ICOA883: STORM: SAFEGUARDING CULTURAL HERITAGE THROUGH TECHNICAL AND ORGANIZATIONAL RESOURCES MANAGEMENT. A EUROPEAN PROJECT FROM A LOCAL VIEW

Subtheme 03: Protecting and Interpreting Cultural Heritage in the Age of Digital Empowerment

Session 3: Application of Digital Technology in Disaster Management Practices
Location: Silver Oak 2, India Habitat Centre
Time: December 14, 2017, 11:45 – 12:00

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Abstract: Following a call by the European Commission on Disaster Resilience and Climate, the STORM partnership was formed by 20 partners, dedicated to 5 main sites: Mellor (England), Rome (Italy), Rethymno (Greece), Tróia (Portugal) and Ephesus (Turkey), presenting the rich diversity of European cultural assets.

This project proposes a set of novel predictive models and improved non-invasive and non-destructive methods of survey and diagnosis, for effective prediction of environmental changes and for revealing threats and conditions that could damage cultural heritage sites.

Moreover, STORM will determine how different vulnerable materials, structures and buildings are affected by different extreme weather events together with risks associated with climatic conditions or natural hazards, offering improved, effective adaptation and mitigation strategies, systems and technologies. An integrated system featuring novel sensors (intra fluorescent and wireless acoustic sensors), legacy systems, state of the art platforms (including LiDAR and UAVs), as well as crowdsourcing techniques will be implemented, offering applications and services over an open cloud infrastructure.

An important result of STORM will be a cooperation platform for collaboratively collecting and enhancing knowledge, processes and methodologies on sustainable and effective safeguarding and management of European Cultural Heritage. The system will be capable of performing risk assessment on natural hazards taking into account environmental and anthropogenic risks, and of using Complex Events processing.

By December 2017 this 36 months project will be half completed. Some preliminary results can be presented at the ICOMOS Scientific Symposium for the archaeological site of Tróia, by the resident archaeology team, the national directorate for cultural heritage and the conservation specialist.

Description of the work, objectives and methodology

In an age of climate change awareness, what actually happens to cultural heritage after a natural disaster? Are procedures and policies for monuments and sites being debated? How can these improve their resilience to the damage caused by natural hazards? How can digital empowerment be able to help the conservation of our common cultural assets?

In the STORM project, heritage and technical experts teamed up to help develop an answer to some of these issues. Having chosen sites from five different countries (fig.1), that both illustrate common problems and are particularly representative of specific hazards, such as flooding, mass tourism, heavy winds, coastal erosion or earthquakes, a set of case scenarios were determined for each of them.

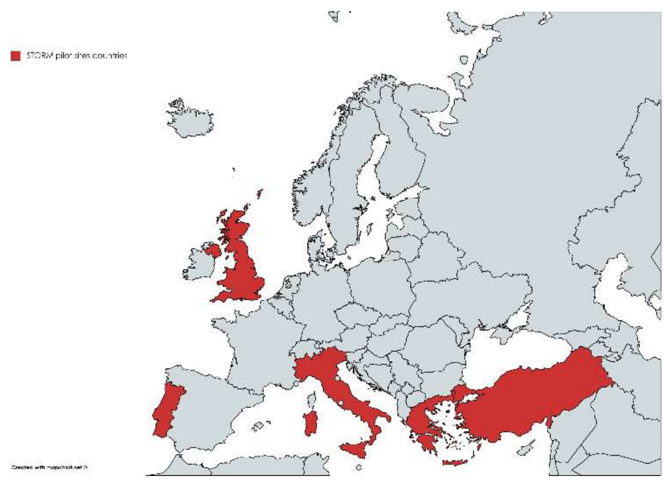

Fig.1– Countries of the pilot sites participating in the STORM project.

The Mellor Heritage Project is a participatory project engaging surrounding communities to take part in the protection of the Brown Low Cairn; the Hill fort; the Church and the Mill. Inland water inundation, extremes of wetting and drying, fire, diseases and pests, urban heat islands, temperature changes, soil erosion, water and storm damage and uncontrolled vegetation growth are some of the identified threats.

The Diocletian Baths are composed by the Roman baths themselves; the cloisters and the museum. The anthropogenic hazards, such as heavy car and bus traffic, which cause air pollution, as well as mass tourism, are some of the main concerns, although heavy rains, winds, thunderstorms, fire and floods are also noteworthy. Here, not only the site is at risk, but also its moveable heritage, such as the collections of the museum.

