PROTECTING THE CULTURAL HERITAGE FROM NATURAL DISASTERS

CULTURE AND EDUCATION

February 2007
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FROM NATURAL DISASTERS

STUDY
This study was requested by the European Parliament's committee on Culture and Education.

This paper is published in the following language:
- Original: EN
- Translations: DE, FR, IT.

The executive summary translations are published in:
- CS, DE, EL, EN, ES, ET, FI, FR, HU, IT, LT, NL, PL, PT, RO, SK, SL.

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Manuscript completed in February 2007.

This study is available on the Internet at:


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PROTECTING THE CULTURAL HERITAGE FROM NATURAL DISASTERS

STUDY

Content:

Natural disasters represent a major threat to cultural heritage. Floods, earthquakes, fires, environmental fatigue or similar long term climate effects sometimes cause irreversible damage to cultural heritage or completely destroy entire areas of cultural heritage, both movable and immovable. Many heritage objects are further damaged by inadequate emergency interventions.

The study examines current national and international instruments and activities to protect cultural heritage from natural disasters, giving examples of best practices and describing problems and shortcomings. Based on an analysis of current and forthcoming EU legislation, priorities for action are defined. Given the increasing occurrence of natural disasters and their impact on cultural heritage, the authors recommend horizontal integration of the protection of cultural heritage from natural disasters into relevant EU policies.
Executive Summary

Natural disasters represent a major threat to cultural heritage. Hurricanes, floods, earthquakes, landslides, volcanoes, wind effects, fires, environmental fatigue or similar long term climate effects and other disasters sometimes cause irreversible damage to cultural heritage, or completely destroy entire areas of cultural heritage, both movable and immovable. Many heritage objects are further damaged by inadequate emergency interventions because urgent responses to basic needs may lead to emergency measures and to planning and rehabilitation schemes for recovery that are insensitive to cultural heritage. According to the World Bank’s Independent Evaluation Group (IEG, 2006), the cost of disaster damage is rising, and in the 1990s it reached US$ 652 billion, which is 15 times higher than in the 1950s. The number of events grew by 400% between 1975 and 2005, with 2.6 billion people affected by natural disasters over the past ten years. Taking into account the facts above, the European Parliament’s Committee on Culture and Education commissioned the study presented here on the need to strengthen European co-operation in the field of protection of cultural heritage from natural disasters.

The Present Situation

Evaluation of consultants’ team experience, targeted questionnaire campaigns and interviews, and the accompanying literature survey show that the issue of protection of cultural heritage from natural hazards and disasters has not been properly accommodated either in EU legislation or in national laws, by-laws and other documents, except in a few countries. There are several reasons for this. Firstly, many well-designed and well-functioning prevention and emergency measures that are effective in saving human lives completely fail to protect cultural heritage assets. Secondly, effective risk management of cultural assets is rare because of inadequate understanding of the assets, failure to calculate the true cost of loss and damage, and difficulty in putting a value on the non-market nature of many cultural heritage values. In recent major floods there have been considerable inadequacies and mistakes in the hydrological predictions, and knowledge about cultural heritage at risk and about its state and conditions have proved to be insufficient. The Central European floods in 2002 confirmed the crucial role of coordinated knowledge-based crisis management. Loss of cultural heritage assets could have been much lower if many mistakes of human behaviour had been avoided. Thirdly, inadequate maintenance of old buildings and materials has raised the extent of the damage in other disastrous events, mainly wind storms, earthquakes and heavy snow. Natural disasters generate loads which are not sufficiently familiar to engineers, and in many cases the induced forces act against the usual gravity loads (e.g. uplifting and suction), horizontal forces (horizontal movement, moisture expansion of most building materials) or dynamic forces (flow, shocks, impacts). Maintenance methods are not always appropriately accommodated in design standards and recommendations, and professionals may not be well informed. Thus they are not educated to design and implement protective or mitigation measures.

Legislation

Generally, cultural heritage protection is a marginal issue for politicians and governments in most European countries. Cultural heritage tends to be eclipsed by environmental issues, which attract greater political attention due to their close relation to health and nature conservation. The importance of cultural heritage is not always well articulated, and it receives little support from

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the media. However, as has been revealed in the report, there is a very sound and solid background of knowledge and experience that can serve as a basis for achieving the goals for which this report has been elaborated.

State supported remedial actions in the face of a range of disasters related to cultural heritage rely on close cooperation with those directly involved, the police and fire services, and in major disasters, the military. Such an approach has been supported by various legal documents on a national level, fully in line with the principle of subsidiarity. Preparedness to respond to natural disasters is solely in the hands of and within the responsibilities of the individual Member States, which can ask for help or assistance from the European Community. However, the capacities built up in individual Member States might be advantageously used in an emergency in other EU or non-EU countries, and this has been supported by numerous EC legal documents and recommendations.

In the legislation framework, a regulation requiring all European public institutions responsible for extraordinarily valuable buildings and collections (museums, archives, monuments, etc.) to reveal their risk preparedness in their published accounts would be useful. As this initiative would encapsulate the broad expanse of European cultural heritage, it is appropriate for the European Parliament to consider taking such an action.

Cultural Heritage Stock at Risk

Any decision about future strategies and measures to protect cultural heritage against natural disaster effects must be justified by a reasonably reliable knowledge of the European cultural heritage stock at risk. The situation in this field in individual European countries varies significantly, and is strongly dependent on the level of national information systems and technology. However, the few existing databases are fragmented and incomplete, and do not contain some data that is essential for natural hazard risk assessment processes and risk management approaches and tools. Moreover, they are not standardized, harmonized or coordinated for effective exploitation when combating disasters. Immoveable cultural heritage has been listed and registered in inventories mostly without systematic geographical positioning, a technical description of the materials and structures applied, or any information about its current state, all of which is decisive for its vulnerability to adverse natural actions. A standardized GMES-supported and constantly maintained European cultural heritage stock database, with monitoring of changes in sensitive cases, would provide invaluable and unprecedented support for planning measures to reduce the impact of natural disasters on the European patrimony, and also for the targeted operability of intervening rescue teams.

Similarly, maps of potential natural hazards related to cultural heritage have not been fully completed across the European territory. Only mapping of flood hazards is partially supported in the proposal for a new Directive on the assessment and management of floods. The maps of the European cultural heritage stock at risk related to maps of natural hazards and potential risks represent a necessary condition for assessments of the risks, and can help to predict the extent of catastrophic events. Such information is lacking over most of the territory of Europe, though it is fundamental for establishing risk management strategies and activities. The newly-planned European remote sensing and global positioning systems will make it possible to monitor the data necessary for modelling adverse situations and evaluating the conditions for giving an early warning. Together with in situ monitoring, this will substantially improve the operability of preventive and operational measures in Europe.
National governmental bodies have issued guidelines and national action plans for combating various types of natural and man-made disasters. These are mostly legal documents, and usually reflect situations that lie under the responsibility of one of the Ministries. The logistics of dealing with disasters are not addressed, nor is cultural heritage frequently mentioned. Similarly, international bodies and institutions published rather general declarations and guidelines where cultural heritage is not properly treated. The purposely created International Committee of the Blue Shield has been evaluated as blocked to fulfil its aims due to “lack of adequate funding, ineffective coordination with international and national agencies responsible for disasters.” The ICBS operates rather within the framework of some of the funding bodies, namely ICOM and ICOMOS.

Measures to Protect Cultural Heritage

Disaster prevention is essential to save cultural heritage. Management and investigations soon after a disaster, in order to define the extent of damage to movable and immovable cultural heritage, are also very important. An example of this is given by the Italian Civil Protection Department (CPD) and the Ministry of Civil Protection, who have set up a special Committee which recently published on the website of the CPD a series of templates to be filled in by specially-trained teams after an earthquake; the templates enable a description of the damage, calculate the vulnerability indices and define the cost of intervention. The majority of European countries developed massive Internet supported information and advising systems for emergency cases related to natural disasters, especially floods. Unfortunately, they usually do not contain either specific instructions concerning cultural heritage or links to such guidelines provided by specialized international websites.

