015): Guidelines for the components and operational structures of the National Civil Protection Service on updating emergency plans for the precautionary evacuation of the "Red Zone" population in the Vesuvian area. ***Decreto del Capo Dipartimento del 2 febbraio 2015 | Dipartimento della Protezione Civile***

Decree of the President of the Council of Ministers, June 24, 2016 (Official Gazette no. 193, August 19, 2016): Provisions for updating emergency planning for volcanic risks in the Campi Flegrei area. ***Dpcm del 24 giugno 2016: Disposizioni per l'aggiornamento della pianificazione di emergenza per il rischio vulcanico dei Campi Flegrei (all'interno la Mappa dei gemellaggi) | Dipartimento della Protezione Civile***

Decree Law no. 140, October 12, 2023 (Official Gazette General Series no. 239, October 12, 2023): Urgent measures for seismic risk prevention related to the bradyseismic phenomenon in the Campi Flegrei area and Conversion Law no. 183, December 7, 2023 (Official Gazette General Series no. 288, December 11, 2023). ***Decreto-legge n. 140 del 12 ottobre 2023 - Misure urgenti di prevenzione del rischio sismico connesso al fenomeno bradisismico nell'area dei Campi Flegrei | Dipartimento della Protezione Civile***

DG Cultural Heritage and Museums website (Türkiye)

Directive of the Ministry of Cultural Heritage and Activities and Tourism, April 23, 2015: Update of the December 12, 2013 Directive on "Procedures for the management of securing and safeguarding cultural heritage in emergencies resulting from natural disasters"

Directive of the Minister of Cultural Heritage and Activities and Tourism (subsequently renamed Ministry of Culture), 12 December 2013, *Procedures for the management of activities for the safeguarding and protection of cultural heritage in the event of emergencies resulting from natural disasters* and subsequent update Directive of the Minister of Cultural Heritage and Activities and Tourism, 23 April 2015.

Domenech de Cellès C., Jakubeit N., KulturGutRetter (KGR): technical characteristics of a cultural heritage response unit, in ***PROCULTHER-NET Project. Technical Bulletin N. 1, March 2023*** pp. 58-64. ISSN 2975-190X. Accessed 22 November 2024

Dunkley M., Mol L., Tulliach A., ***Heritage at war***, White Horse Press, 2024. Accessed 9 December 2024

Google Earth Engine

Fattore C., Abate N., Faridani F., Masini N., Lasaponara R., Google Earth Engine as Multi-Sensor Open-Source Tool for Supporting the Preservation of Archaeological Areas: The Case Study of Flood and Fire Mapping in Metaponto, Italy, Sensors 2021, 21, 1791

Fiorentino G., Forte A., Pagano E., Sabetta F., Baggio C., Lavorato D., Nuti C., Santini S., Damage patterns in the town of Amatrice after August 24th 2016 Central Italy earthquakes. ***Bulletin of Earthquake Engineering***, 2018 (16):1399–1423. Accessed 12 November 2024

GAMMA Remote Sensing Software Information. Accessed 26 November 2024

Granata G., Presentazione, in Sabba F., Viaggi tra i libri. Le biblioteche italiane nella letteratura del Grand Tour, Pisa-Roma, Fabrizio Serra Editore, 2018, p. 15.

Grimaz S., Cavriani M., Mannino E., Munaro L., Bellizzi M., Bolognese C., Caciolai M., D'Odorico A., Maiolo A., Ponticelli L., Barazza F., Malisan P. and Moretti A.; 2010: Schede tecniche delle opere provvisionali per la messa in sicurezza post-sisma da parte dei vigili del fuoco (Shoring templates and operating procedures for the support of buildings damaged by earthquakes). Corpo Nazionale dei Vigili del Fuoco, Roma, Italy, 128 pp., (in ***Italian***, ***English*** and ***French***) - ***Manuale e Vademecum STOP***. Accessed 24 November 2024

Grimaz S., Cavriani M., Mannino E., Munaro L., Bellizzi M., Bolognese C., Caciolai M., D'Odorico A., Maiolo A., Ponticelli L., Barazza F., Malisan P. and Moretti A.; 2010: Manuale opere provvisionali. L'intervento tecnico urgente in emergenza sismica. Corpo Nazionale dei Vigili del Fuoco, Roma, Italy, 410 pp. (in Italian). ***Manuale e Vademecum STOP*** . Accessed 24 November 2024