In the Historical Centre of Rethymno there are public and religious buildings from the Venetian and Ottoman period, such as the Rimondi Fountain, the Loggia, the church of Santa Maria of the

Augustinians, the mosque of Gazi Hussein Pasha, the Kara Musa Pasha mosque or the public baths. There is also a Fortezza and a soap factory.

The Roman Ruins of Troia, the largest large fish-salting production centre so far known in the Roman Empire, present a number of fish-salting workshops, baths, houses, cemeteries, a mausoleum and a basilica. Located on the shoreline, many archaeological areas are exposed to tidal and river currents and sea waves and suffer a slow but progressive degradation, heightened by climate change (fig.2).

Fig.2– Example of destruction of fish-salting workshop by the high tide.

Finally, Ephesus is a Greco-Roman harbour city, partially destroyed by an earthquake in 614 AD. This is still considered one of the main hazards of the archaeological site and specifically the structure of the Great Theatre is being monitored. A detailed numerical 3D solid model of the structure is generated using 3D laser point clouds provided by radar measurements and its structural performance is assessed to detect possible weaknesses or damage initiation locations.

Divided into twelve work packages, STORM is focused in three main areas: prevention, intervention and policy.

Prevention

So cultural managers can be alerted to take action in their sites in case of an extreme event, prevention systems with effective prediction of environmental changes, revealing threats and conditions that could damage materials and structures are being developed in this project.

Predictive models are being studied for each of the five pilot sites by the Austrian Zentralanstalt für Meteorologie und Geodynamik (fig.3). In the case of Tróia, there is a meteorological station, collecting data for 10 years, and, for greater accuracy, a second one is now being installed at the site.

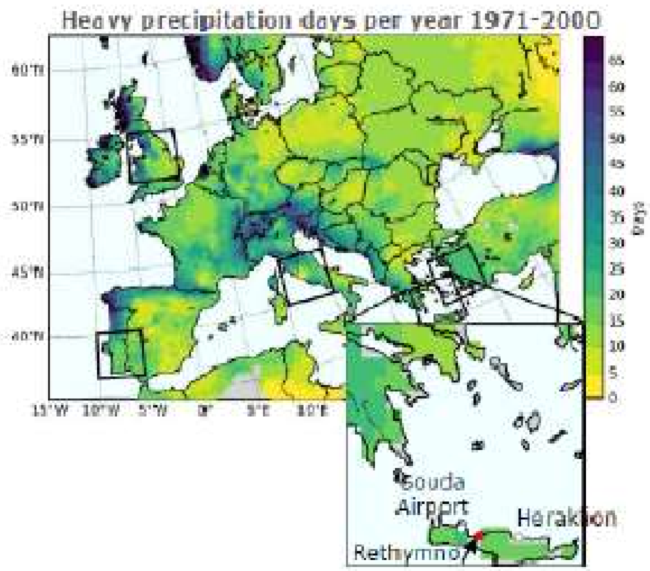

Fig.3– Historical data on heavy precipitation.

Risk assessment is also important and, under the guidance of the University of Stuttgart, each site is developing site-specific risk maps analysing its particular hazards.

Furthermore, non-invasive and non-destructive methods were divided into diagnosis and surveillance.
Diagnosis is done with the deployment of permanent sensor(s) on the sites or at least used regularly to monitor the dynamics of the natural hazards. Multispectral aerial photography through reflectance (elastic scattering) spectroscopy is being performed occasionally at Mellor and X-ray based p-XRD and XRF analysis is also providing occasional data in Rethymno. Crack monitoring, ultrasound and other vibrational techniques are in use in the Baths of Diocletian, Rethymno and Ephesus.

The induced fluorescence sensor, developed by INOV, is already being tested in Tróia on the wall paintings of the Basilica. Its aim is to detect biological colonization, before it becomes visible, usually through green stains, allowing an early treatment and diminishing the damage on the surfaces where it appears. Since this hazard is favoured by humidity, it is combined with the monitoring of environmental conditions by the weather station, which is part of permanent diagnosis systems.

Providing permanent data for all sites are weather stations, besides sensors in the specific case of Mellor, which have installed fifteen sensor nodes. Yet, these are not the only permanent data providers. In the Baths of Diocletian environmental sensing via fibre optics is also being attempted and environmental sensing via WASNs is being developed by TEIP for Tróia, Mellor and the Baths of Diocletian.