Preventive measures are typically sorted into two categories: structural and non-structural. Structural measures are difficult to materialize in the case of cultural heritage protection because they are mostly visible and disturbing, and often not cost-effective. This subject needs further research and comparison to best practice non-structural measures. As far as structural measures are concerned, the application of standards to protect cultural heritage from natural hazards leads to the problem that the originality, authenticity and aesthetic qualities and values of historic monuments should not be compromised. However, only one European Standard is in practice available for effective protection of cultural heritage against earthquakes. In Italy a Seismic Code (EuroCode-8) was published in March 2003 containing rules for existing masonry buildings (minor historic architecture). From this code, the Ministry of Cultural Heritage derived guidelines for monuments. Recent experience with damage from excessive weather loads, namely wind and snow, together with real opportunities to adapt the architectural heritage to reduce this damage, has indicated that some amendments to the relevant standards might be suggested and accepted. Standardization of some preventive processes and procedures, e.g. mapping and monitoring, would certainly bring positive results.

Best practice is usually difficult to generalize in a sufficiently informative way. Some basic principles which have proved to be efficient are presented in the report with references to more detailed information and case studies that have been published in various forms and media, (e.g. proceedings of specialized conferences, or the Internet). Let us summarise four pillars for mitigating adverse natural disaster effects on cultural heritage:

i) regular inspection and careful maintenance of the historical stock & improved land use planning and management;
ii) raising awareness and regular coordinated training;
iii) international cooperation and availability of funding, and;
iv) legislative support.

These principles are illustrated and further developed in the report. In fact, all four are already applied in various EU documents and policies concerning civil protection, and cultural heritage aspects can easily be added. Useful data on best practice can also be extracted from the experience of non-European countries, above all the USA, Japan and Taiwan. Many countries have concentrated their efforts on raising knowledge about emergency and early salvage procedures. Different tools have been prepared by different countries, for example the Emergency Response and Salvage Wheel which was designed to assist cultural institutions and agencies in the first 48 hours following an emergency. It is essentially a two-sided rotating chart which allows readers to gain critical response information in two key areas. One side leads readers through a sequence of nine basic emergency response steps, from safety precautions to salvage priorities. The other side identifies salvage techniques and responses appropriate for particular types of collections or objects. Advice focuses primarily on means for controlling and mitigating water and moisture action, perhaps the main source of damage to cultural heritage.

One of the most advanced national systems for improving risk-preparedness for cultural heritage is in Switzerland. The government has taken particular interest in developing an integrated set of policies, tools and mechanisms to improve risk preparedness for cultural heritage. The PBC (La Protection des Biens Culturels) was established to preserve the Swiss cultural heritage and this effort is supported by a series of preparedness manuals and training courses. The Swiss protection programme includes detailed maps on which inventoried cultural properties are located, and depict properties in both urban and rural settings.

**Europe-Wide Protection of Cultural Heritage**

European cooperation in emergency situations proved its efficiency at several recent situations, e.g. at the 1999/2000 windstorm Martin in France, the 2000 forest fire in Macedonia, the 2000 forest fire in Slovakia, the 2002 flood in Central Europe (Czech/Austrian cooperation), and the 2003 flood in France. In all cases the Member States cooperated without problems and the rescue teams started to operate within a few days, usually 2, after acceptance of the offered assistance by the affected country. There are examples of useful cross-border cooperation, e.g. in the Nisa Euroregion where Czech and German fire brigades operate in both countries without obstructions.

From the identified problems and shortcomings we mention here the most substantial:

- A real time road management system based on good mapping of crossings of roads with rivers and *in situ* data together with Earth Observation monitoring during the flood is necessary for evacuation operations. During the Gard flash flood in 2002, more than 200 rescue vehicles were lost on flooded roads. Even a crude assessment of this type of hazard would considerably help Civil Protection services to manage road traffic and to coordinate rescue actions. Blocked roads and access to endangered cultural heritage has been one of the frequent problems and caused many losses preventing evacuation or rescue operation.

- Cultural institutions variously have their own disaster plans which do not necessarily include the response in a major disaster. When a major disaster occurs only the police and fire brigade are allowed on site until it is safe. By this time quite major damage could have occurred through inappropriate actions e.g. too much water, unnecessary demolition of building fabric, not knowing what to save first if there is an opportunity to remove valuable items. The police and fire brigade have their own plans and procedures which do not take
account of cultural heritage as a specific issue. Many regional disaster plans take account of animals, crops etc, but not heritage. Emergency organizations do not talk to curators, conservators, architects etc. There needs to be more seamless integration and with everyone working together from the onset of the disaster.

- European countries exhibit various approaches to insuring cultural heritage against natural hazards. For instance flood insurance is not popular in Europe, and in some countries it is not possible to insure property positioned in the area with possible inundation. A detailed study of flood insurance programmes in Europe and a comparison with the US National Flood Insurance Programme shows that the American system offers substantial benefits to cultural institutions, and has decreased federal disaster assistance ten times.

**The Framework Programmes and Cultural Heritage**

The European Commission has been supporting several international research projects on the triggering mechanisms and behaviour of natural and man-made disasters, their effects and possible preventive and remedial measures. More than one hundred projects have been completed with support from recent EC research programmes or have been running within the 6th Framework Programme (FP). They cover problems of floods, landslides, earthquakes, tsunamis, forest fires, avalanches, volcanoes and multi-risk situations. Most of the projects study basic phenomena and mechanisms related to natural hazards, without explicitly focusing on protection of cultural heritage from disasters. However, the results of several projects are applicable to an effective European strategy in this area. They mostly provide the EU with powerful tools for mapping, monitoring and predicting natural disasters and their territorial impact. Let us mention some of these projects:

1. The vulnerability of cultural heritage to natural disasters and similar threats was discussed within the ARCCHIP project workshops which revealed a number of examples of good and bad practice, and they have also revealed some gaps in knowledge. Climate change has had a substantial effect on the frequency of occurrence of some harmful natural events, namely windstorms, floods and landslides.

2. Triggering mechanisms, impacts and mitigation measures related to cultural heritage and cultural landscape have been investigated in the NOAH’S ARK project, which is still running. Reports summarizing results on vulnerability of cultural heritage to natural hazards and possible mitigation measures are published on the project web site.

3. The recent COST Action C17 “Fire Loss to Historic Buildings” activities on the impact of fires on cultural heritage and on mitigating these impacts contributed substantially to this report.

4. A new 6th FP project, CHEF, focuses on floods in relation to cultural heritage in all its complexity. This project started in February 2007.

5. The largest ongoing integrated project, FLOODsite, has some sections that take into account cultural heritage issues in relation to socio-economic evaluations of flood damage.

6. The national German project DISFLOOD (Disaster Information System for Large-scale Flood Events using Earth Observation) contains elements which support the cultural heritage stock at risk inventory in flooded areas. This project focuses on urban territories and involves many historic cities.

7. In addition to the NOAH’S ARK project, which deals exclusively with principles of protection of cultural heritage from climate change impact, there is another large LESSLOS
integrated project dealing with landslides and multi-risk situations (together with earthquakes), which studies cultural heritage vulnerability and protection strategies and assesses historic bridges in accordance with European standards.

8. Protection of cultural heritage against earthquakes has been also studied in the ongoing 6th FP project PROHITECH. This project delivered several useful outputs in both the non-structural measures (guidelines and assessment tools) and the structural strengthening suggestions.

9. The cultural heritage issue has been added to the SAMCO agenda in 2006. This European Network for Structural Assessment Monitoring and Control evaluates results from combined structural, environmental and safety monitoring systems which provide data on deterioration processes and situations endangering historic materials and structures and support early warning systems preventing loss of cultural heritage.