Haghighi M., Motagh, M., ***Uncovering the impacts of depleting aquifers: A remote sensing analysis of land subsidence in Iran***, Science Advances, 2024, 10 (19). Accessed 12 December 2024

Harris-Geospatial ENVI SARscape -Read, Process, Analyze, and Output Products from SAR Data Available online, accessed 26 November 2024

Iacono E., Fritsch B., Data acquisition and data management for the emergency rescue of cultural heritage, ***PROCULTHER-NET Project. Technical Bulletin N. 2, June 2023***, pp.35-39. ISSN 2975-190X. Accessed 22 November 2024

ICOMOS, La sécurité du patrimoine : journées d'études internationales préparées par la Section française de l'ICOMOS, la Direction de l'architecture et du patrimoine et la Compagnie des architectes en chef des monuments historiques, Rennes, 10-11 décembre 1998, Bulletin de la Section française de l'ICOMOS, 1998, n° 42-43

Institute of Methodologies for Environmental Analysis (IMAA) website

İRAP - Provincial Disaster Risk Reduction Plan, AFAD, 2022, ***http://www.irap.afad.gov.tr*** Accessed 21 November 2024

Kai W., Vatan M., ***Kültürel sürekliliğin sağlanmasında periyodikbakımveonarımlarınrolü: 2015 Nepal depremimüdahaleaşaması***. 2015 Mimarist, 15(54), pp. 28 - 33. Accessed 21 November 2024

Lanorte A., De Santis F., Aromando A., Lasaponara R., ***Low Cost Pre-operative Fire Monitoring from Fire Danger to Severity Estimation Based on Satellite MODIS, Landsat and ASTER Data: The Experience of FIRE-SAT Project in the Basilicata Region (Italy)***, in: B. Murgante *et al.,* Computational Science and Its Applications - ICCSA 2012. ICCSA 2012. Lecture Notes in Computer Science, vol 7335. Berlin - Heidelberg, Springer, 2012. Accessed 26 November 2024

Lasaponara R., Abate N., Fattore C., Masini N., Open Big Earth Observation Data and Artificial Intelligence for the Study and Preservation of UNESCO Natural and Cultural Heritage: The Case of Machu Picchu, in: Ziółkowski M., Masini N., Bastante J. M. (Ed.), Machu Picchu in Context: Interdisciplinary Approaches to the Study of Human Past, 2022, 239-264

Lazecký M., Spaans K., González P.J., Maghsoudi Y., Morishita Y., Albin, F., Elliott J. Greenall N., Hatton E., Hooper A., Juncu D., McDougall A., Walters R.J., Watson C.S., Weiss J.R., Wright T.J. ***LiCSAR: An Automatic InSAR Tool for Measuring and Monitoring Tectonic and Volcanic Activity***, Remote Sensing, 2020, 12, 2430. Accessed August 2024

Legislative Decree 17 October 2016, n. 189, Urgent interventions in favour of the populations affected by the seismic events of 2016

Luo L., Wang X., Guo H., Lasaponara R., Zong X., Masini N., *et al.,* ***Airborne and spaceborne remote sensing for archaeological and cultural heritage applications: A review of the century (1907-2017)***, Remote Sensing of Environment, 2019 (232), 111280. Accessed 27 November 2024

Marchetti N., Curci A., Gatto M. C., Nicolini S., Mühl S., Zaina F., A multi-scalar approach for assessing the impact of dams on the cultural heritage in the Middle East and North Africa, Journal of Cultural Heritage, 2019 (37), 17-28

Masini N., Lasaponara R., Recent and past archaeological looting by satellite remote sensing: Approach and application in Syria, Remote Sensing for Archaeology and Cultural Landscapes: Best Practices and Perspectives Across Europe and the Middle East, 2020, 123-137

Mercalli M., Security depots for the storage of movable cultural heritage assets in emergencies, ***PROCULTHER-NET Project. Technical Bulletin N. 1, March 2023*** pp. 30-35 ISSN 2975-190X. Accessed 12 November 2024

Ministry of Culture and Tourism website (Türkiye)

Ministry of Culture, Directive of the General Directorate of Archaeology, Fine Arts and Landscape 12 September 2016, n. 11087, Procedures for removing and recovering debris from assets of cultural interest and historic buildings

Morishita Y., Lazecky M., Wright T.J., Weiss J.R., Elliott J.R., Hooper A. ***LiCSBAS: An Open-Source InSAR Time Series Analysis Package Integrated with the LiCSAR***