On the other hand, surveying methods like ERT; GPR and IR thermal imaging systems are being adopted in Rethymno, whereas acoustic sensors will be tested in Tróia, Mellor and the Baths of Diocletian.
As surveying solutions, either TLS or photogrammetric systems are being used for all sites. While TLS is being used in all sites, except Tróia, photogrammetry is a solution for Mellor, Rethymno and Tróia.

The use of photogrammetry was proposed for Tróia to record Roman structures located on the shoreline, as this method is not only more flexible in less accessible areas but also more cost-effective when compared to other methods. In Tróia, there are Roman remains along 2 km, very exposed to the river and only accessible in the low tide. Their location makes those buildings also available for other social, economic or cultural uses, like fishermen's shelters, as well as being totally exposed to tourists, beach vacationists or treasure hunters.

The main goal is to capture the complete 2D plan of the masonry, allowing the generation of a 3D model, with texture and in a geo-referenced detailed model. This was done for the two case-studies selected on the shoreline, workshops 21 and 23, in June 2016 (fig.4), the first month of this project. A new survey was done in September 2017, to determine the rate of loss of the Roman vestiges via model comparison. This will furthermore allow its virtual reconstitution for research purposes and, eventually, for recreational models accessible to the general public.

Fig.4– Photogrammetric survey in 2016 at Workshop 23.

Intervention

Direct conservation actions aiming at stabilising and/or consolidating historical structures are a powerful means of building resilience to disaster events. In Tróia, the conservation-restoration of the stone structures has been focusing on the most urgent problems, within budgetary restrictions. This translates into identifying partial collapse and pre-collapse (crisis) situations, so that priority is given to the treatment of the most serious decay processes, with partial reconstructions where necessary for structural stabilisation, aiming at preserving scientific and documental values to the largest extent possible[1].

The STORM disaster risk assessment currently being developed for Tróia will allow for a more holistic planning of its conservation needs, and thus for a more informed prioritisation of interventions. Likewise, the disaster risk control plan that will follow the assessment stage should permit to identify and implement the preparedness and response actions to be undertaken in disaster contexts for the safeguard of the heritage (material) assets. It should be noted here that there are currently no emergency procedures in place at the Tróia site explicitly directed at the protection of the archaeological structures, a fact which heightens the criticality of applying the STORM tools and framework tailored to the specificities of the Roman Ruins.

[1] Proença and Revez, 2017.

In terms of preparedness, an extensive survey is being finalised for the creation of a detailed database on materials and structures, including description and mapping of conservation condition, which is to be made available at the STORM platform to serve as a support tool for the site manager and, eventually, emergency intervention teams. On the other hand, risk maps will soon be in place for each of the sites, and from the information therein it will be possible to define and implement training actions (including drills) and set up the procedures and materials to be deployed for a quick response to emergency situations.

At the Tróia site, carrying out the STORM project and being able to count with the support of the involved partners has made a relevant difference both in the awareness gained by the site staff to the natural hazards and climate change factors threatening the site and in the substantial improvement in communication channels with the concerned emergency services and heritage authorities, who are also STORM partners.

Policy, planning and processes

The STORM project surveyed and analysed the main existing legislation and procedures in the five pilots' countries, regarding all the steps of the heritage disaster management cycle. The results showed that none of the five countries is in the process of implementing a risk management strategy for cultural sites based on validated knowledge and a multi-hazard methodology. Regardless of their political organisations and administrative structures, a reactive approach to disaster prevails in all countries, instead of one of prevention or preparedness for the negative impacts of disasters on cultural assets.
The survey demonstrated that, except for the UK, current norms solely require the existence of emergency management plans aimed at the safety of visitors/staff and, occasionally, to the indirect protection of buildings and cultural assets[2].

The Italian track record of disasters and the importance of its cultural heritage prompted the Ministry of Culture, the Fire Fighter Corps and the Civil Protection to jointly develop complementary regulations to reinforce measures of conservation and rescue of threatened or damaged cultural assets. As a result, Italy implemented a Cultural Heritage Risk Map and created normative documents, coordinating the different actors on how to assess and minimise cultural heritage damages, following an emergency. Despite such efforts, survey analysis revealed that in practice these instruments are seldom included in site emergency planning, greatly due to lack of: coordination between services, investment and training of technical teams. As already raised both by the Council of Europe, scientists and by the European Commission[3], there is a need to promote the development of scientific and technological knowledge applied to the conservation of cultural assets threatened by natural phenomena and climate change. In this respect, England reported the implementation of several actions in North West England sites based in scientific data, whereas Turkey reported studies for the development of guidelines for earthquake risk management in historical structures in the scope of a multidisciplinary project under the auspices of public institutions and with contributions from ICOMOS Turkey[4].