10. The project entitled “Management of Natural and Technological Risks” under the JRC Enlargement action within the 6FP dealt with investigation risk mapping practices and policy for priority hazards in several Central European countries. With the help of a questionnaire, the survey focused on several hazards, including landslides. The respondents assigned a lower level of importance of cultural heritage exposed to landslide risk than of infrastructure or private property objects.

FP7 devotes numerous research areas to natural hazards within the Theme 6 “Environment (including climate change)”. No specific features are presented in relation to cultural heritage, pan-European or cross-border cooperation and integration policies in the first call for projects. It is positive that the area 6.3.2 “Protection, conservation and enhancement of cultural heritage, including human habitat” opens the door for research into damage assessment of cultural heritage from environmental action which involves weathering and climate change effects and, in principle, might include damage from natural disasters. However, tasks focused on disaster prevention models of heritage building and monuments are planned for future years and calls. Here the consultants recommend formulating tasks on risk assessment related to individual natural hazards, in which cultural heritage and international cooperation issues will be explicitly defined in the relevant calls for research projects, including long term hazards (weathering and long term repeated actions) and necessary interdisciplinarity (socio-economic issues). While new protection methods are infrequently introduced most protection efforts remain conventional. The principle must be to employ the most cost-effective protection methods. However, there is a definite gap in knowledge as to how cost-effective the conventional as well as new protection methods really are. With various European databases and statistics now emerging, evaluations are becoming feasible. It is fundamentally important to future protection of heritage that measurements of cost-effectiveness are made. Such undertaking is beyond the ability of any single country. However, a pan-European effort is manageable by a moderate research program and the results should make a profound impact on future practices by all. The report summarises other knowledge gaps which are to be considered in EU research programmes.

European Measures to Protect Against Disaster

The Community Civil Protection Mechanism (CCPM) was established by Council Decision No. 2001/792/EC, Euratom on October 23, 2001. It supports and facilitates mobilization of the emergency services to meet the immediate needs of countries struck by disaster. It improves the coordination of assistance interventions by defining the obligations of Member States and of the Commission, and by establishing certain bodies and procedures, such as the Monitoring and Information Centre (MIC). The mechanism is intended to help ensure better protection, primarily
of people but also of the environment and property, including cultural heritage, in the event of major emergencies occurring inside or outside the Community. It consists of four key elements - Pre-identification of intervention resources (with intervention teams which are the core component of the mechanism), A training programme to improve response capability, Assessment and coordination teams, and Establishment of a common emergency communication system. CCPM is a sound and powerful instrument for protecting cultural heritage from natural disasters. Since 2001, several related acts have been introduced – Council resolutions, decisions and proposals which substantially enhance the role of the cooperation mechanism. COM (2005) 137 (“Improving the CCPM“) and COM (2006) 29 – Official Journal C 67 of 18.03.2006 (“recast of Decision 2001/792/EC”) are major improvements to the mechanism, and will help to provide better protection of cultural heritage in emergency events. The suggested “modular approach” will give an opportunity to create specialized standby intervention teams with appropriate training and experience to safeguard cultural heritage from the adverse effects of natural (and man-made) disasters.

Similarly, recent proposals to reinforce the analytical and assessment capacity of MIC offer a very progressive way to enhance the capability and actions of MIC in the area of cultural heritage protection. The consultants attach special importance to the possibility of improving disaster prediction and early warnings, as well as in situ assessment and coordination activities, which all are key factors in the rescue of cultural heritage assets. The availability of a more stable cadre of well trained and experienced personnel with powerful equipment will certainly increase the effectiveness of emergency measures and actions, which could also be utilized outside the EU, in the sense of the Barnier report.

This report suggests the establishment of a “Europe aid” civil protection force. Such an EU programme to provide security for European citizens outside the EU territory can easily and favourably be linked to action to protect and safeguard cultural heritage. In fact, the Barnier report does not discuss issues of cultural heritage protection, as it focuses on humanitarian issues. However, the very well elaborated and clearly presented proposal for a European civil protection force – “Europe aid” - is well structured and prepared to include “modules” on protecting and rescuing cultural heritage in emergency situations. In this way, the European civil protection force initiative further increases the capacity and helps to create critical mass to safeguard cultural heritage from natural disasters. The amendments to humanitarian and civil protection aid integrated with interventions to safeguard cultural heritage will not only raise the visibility of the EU, but will also substantially improve the durability and sustainability of the added value of the EU and of “Europe aid” worldwide.

Success and effectiveness in emergency situations is strongly dependent on experience, and on learning lessons from previous events. Emergency situations mostly do not recur in the same place or even in the same country within a short period of time. Joint interventions by international teams are therefore a particularly valuable way to learn from disasters. Personal experience is crucial, and creates a solid background for improved, in-time and correct decisions. This fact, together with the economic advantages of maintaining only limited personnel and equipment on permanent alert shows the European value of jointly operated, coordinated and controlled actions to protect cultural heritage from natural disasters.

Generally, there has been no holistic and uniform approach for dealing with natural hazards and cultural heritage, nor for dealing with natural hazards only. Hazards are addressed in heterogeneous ways, under various headings and at different levels by existing Community instruments. Cultural heritage protection is frequently treated as if it were an environmental
issue, though the reasons for this are unclear, and there are many inconsistencies. Spatial and urban development documents tend not to include provisions for protection of cultural heritage, though most cultural heritage is located in settlements. Cultural landscapes and transboundary issues also need to be considered. However, the EU Structural Funds, which play an important role in cohesion policy, are potential instruments for preventive measures. Environmental protection, including support for cultural heritage and risk prevention, has been given much greater emphasis in the new cohesion policy reform. Under all three objectives risk prevention is mentioned as a priority, namely within territorial cooperation, which acknowledges risk prevention at cross-border, transnational and interregional level. The themes include protection against flooding, earthquakes and avalanches, and involve supplying equipment, developing infrastructures, transnational assistance plans and risk mapping systems. The Interreg programmes should be especially encouraged, because they provide a space for creative projects on measures to protect cultural heritage from natural disasters, and they involve the most relevant stakeholders and governmental bodies. They may also be the best sources of good and bad practice experience for the enlarged MIC.

Two newly proposed Directives should be exploited for protection of cultural heritage for which amendments are needed. The risk maps required in the Directive on the assessment and management of floods should be obliged to contain an inventory of cultural heritage stock, including archaeology and cultural landscape. Risk management plans have to involve specific measures for taking cultural heritage adequately into consideration in the affected territory. In Article 9/2, spatial planning, land use and natural conservation are mentioned as aspects which must be taken into account when appropriate levels of protection are established. Cultural heritage conservation should be added here, too. During the conciliation procedure, the European Parliament and the Council reached an agreement on the INSPIRE Directive (Infrastructure for Spatial Information in the European Community) on 21 November 2006. The Directive will require EU member states to improve the administration of their map services and other spatial data services according to common principles. The data includes protected sites and potential hazards and, again, the cultural heritage is to be added.

The European dimension in the field of the protection of cultural heritage in emergency situations is demanded due to several aspects.

- First, awareness will be improved, namely the awareness of politicians and governments about the problems of cultural heritage in emergency situations which will help to accelerate decision making and international operations. European cooperation has a great potential in researching knowledge and gathering, evaluating and providing for dissemination best practice examples as well as bad experience, especially for emergency professionals. This power has not been adequately exploited so far. The ESPON Hazards project developed a typology of regions that clusters areas in Europe, which are threatened by similar hazards in space and time. The project further created hazard interactions maps and linked them with climate change effects which is again all European and trans-border feature.

- Further, in recent years a strong tendency to invest into preventive and mitigation preparedness measures has been apparent and promoted. At the same time non-structural rather than structural means are preferred especially in connection with protection of cultural heritage. In both approaches there is enough space for innovative solutions or techniques and for breakthrough concepts, which calls for creation of critical mass within EU research, planning and development programmes. Specific features of some natural hazards require developing and adopting preventive measures in a harmonized way by several European countries. On the non-structural level bi-lateral or multi-lateral agreements are usually
signed, in which coordination process is included, nevertheless, the EU central coordination unit – the MIC – proved to be a very efficient and useful instrument in emergency situations. The importance of a sophisticated and suitable insurance system as a preventive measure is well known and a EU incentive or facilitating initiative might be extremely fruitful for establishment of such a tool.