Automated Sentinel-1 InSAR Processor, Remote Sensing, 2020, 12, 424. Accessed August 2024

Nicholls R. J., Shirzaei M., Earth's sinking surface, Science, 2024, 384 (6693), 268-269

Oakley N. S., Cannon F., Munroe R., Lancaster J. T., Gomberg D., Ralph F. M., ***Brief communication: Meteorological and climatological conditions associated with the 9 January 2018 post-fire debris flows in Montecito and Carpinteria, California, USA***, Nat. Hazards Earth Syst. Sci., 18, 2018, 3037–3043, Accessed 26 November 2024

O'Keefe R., Péron C., Musayev T., Ferrari G., ***Protection of Cultural Property – Military Manual***, UNESCO, 2016. ISBN 978-92-3-100184-0. Accessed 9 december 2024

Oktay S., Taş N., Taş M., ***Kulturel Miras Alanlarının Korunması ve Afet Yonetimi İlişkisi***. Resilience Journal, 2020, 4(2), pp. 305-321. Accessed 21 November 2024

Piacentini V., Proietti G., architects, Italian Presidency of the Council of Ministers, Civil Protection Department DPC, Training and exercise: an effective approach to build cultural heritage protection capacity, in ***PROCULTHER-NET Project. Technical Bulletin N. 2, June 2023***, pp. *15-24.* ISSN 2975-190X. Accessed 23 November 2024

Pedersoli J. L., Antomarchi C., Michalski S., Aslan Z., Sabik A., A Guide to Risk Management of Cultural Heritage, Ottawa-Ontario-Canada, ICCROM - Canadian Conservation Institute, 2016

Plank S., Rapid damage assessment using multi-temporal SAR—A comprehensive review and outlook to Sentinel-1, Remote Sensing, 2014, 6(6), 4870-4906

Presidency of the Council of Ministers, Italian Civil Protection Department, National risk assessment, ***Overview of the potential major disasters in Italy: seismic, volcanic, tsunami, hydro-geological/hydraulic and extreme weather, droughts and forest fire risks***. Updated: December 2018, 1. Accessed 12 November 2024

Presidency of the Council of Ministers Italian Civil Protection Department - Disaster risk management training Seminars, Di Bucci D., Dolce M., ***Super Case Study 1. Earthquakes in Central Italy in 2016-2017***. Accessed 12 November 2024

PROCULTHER Project. Key elements of a European Methodology to Address the Protection of Cultural Heritage during Emergencies, Città di Castello: LuoghInteriori, 2021. ISBN 978-88-6864-370-6

PROCULTHER-NET Project. Technical Bulletin N. 1, March 2023 ISSN 2975-190X

PROCULTHER-NET Project. Technical Bulletin N. 2, June 2023 ISSN 2975-190X

PROCULTHER-NET 2 Project. Technical Bulletin N. 3, July 2024 ISSN 2975-190X - ISBN 978-88-6864-548-9

Rayne L., Rouhani B., Makovics JL., Remote sensing and Disaster Risk Management for Cultural Heritage. In: Managing Disaster Risks to Cultural Heritage, 2023 Nov 15, pp. 114-132. Routledge

Regione Basilicata, ***Piano Antincendio Regionale (P.A.R.***). Accessed 26 November 2024

Scardozzi G., ***Multitemporal satellite images for knowledge of the Assyrian capital cities and for monitoring landscape transformations in the upper course of Tigris River***, International Journal of Geophysics, 2011. Accessed 27 November 2024

Schreier G., Opportunities by the Copernicus Program for Archaeological Research and World Heritage Site Conservation, in Remote Sensing for Archaeology and Cultural Landscapes: Best Practices and Perspectives Across Europe and the Middle East, 2020, 3-18

Tapete D., Cigna F., Appraisal of opportunities and perspectives for the systematic condition assessment of heritage sites with Copernicus Sentinel-2 high-resolution multispectral imagery, Remote Sensing, 2018, 10(4), 561

TARAP Document, 2022. ***www.tarap.afad.gov.tr*** Accessed 21 November 2024

Ünal Z. G., ***Kültürel mirasın korunması. İsmepRehberKitaplar***, pp. 1 - 71. Istanbul, 2014. Accessed 21 November 2024

Valland R., Le front de l'art : défense des collections françaises, 1939-1945, Réunion des Musées nationaux, 2014, 408 p. Available also in English: ***https://www.monumentsmenandwomenfnd.org/post/rose-valland-s-dream-realized-the-art-front***

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