Conclusion

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[2]Neto and Pereira, 2017.
[3]Lefèvre and Sabbioni, 2009
[4]Neto e Pereira, 2017.

In line with the current concerns presiding to heritage policies and processes, as defined by UNESCO[5], the development and implementation of Disaster Risk Management approaches to cultural sites are important steps to advance the sustainable development agenda in the heritage sector.

Preventive action on the conservation of historic structures, emergency measures (to mitigate natural or climate change caused disasters) and a network of shared knowledge and tools among all European partners bring a valuable contribution that enables going far beyond the current state of the art. In particular, STORM aims at defining, developing and accessing a technological integrated framework providing eco-innovative, cost-effective and collaborative methodologies to support all the involved stakeholders to better act in the prevention and intervention phases.

On the whole, it can be said that the present shortage in services and instruments actually efficient in fighting the negative impacts of disasters on cultural assets is a result of a widespread apathy of governments and the unaccountability of civil society regarding their cultural heritage. Walking the path to the creation of a cultural heritage risk strategy implies starting from individual and collective consciousness and taking alert, informed and responsible actions.

STORM will set collaboration and knowledge-sharing frameworks for all the involved in the risk management processes, in order to co-create, share and maintain improved practices and policies, knowledge and experience on cost-effective and eco-innovative solutions for sustainable management and conservation of Cultural Heritage in Europe. This can only be implemented via the digital empowerment of governments and civil society, simultaneously with a much needed change in mentalities.

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[5]UNESCO, 2015.

ICOA883: STORM: SAUVEGARDE DU PATRIMOINE CULTUREL PAR LA GESTION DES RESSOURCES TECHNIQUES ET ORGANISATIONNELLES. UN PROJET EUROPÉEND'UN POINT DE VUE LOCAL

Sous-thème 03: Protéger et interpréter le patrimoine culturel à l'ère de l'autonomisation numérique

Session 3: Application de la technologie numérique aux pratiques de gestion des catastrophes
Lieu: Silver Oak 2, India Habitat Centre
Date et heure: 14 Décembre, 2017, 11:45 – 12:00

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Résumé: Suite à un appel de la Commission européenne sur la résilience aux catastrophes et le climat, le partenariat STORM a été formé par 20 partenaires, dédiés à 5 sites principaux: Mellor (Angleterre), Rome (Italie), Réthymnon (Grèce), Tróia (Portugal) et Ephèse (Turquie). Ces sites présentent la diversité des biens culturels européens.

Ce projet propose une série de nouveaux modèles prédictifs et de méthodes améliorées non invasives et non destructives d'enquête et de diagnostic, pour une prédiction efficace des changements environnementaux et pour révéler les menaces et les conditions qui pourraient endommager les sites du patrimoine culturel.

De plus, STORM déterminera comment différents matériaux, structures et bâtiments vulnérables sont affectés par différents événements météorologiques extrêmes ainsi que les risques associés aux conditions climatiques ou aux risques naturels, offrant des stratégies, systèmes et technologies d'adaptation et d'atténuation améliorés et efficaces. Un système intégré comprenant de nouveaux capteurs (capteurs acoustiques intra fluorescents et sans fil), les systèmes existants, des plateformes de pointe (LiDAR et UAV) et des techniques de crowdsourcing seront mis en place, offrant des applications et des services sur une infrastructure cloud ouverte.

Un résultat important de STORM sera une plate-forme de coopération pour collecter et améliorer de manière collaborative les connaissances, les processus et les méthodologies sur la sauvegarde et la gestion durables et efficaces du patrimoine culturel européen. Le système sera capable d'évaluer les risques naturels en tenant compte des risques environnementaux et anthropiques et d'utiliser le traitement des événements complexes.

D'ici décembre 2017, ce projet de 36 mois sera à moitié terminé. Des résultats préliminaires seront présentés lors du Symposium scientifique de l'ICOMOS pour le site archéologique de Tróia, par l'équipe d’archéologues locale, la direction nationale du patrimoine culturel et le spécialiste de la conservation.