- European programmes and documents, including existing or proposed directives, are generally in support of mapping natural disaster targets, but unfortunately do not explicitly include cultural heritage. This needs to change, and the consultants even feel that for a really innovative approach a special harmonized pan-European cultural heritage inventory mapping initiative is essential. It can be done in three steps, starting with a research and development project, supported by the design and choice of the best methodology. This would be followed by a standardisation procedure and finalised by an EC-supported mapping campaign. It should be emphasized that such mapping has other positive economic side effects, namely for tourism, education and awareness raising, security improvements, scientific work, historic studies, development of intelligent and interactive GIS systems, and protection against various threats, e.g., climate change and pollution from new emission sources, mainly cars. Therefore, it might qualify for aid from the structural funds. A suitable European marking system should be applied for emergency situations. Use can be made of the existing Blue Shield visual mark, which should, however, be upgraded for better performance at night and in low-visibility situations.

- More attention to cultural heritage should be paid to the EU collaborative research programmes and projects focused on natural hazards and disasters. This issue should be strengthened in the priorities of the ERA NET projects as well as in the planned research activities of the European Construction Technology Platform – Focus Area Cultural Heritage. Items of cultural heritage safeguarding from natural (and human made) disasters are not integrated into the themes of the EU security research, even though the monuments and historic complexes are quite frequent target of terrorist attacks. Terrorism and armed conflicts have not been the explicit subject of this study, however, because of many similarities with natural disaster emergencies, it is important to harmonize research in these fields and to use financial resources more efficiently. Moreover, the results would be useful for EU activities outside Europe, including rescue of EU citizens-tourists in danger.

- Facilitating exchange of knowledge and experience on protection of cultural heritage from natural disasters is the most important added value of pan-European activities in the field. Natural disasters can occur in areas where they have not been experienced previously. Therefore the role of transfer of knowledge and experience must be emphasized and the adequate tools developed and offered for use. It concerns practical issues as well as research or investigation results.

- Non-structural standards and harmonized European recommendations focused on variety of problems – from data collection, damage assessment and evaluation, inventory and mapping of hazards and stock at risk to creation of thematically oriented Geographic Information Systems, warning systems and similar management tools – are inevitable for progress and success in combat with natural disasters and they are widely demanded. They will further support development of technical standards for prevention and mitigation of damage from individual or multiple hazards, such as earthquake, fire, landslides and climatic loads.

- European cross-border cooperation in protection of cultural heritage threatened by natural and man-made disasters is not supported by any specific legal document. The emergency cooperation functions quite effectively within general schemes, as shown by numerous
examples from recent disasters. This cooperation is mostly based on bilateral or multi-lateral agreements, nevertheless, support and coordination from the EU is demanded.

- Cost effective capacity building, pooling of resources and necessary alert and rapid response in emergency situations will certainly profit from joint European level measures.

The above mentioned findings and conclusions are summarised in several priority points at the end of the report.
Given the increasing impact of natural disasters, the need to tackle them more effectively has gained a great deal of attention inside the European Parliament. Members of the EP are of the opinion that there is often not enough coordination at European level on measures taken in response to disasters, and that the diversity and the lack of coordination between the mechanisms and solutions existing at national and regional levels are not conducive to effective action. MEPs therefore believe that enhanced coordination at European level can improve the way natural disasters are tackled. Therefore they recently called on the Commission to draw up a European strategy to combat natural disasters and to propose directives on prevention and risk management.

Human and natural disasters also pose a major threat to cultural heritage. Hurricanes, floods, earthquakes, landslides, volcanoes, wind effects, fires, war and other disasters sometimes cause irreversible damage to cultural heritage, or completely destroy entire areas of cultural heritage, both movable and immovable. Unfortunately, heritage objects can also be damaged by an inadequate emergency response. Urgent responses to basic needs may lead to emergency measures and to planning and rehabilitation schemes for recovery that are insensitive to cultural heritage.

While recognizing that in the immediate response to disasters of all kinds, the first priority must be to save human lives and to provide for basic needs, emergency responses and recovery actions should, as much as possible, avoid adding further harm to cultural heritage. The cultural heritage is priceless and often non-renewable, and it is necessary to integrate all necessary measures to protect it from disasters. It is crucial, therefore, that concern for cultural heritage be integrated into existing disaster management policies and mechanisms.

Article 151 of the Treaty establishing the European Community includes a reference to the conservation and safeguarding of cultural heritage of European significance. Article 151 (4) stipulates that the Community shall take cultural aspects into account in its actions under other provisions of the Treaty.

In the context of recent proposals to improve the tackling of natural disasters, the European Parliament's Committee on Culture and Education therefore commissioned the study presented here on the need to strengthen European co-operation in the field of protection of cultural heritage from natural disasters.

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1. INTRODUCTION

1.1. Natural disasters & their impact on cultural heritage

Knowledge about the characteristic features and the impact of natural disasters that threaten cultural heritage is a prerequisite for evaluating the measures that have been designed, adopted and applied on a national or international scale in order to prevent, reduce and repair the impacts of natural disasters. The main types of natural disasters are presented below, and typical problems are illustrated by recent examples in relation to cultural heritage. Among natural disasters we also understand large single-event fires and climate change effects. Examples of damage to cultural heritage are given in Annex 5.

1.1.1. Floods

Floods are the most frequent natural disaster with an increasing adverse impact in urbanized territories. They vary considerably in extent and duration, ranging from small inland or coastal floods, with only a local impact, to disastrous events affecting large territories and several countries. They cause damage and failures due to static and dynamic loads (water pressure, water flow, uplift forces), due to impacts from floating objects, due to wetting of building materials (which is difficult to treat), and due to the effects of soluble salts, chemical pollutants and biological infection. Though floods are usually of short duration, repairing the consequences can take a very long time and require enormous efforts. Floods can damage or even destroy historic buildings, infrastructure, cultural landscapes and gardens, and in many cases also moveable cultural heritage (see Annex 2 & 5). Masonry materials affected by salt transport can suffer long-term damage, with little possibility of repair and protection.

In relation to climate change, permanent problems of high water emerge. Rising sea level threatens many areas, e.g. the east coast of England, and could result in catastrophic flooding. There is some evidence that flood barriers may be ineffective as sea levels rise beyond previous predictions. (Let us mention examples of the loss of cultural heritage in Orkney due to rising sea level - partly from post-glacial tilting, but increasing from rising sea levels due to climate change).

The rising sea level and increasing human exploitation of land have been increasing the occurrence of floods in areas that have seldom or never experienced them. Quite dangerous for cultural heritage, namely archives and museums, are so-called flash floods, characterised by a rapid rise and fall of floodwaters with peak flows occurring within hours of heavy rain. There are several additional factors influencing cultural heritage losses due to flood, e.g. neglect and deterioration of historic buildings, inadequate warning times, location of contents, prevention strategies, prior flood experience, after-flood remedial work, etc.

1.1.2. Landslides

Landslides and similar phenomena (e.g. avalanches, mud flows, debris flows, rock falls) cause major loss of historic objects and architectural heritage. They affect large areas, and the damage is mostly irreparable. The object or building is dislocated from its original position, severely distorted and in many cases partly overturned. Landslides frequently accompany floods, having the same triggering mechanism from heavy rains. Earthquakes are the second major cause of

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4 For example: [http://www.planning-applications.co.uk/ppg25_floodrisk.pdf](http://www.planning-applications.co.uk/ppg25_floodrisk.pdf)
Protecting the cultural heritage from natural disasters

landsides. Further important triggering factors are erosion (e.g., by river or sea) and human activities (excavations at the bottom of a slope or surcharge at the top of a slope). Landslides occur at a very wide range of velocities. Unlike other natural disasters, which occur rapidly and almost without any warning, some landslide phenomena are slow and can take place over a period of many years. Such landslides can be destructive, but there is more time available for emergency actions. From the territorial point of view, landslide hazards are widespread throughout Europe, though the real threats are very local and affect rather well predictable areas.

1.1.3. Winds, storms and hurricanes

Wind primarily causes loading and mechanical damage to structures, but it can also increase or decrease the chemical action of water and gases on cultural heritage objects. The flow around structures has a substantial influence on the deposition of pollutants, biological corrosion, cycles of drying and wetting, as well as mechanical wear of the attacked surfaces. Wind transports water, salts, dust and gases to the object or can conduct them away. It is clear that the air flow effects on historical structures or sculptures located in the open air can be quite disparate. In an effort to provide a systematic description of their negative impacts in order to anticipate hypothetical risks, we may define two basic groups of possible failures which fundamentally differ in their causal relations.

First, damages due to wind erosion are to be considered. Wind and weather affect building materials, and after long-term action the abrasive impact can lead to significant changes to all exterior parts of the structures. Preventive maintenance and monitoring of weather conditions and changes can considerably reduce future financial costs. The second group of damages is when the bearing capacity of the construction materials is considerably exceeded by the wind loading, especially in combination with rain, which is often the case. An acute increase in material stress can cause local mechanical damages, and in the case of extreme events (windstorms, hurricanes) structures can even collapse. This often happens suddenly and unexpectedly, which makes precautionary measures much more difficult.

Strong winds and storms cause damage and failure to both cultural heritage and natural heritage. Windstorms are dangerous namely for tall buildings, high or light roofs, released or slender building elements. Large trees in the vicinity of valuable buildings or sculptural monuments can cause serious damage when they fall down or when heavy boughs break off them. Winds can affect extremely large territories in several countries and can be accompanied by floods and hail, snow or sand storms. According to the Munich reinsurance Company, regional storms are the highest source of financial and insured losses in Europe. Winter storms can initiate associated effects such as storm surges, floods, avalanches, landslides, high seas and waves, excessive snow loads and rain pressure, and coastal erosion. They are difficult to predict, and it is not possible to reduce their occurrence. Limited measures to protect cultural heritage can, however, be suggested.

1.1.4. Earthquakes & tsunamis

Seismic activity threatens thousands of cultural heritage objects. Within and outside the plane of seismic activity, actions caused by an earthquake can severely affect the stability of historic buildings, particularly of masonry buildings, causing heavy crack patterns and damaging facades, corners, roofs and floors, leading to partial and total collapse.

For examples of outcomes of the 6FP EC Project NOAH’S ARK [http://noahsark.isac.cnr.it](http://noahsark.isac.cnr.it)
Buildings are particularly vulnerable when no maintenance has been carried out for years. This frequently happens in the case of vernacular or minor historic buildings which are not protected by Heritage Offices. Invasive and non-compatible repair techniques can also cause major damage, rather than protecting the buildings, when the next earthquake strikes.

Movable cultural heritage inside damaged buildings (e.g., in churches and museums), can also be lost, not only during the earthquake, but also when they are incorrectly removed and transported away from the buildings.

1.1.5. Fire

Climate change with long dry periods increases the danger of fires. Fires can be started by lightning, short-circuits, human error, or arson. Fires were historically more dangerous in settlements than they are nowadays. Nevertheless, important monuments continue to be lost due to fire. Recent investigations of the COST C17 Action have recorded hundreds of events of catastrophic fires in cultural heritage objects. Such events may be categorized according to: i) Loss of major archives, collections or artefacts in single-event fires; ii) Loss of major historical buildings in single-event fires; iii) Conflagrations of historic town centres (Edinburgh and similar). As was mentioned above, and as Finnish statistics have shown, fires frequently occur together with strong winds (in more than 50% of cases) and earthquakes, and are one of the main multi-hazard elements.

1.1.6. Other natural disasters

Several other types of natural disaster are a threat to cultural heritage. Volcanic activities destroy large territories in the vicinity of eruptions. Houses are often built on the sides of volcanoes, even near the crater, particularly after it has been inactive for a long period (e.g. the built environment on Mount Vesuvius is so heavy that 600,000 people would have to be evacuated in the event of an eruption).

Land subsidence due to karst effects, water pumping or historical mining is another type of natural disaster that threatens the cultural heritage. The historic cities of Oppenheim (Germany), Norwich (UK) and Ravenna (Italy) are representative examples of places where unexpected ground loss or large-scale settlement places historical monuments in danger.

Hailstorms, snowstorms and sandstorms can be catastrophic, due to the possible impacts of flying objects, overloading, icing and other sudden effects. Drought and desertification are phenomena that can also be taken into account in relation to the cultural landscape and archaeological sites.

1.1.7. Environmental change

The responses to the questionnaire, and also the results of several research projects mentioned below, show that environmental changes and especially climate change are considered to be on a disastrous scale. Although climate change is not prominent in the report as a causative factor for natural disasters, (Floods, Landslides, Wind & Storms, Fire etc.), there are direct examples of

6 Electrical discharge is a normal weather phenomenon, and may cause structural damage, in addition to ignition.

increasing amounts of falling masonry due to extreme weather/storms (predicted to increase with climate change). In this respect the timescale of a natural disaster should perhaps be modified. Many events are seen as instantaneous, yet may form part of a longer term 'event' taking place over decades (e.g. increasing rainfall, rising sea levels). The effects are not very apparent, and they have a less pronounced impact on human lives and human needs, but they should be considered as an alarming, ongoing emergency situation for the sustainability of cultural heritage.

1.2. Lessons from major recent disasters

1.2.1. Published experience

In recent decades, all major disasters and their consequences have been reported in national and international documents and evaluation reports. These are a basic source of data for cultural heritage protection, covering technological, procedural and operational issues. It is widely known that many well-designed and well-functioning prevention and emergency measures that are effective in saving human lives completely fail to protect cultural heritage assets, (Thieken et al., 2005), even though these assets are in most cases highly valued by the population.\(^8\)

It is widely accepted that “effective risk management of cultural assets is rare because of inadequate knowledge of the assets, failure to calculate the true cost of loss and damage, and difficulty in putting a value on the non-market nature of many cultural heritage values”, (Taboroff, 2000).

In recent major floods there have been considerable inadequacies and mistakes in the hydrological predictions, and knowledge about cultural heritage at risk and about its state and conditions have proved to be on an extremely low level. In specific cases, this lack of knowledge has increased the damage, e.g. due to failure of old bridges, dikes, dams, and deteriorated parts of buildings (Bulgaria, Czech Republic). Neglected maintenance of old buildings and materials has raised the extent of the damage in other disastrous events, mainly wind storms, earthquakes and heavy snow, (e.g. Schmuckle-Mollard, 2006, Annex 5).

Natural disasters generate loads which are not sufficiently familiar to engineers, and in many cases the induced forces act against the usual gravity loads (e.g. uplifting and suction), horizontal forces (horizontal movement, moisture expansion of most building materials) or dynamic forces (flow, shocks, impacts), (Drdácký & Sližková, 2005). They are not always appropriately accommodated in design standards and recommendations, and the professionals are not well informed. Professionals have not been educated to design and implement protective or mitigation measures.

For most disasters, no accurate figures about the affected landscape and cultural heritage are available, (which is generally also the case for other stock at risk, and also for the population), (e.g. Thieken et al., 2005).

\(^8\) For example, (Thieken et al., 2005), “Generally, cultural heritage sites are highly valued by the Bulgarian population. In some cases this has resulted in a sincere concern for damage to cultural heritage. In other cases, the priority was for protection of life and property of the civilians at the expense of protection of churches, etc. We acknowledge that the population could have done nothing to protect these cultural sites. However, flood risk management measures to ensure the protection of those cultural sites most highly valued by the Bulgarian population should be considered in the long term.”
From a few nationally recorded examples we have extracted, e.g., the Hadlow Tower which was badly damaged in the 1987 storm. This structure was on the 1998 World Monuments Fund's list of 100 endangered buildings of international architectural importance. The condition of Hadlow Tower, a 19th-century folly near Tonbridge, Kent, is listed as "poor" in English Heritage's 2006 register of buildings at risk. Similar reports from the great storm in England, in 1987, are reported (see, e.g., grave damage to the Christchurch Park arboretum in central Ipswich).

There is a report from Norwich Cathedral, where the spires 100 m in height moved about 0.08m to and fro in the high winds. The United Kingdom has become twice as stormy over the last 50 years, with an increase in heavy rain showers. High pressures have increased on an average by 3 hPa, and low pressures decreased by 3 hPa since 1950. This has resulted in much windier weather.

Since the great floods in 1953, the Netherlands has not suffered from any major natural or man-induced catastrophe. Nonetheless, in recent years a number of cultural heritage objects have been damaged or demolished as a result of destructive emergency situations. Fires destroyed several architectural monuments, e.g., architectural monuments in the Nieuwstad in Leeuwarden. Seismic shocks caused severe damage to monumental buildings, e.g., the parish church of Herkenbosch and the Minderbroeders Church in Roermond, both in the province of Limburg. The Roermond earthquake of April 13th 1992 had a magnitude of 5.8 on the Richter scale. The river floods of February 1995 made headlines in the world news, causing more than 200,000 people to be evacuated from their houses. The rising water was a serious threat to monuments and collections, including a depot of the Arnhem Open Air Museum in the Tielerwaard. Examples such as these show the need for a considerable level ongoing alertness.

Many historical monuments and sites of non-quantifiable value are founded on unstable rock blocks. The most prominent examples are the Acropolis in Athens, the Delphi Archeological site, Meteora in Greece (Christaras, 2003), the ancient town of Orvieto in Italy (Tommasi et al., 1997), the Alhambra palace in Spain (Justo et al., 2005), Spiš castle in Slovakia (Vlčko, 2004), and others. The slope instabilities are often related to a number of factors, including climate impacts, geological reasons and human activity. The key point for the appropriate protection action is to recognise the main contributing factors.

After the 1976 earthquake which hit Friuli, and the 1980 Irpinia earthquake, research on prevention and repair of existing masonry buildings was encouraged by the Italian CNR. A special Research Group, the National Group for Defence against Earthquakes (CNR-GNDT) was set up. It coordinates research in the field of Structural Engineering for the protection, prevention and repair of steel, concrete and masonry buildings. Part of the research funding was for a study of masonry buildings, not necessarily monuments, and also for minor architecture in the tissue of historic centres, and also new masonry buildings.

Another Institute, the National Institute of Geophysics and Vulcanology, carries out research on seismology and volcanic eruptions. The two groups collaborated for a long time. GNDT and INGV have published the results of their research on their websites.

From 2003 - 2005, a three-year GNDT research programme was supported by the Civil Protection Department. Specific research projects were funded to study the vulnerability of historic centres to earthquakes. The research results can be found as books and papers, or as reports on the GNDT website.
Since 2006 the Civil Protection Department has been directly funding a three-year research Program, called RELUIS (Rete dei Laboratori Universitari di Ingegneria Sismica (Network of the University Laboratories of Seismic Engineering), with a total budget of €15 million. The aim of the project is to finance the construction of shaking tables for advanced experimental research on steel, concrete, timber and masonry structures, including existing and historical structures, and also to collect, homogenize and digitize the already existing large amount of research in the various fields. After the first year of the programme a website was made available to researchers and also to professionals (architects and engineers), where all the publications and research results are reported.

1.2.2. Personal experience

All members of the consulting team have personal experience of some of the recent major disasters that have damaged cultural heritage. This intimate contact with disasters has provided data that is authentic and unbiased, especially in the field of effective preventive measures, warning problems and failures, behaviour of decision makers, efficiency of national programmes and the role of international cooperation.

The Central European floods in 2002 confirmed the crucial role of coordinated knowledge-based crisis management. Loss of cultural heritage assets could have been much lower if many mistakes of human behaviour had been avoided. Some examples are given in the paragraph on “bad practice” (Jirásek, 2003). On the other hand, this event provided all stakeholders with experience which can be utilized in future mitigation and preventive measures (e.g., Drdáký et al., 2006).

Strong winds in Europe, named Lothar, Martin and recently Kyrill, caused costly damage to several castles and monasteries in the Czech Republic and throughout Europe.

The castle of Jezeří is located on a steep hill in the Krušné hory mountains, Czech Republic. Brown coal mining at the foot of the slope (open pit mines 120 - 200 m in depth) endangers the stability of the slope. There had already been several landslides in the vicinity of the castle in the past, and the recent landslide in June 2005 came to a stop very close to the castle. Thus, initiation of a catastrophic landslide by human activity creates an obvious link between a natural disaster and a threat to cultural heritage. There has been enormous pressure from the international mining company and also from some politicians to relieve the cultural heritage status of the castle, or to allow drastic slope stabilization measures which would destroy the valuable landscape character around the castle (Marek, 2005, 2006). A comparable situation was encountered in case of the 12th Century Abbey of Le Thoronet, in France (Koch Paquier et al, 1990). An open bauxite pit destabilized a hill above the abbey, and the activated landslide was approaching the abbey with a velocity up to 2 cm/year. A costly drainage gallery in the hill was able to stop the movements.

After the strong earthquakes in 1976 and 1980, which badly affected the regions of Friuli and Irpinia and their historic centres, the first Italian Seismic Code was prepared, but it paid little regard to cultural heritage. Concerning repairs to historic masonry buildings, the suggestion was to treat the old masonry structures like new structures, in order to establish safety coefficients in the structural analysis in seismic areas. “Box” behaviour was assumed for masonry structures under the hypotheses of stiff connections between the walls and between the floors and the walls, and stiff behaviour of the floors in their plane. These assumptions implied the replacement of timber floors and roofs by concrete ones; in addition, the masonry walls were stiffened by grout injections and also by reinforced injections.
The Umbria and Marche earthquake in 1997 affected areas where, after a previous earthquake in 1979, the Code had been applied and the type of intervention mentioned above had been carried out. Observations of the post-earthquake effects carried out in four historic centres in Umbria and, for purposes of comparison, in two historic centres in Liguria showed that building collapses had occurred mainly due to lack of maintenance and due to incompatibility of the techniques adopted for repair work. Heavy concrete beams hammered the walls, tie beams introduced into the walls caused them partially to collapse, injections failed because the walls were not injectable (see Annex 5). This phenomenon was recorded by L. Binda and at other Universities (Padua, Genova, etc.) in an extensive survey extended to the historic centres of Campi, Castelluccio, Montesanto and Roccanolfi in Umbria. Other groups worked on the vulnerability of historic centres and buildings belonging to the cultural heritage patrimony.

A helpful aspect of the survey was the collection of mechanisms of failure typical of the different typologies of historic buildings. It became clear that in order to carry out a vulnerability analysis of these structures there was a need for a detailed survey of the buildings and a characterization of the morphology of the masonry walls and the mechanical characteristics of the masonry. A methodology for collecting data in a database helpful to professionals, together with recommendations and guidelines for the choice of compatible materials and techniques for the intervention, was therefore proposed in collaboration among a number of Universities. The information was extremely helpful as a basic document for the new seismic Code published in Italy in 2003; a large part of the code is now dedicated to existing masonry buildings, and on the basis of this recommendations were prepared by the Ministry of Cultural Properties in Italy for the monumental buildings under its control.

The methodology for the investigation and the vulnerability analysis based on the observed mechanisms of failure were applied to churches and monuments damaged by the 2004 earthquake in the Lake of Garda area. A large research project on historic centres and monuments is now supported by the Civil Protection Department in Italy.

1.2.3. Questionnaire campaign

The current situation in relation to protection of cultural heritage from natural disasters in the EU Member States including the two states that acceded in 2007, has been examined through a questionnaire sent to relevant specialists in the countries listed in Annex 1. The results have been exploited in all chapters of the report. Unfortunately, the number of responses was quite low.

One of the most detailed reviews was elaborated in Bulgaria, and it is added in an abbreviated form as Annex 3 because of much interesting data on all kinds of disasters related to this report from a new EU Member state. Moreover, Bulgaria is a country with quite high occurrence of natural hazards.

There were only two responses for the topic of landslides, from Ján Vlčko (Slovakia) and Felix Darve (France). They stress the role of monitoring and detailed model simulations of selected major objects. Their answers have been incorporated in appropriate sections below.

Only a few written answers to the questionnaire were given by the national representatives of the International Wind Engineering Society (IAWE). The French representative reported World Wide Web sources of wind damage to historical buildings and monuments. These are reported in Annex 5. There is a clear lack of data distinguishing between general damage to the buildings
and historical monuments. The insurance losses in annual reports (see, e.g., Rauch 2002) give general loss estimates only.

Similar questionnaires have already been attempted in other research programmes. In the 'Central and Eastern Europe' regional workshop Integrating Cultural Heritage into National Disaster Planning, Mitigation and Relief in Skopje 1997, it was observed that it is unusual to find cultural heritage well integrated into existing natural disaster management (Revival, 1998).

In Australia, an investigation into the knowledge and perceptions held by Rural Fire Service (RFS) Brigade Captains, by far the largest group of disaster managers throughout the state, revealed significant deficiencies in the perception of cultural heritage and unawareness of formal frameworks for cultural heritage (Graham and Spennemann, 2006).

This campaign and the accompanying literature survey show that the issue of protection of cultural heritage from natural hazards and disasters has not been properly accommodated either in EU legislation or in national laws, by-laws and other documents, except in a few countries (e.g. Italy, where mistakes made on several occasions, e.g., the Florence flood, have convinced the authorities of the advisability of organizing prevention and intervention measures through Civil Protection Service). There are several reasons for this. Generally, cultural heritage protection is a marginal issue for politicians and governments in most European countries. Cultural heritage tends to be eclipsed by environmental issues, which attract greater political attention due to their close relation to health and nature conservation. The importance of cultural heritage is not always well articulated, and it receives little support from the media. However, as we shall see in the report, there is a very sound and solid background of knowledge and experience that can serve as a basis for achieving the goals for which this report has been elaborated.

The pan-European dimension of natural disaster hazards is illustrated by the maps prepared within the DG REGIO supported ESPON Programme, (see below, p. 31, and Annex 5).
2. PREPAREDNESS TO PROTECT CULTURAL HERITAGE FROM NATURAL DISASTERS – CURRENT SITUATION

2.1. General situation

2.1.1. Legal framework & consequences

Basically, preparedness to respond to natural disasters is solely in the hands of and within the responsibilities of the individual Member States, which can ask for help or assistance from the European Community. However, the capacities built up in individual Member States might be advantageously used in an emergency in other EU or non-EU countries, and this has been supported by numerous EC legal documents and recommendations (see further).

State supported remedial actions in the face of a range of disasters related to cultural heritage rely on close cooperation with those directly involved, the police and fire services, and in major disasters, the military. Such an approach has been supported by various legal documents on a national level, fully in line with the principle of subsidiarity. In most of these documents, cultural heritage issues are not specifically treated. However, the national legal framework and also the European legal framework create an environment which might indirectly help to protect cultural heritage from natural disasters. Let us mention some of such influences in this Chapter.

There are legal consequences that may play an important role as a key driver in mitigating the difficulties that can be encountered in this area of concern. There is an emerging need for cultural heritage private stakeholders to declare risks (risk preparedness) when submitting their company’s balance sheet. In order to cover the interests of shareholders, it is necessary to declare all possible risks that the company can be subjected to. If this is not done, such an omission can be considered a criminal offence. This requirement is determined by international law covering Europe and the USA. Two key issues stem from this:

1. Do company managers know the full extent of their risks, and is it possible for them to properly declare these risks in terms of cultural heritage values?
2. How will insurance companies react should a criminal offence be proven in such circumstances? Normally, a proven criminal offence means that the insured party loses its insurance cover.

If original historic properties, or their cultural contents, are deemed to be of significant or of unique societal value, though it is not possible to put a realistic financial value on them, the ensemble could be a critical component of a business. Losing the components of these objects due to a disaster would, in many cases, also lead to loss of the business. Consequently, no level of insurance cover will be able to adequately recover the business if the original authentic value of the business is lost. The question is how companies are to express the levels of risk that can occur, and how they fully declare these risks in their balance sheets. Many companies that are cultural heritage stakeholders are ill-prepared for such a situation.

Currently, the relevant regulations only require private companies to reveal their risk preparedness in their published accounts. In due course it may be possible to enact a similar regulation to require all European public institutions responsible for extraordinarily valuable buildings and collections (museums, archives, monuments, historic structures, etc.) to follow this lead. As this initiative would encapsulate the broad expanse of European cultural heritage, it could be relevant for the European Parliament to consider taking such an action.
In this process the following topics would have to be considered on a local site or on a territorial level, in accordance with existing EU documents and recommendations:

1. Creation of Relevant Databases
2. Risk Management Planning and Risk Assessment Awareness
3. Damage Limitation Planning (including maintenance planning)
4. Business Continuity Planning
5. Liaison with Fire Brigades and Other Authorities (including feedback reporting)
6. Staff Training and Management

This needs to be supported by strict connections between the ministries responsible for cultural heritage and civil protection agencies.

2.1.2. European cultural heritage stock at risk

Any decision about future strategies and measures to protect cultural heritage against the effects of natural disasters must be justified by a reasonably reliable knowledge of the European cultural heritage stock at risk. The situation in this field in individual European countries varies significantly, and is strongly dependent on the level of national information systems and technology. There are a few examples of national attempts to map cultural heritage at risk, (e.g. Italy\(^9\) and Norway). In Slovakia, there is an inventory covering the whole country, encompassing 52 medieval castles. Each castle has a geological map with geohazards acting on the cultural site. However, even these databases are fragmented and incomplete, and do not contain some data that is essential for natural hazard risk assessment processes and risk management approaches and tools.

An enormous labour force and much time have been devoted to building a variety of local and regional databases on cultural heritage stock, especially in cities. However, the databases are not standardized or even harmonized and coordinated for effective exploitation when combating natural (and man-made) disasters.

Immoveable cultural heritage has been listed and registered in inventories mostly without systematic geographical positioning, without a technical description of the materials and structures applied, and usually without any information about its current state and current health, all of which is decisive for its vulnerability to adverse natural forces and actions.

A standardized GMES-supported and constantly maintained and updated European cultural heritage stock database, with monitoring of changes in sensitive cases, would provide invaluable and unprecedented support for planning measures to reduce the impact of natural disasters on the European patrimony, and also for targeted operability of rescue teams during interventions.

2.1.3. Maps of natural hazards

Similarly to the issue discussed above, maps of potential natural hazards have not been fully completed across the European territory. However, the situation with mapping natural hazards in Europe is substantially better than the mapping of cultural heritage stock, especially in relation to specific disasters (earthquakes, landslides, volcanic activities). Mapping of flood hazards is

\(^9\) For example, in Italy the Civil Protection Department is working with the Ministry of CH on comprehensive databases at the level of individual historic centres.
supported by the Directive on the assessment and management of floods. Cultural heritage issues should be considered in the proposed contents of flood risk management plans based on an inventory of the risks, and thus, indirectly, the mapping of cultural heritage in inundation areas will be required and carried out.

The maps of the European cultural heritage stock at risk discussed in the previous paragraph must be related to existing maps of natural and man-made hazards and potential risks. This will enhance the assessments of the risks, and can help to predict the extent of catastrophic events. Such information is lacking over most of the territory of Europe, though it is fundamental for establishing risk management strategies and activities. Some parts of France are covered by PPR (Plan de Prévention des Risques) maps.

The newly-planned European remote sensing and global positioning systems will make it possible to monitor the data necessary for modelling adverse situations and evaluating the conditions for giving an early warning. Together with in situ monitoring, this will substantially improve the operability of preventive and operational measures in Europe.

2.2. Specific tools to protect cultural heritage

2.2.1. National instruments & activities

National governmental bodies have issued guidelines and national action plans for combating various types of natural and man-made disasters. These are mostly legal documents, and usually reflect situations that lie under the responsibility of one of the Ministries, in Bulgaria, e.g., the Ministry for Calamities and Failures. However, the plans are also worth applying in relation to cultural heritage, which is only infrequently included in the plans. Some examples are given below.

Greece recently issued the Greek National Action Plan for Combating Desertification (GNAPCD 2003), which is supported by a State Law based the UN Convention for Combating Desertification. This Convention includes a special annex for the Mediterranean countries (Annex IV), and was ratified by the Greek Parliament in 1997. GNAPCD takes into account the needs of natural heritage, but there are no measures referring to cultural heritage. However, there are references to EU directives and recommendations, which are thus well placed to rectify or improve shortcomings in individual national political norms. Such a situation can be observed in most other EU countries, and the consultants see this as an important argument for developing and implementing an EU legal document to protect cultural heritage from natural disasters. As far as international cooperation is concerned, GNAPCD supports cooperation with other Mediterranean countries in gaining EU funding through the Interreg programme. A Portuguese National Action Plan (NAP) was approved in 1999 with no specific items on cultural heritage protection. In the same year, the Italian NAP was passed. This plan envisages integrated measures that take into account landscapes and historical centres. The Italian NAP stresses support for targeted research and international scientific projects, and also for

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12 The United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa, the Convention's full name, was adopted on 17 June 1994 and opened for signature in Paris in October 1994. As of 14 January 1997, the Convention (CCD) had been ratified by 60 countries. It entered into force on 26 December 1996.
14 www.unccd.int/actionprogrammes/northmed/national/2000/italy-eng.pdf
international cooperation with other affected countries, including management and coordination. The plans also anticipate activities in non-EU countries. Other Mediterranean and Black Sea countries affected by desertification (Spain, Turkey, Armenia, Georgia, Azerbaijan, Moldova, Romania) do not include protection of cultural heritage among the topics of concern in the combat against desertification.\(^{15}\)

Documents responding to the threat of flooding usually do address problems of cultural heritage. For example, the British government’s interim guidance\(^{16}\) on improving the flood resistance of domestic and small business properties “Preparing for Floods”, issued in October 2003, gives basic advice and several other useful links. International cooperation is not taken into consideration.

In Bulgaria, landslide activity is under observation by the Permanent Commission for Disasters and Emergencies at the Bulgarian Council of Ministers and also by the Civil Protection Service. Due to intensive landslide activity along the seacoast, a specially-created department at the Ministry of Regional Development and Housing Policy coordinates practical action against the phenomenon (Delev, 2004, Delev, 2006, Annex 3).

In Slovakia, there is a research programme “Monitoring of selected geological factors”, which includes a subprogramme “Monitoring the subgrade of historic monuments”. This programme can be accessed on the website of the Geological Survey of Slovakia.\(^{17}\)

In order to fulfil its obligations to protect the national cultural heritage, the Dutch government created a national organisation, the Cultural Protection Inspectorate\(^{18}\), which is run and coordinated by the Ministry of Education, Culture & Sciences (Onderwijs, Cultuur & Wetenschappen). The Inspectorate is made up of volunteers appointed by the Minister. There are two kinds of inspectors, Provincial Inspectors and Regional Inspectors. Each inspector has some kind of connection, often of a professional nature, with the Dutch cultural heritage. The provincial inspectors coordinate measures aimed at protecting monuments and other cultural property within their areas of jurisdiction. It is their task to ensure that action can be taken in the event of emergencies. The regional inspectors, in their turn, support the provincial inspectors. They are responsible for protecting the monuments and other cultural property in their own regions in close collaboration with local mayors and municipal disaster relief organisations. They encourage the drawing up of emergency plans to protect cultural property and make recommendations on protective action. Their regions generally coincide with those of the regional fire services.

In Estonia, heritage protection and its management have been the task of the Inspectorate of Antiquities, which has functioned within the framework of the Ministry of Culture since 1993. The Board has sub-structures in all 15 counties. One of the tasks of the Inspectorate is to keep a register of more than twenty thousand fixed and movable monuments, listing new monuments, stocktaking, and organising various salvage and emergency works.

In the last 15 years, in most European countries the Civil Protection Sector has been organized as a National Service directly coordinated by the Prime Minister and composed of municipalities, provinces, regions and volunteer organizations.

The national Civil Protection Departments in Italy, directly controlled by the Presidency of the Council of Ministers, mostly take care of: (i) intervention procedures and actions common for the whole system, (ii) risk prevention legislation, (iii) help for peripheral structures (the weakest ones), (iv) training and education, (v) information for the public, and the culture of young people, (vi) creating and organising information networks for risk prevention, (vii) producing and disseminating exceptional codes to accelerate interventions and mitigate calamitous effects. They make use of military and civil organisations, e.g., the fire service, the army, forest rangers, the Red Cross, etc., but they depend above all on volunteers organized at regional level. The Civil Protection Department serves as the national authority responsible for cooperation with the MIC.

In the Czech Republic all emergency activities are coordinated and controlled by the Operational and Information Centre of the Ministry for Home Affairs, which also serves as the national contact point to the MIC. All major cultural heritage monuments and collections of artefacts (museums, archives, libraries) have emergency plans elaborated in cooperation between the local managers and the Integrated Emergency System (IES), in accordance with the Ministry of Culture guidelines. IES brings together police, fire brigades and the health emergency service.

Unlike Europe, where there is still no central coordination of emergency situations, in the United States the Federal Emergency Management Agency (FEMA)\(^\text{19}\) was founded in 1979. FEMA integrated all the formerly dispersed structures of activities in the field of so-called disaster mitigation, and its mission is to reduce loss of life and property and protect critical infrastructure from all types of hazards through a comprehensive, risk-based, emergency management programme of mitigation, preparedness, response and recovery. FEMA became part of the U.S. Department of Homeland Security on March 1, 2003 and has continued in its mission to prepare the nation for all hazards and to effectively manage federal response and recovery efforts following any national incident. FEMA also initiates proactive mitigation activities, trains first responders, and manages the National Flood Insurance Programme. In 1995 FEMA, together with Heritage Preservation\(^\text{20}\), formed the Heritage Emergency National Task Force to help promote preparedness and mitigation measures and provide expert information on response and salvage. The Task Force works to help libraries, archives, museums and historic sites safeguard their collections. The Task Force is a partnership of 36 national organizations and federal agencies that brings to its programmes a nationwide network of expertise. Its best known disaster resource, the Emergency Response and Salvage Wheel, is used by cultural institutions around the world and has been translated into six languages (see below).

In September 2005 FEMA issued an updated version of a review on federal funding for cultural institutions under the title “Before and After Disasters”\(^\text{21}\). This guide includes summary descriptions and contact information for 15 federal grant and loan programmes. It covers sources of federal assistance for preparedness, mitigation and response, as well as for recovery. Sample projects in disaster planning, training, treatment research and restoration illustrate the funding


\(^{20}\) Heritage preservation is a national nonprofit advocate and resource for the proper care of works of art, books and archives, documents and photographs, architecture and monuments, natural science specimens, and family heirlooms.

\(^{21}\) FEMA 533, September 2005, [www.heritagepreservation.org](http://www.heritagepreservation.org)
guidelines and show how carefully the state supports financial issues related to safeguarding cultural heritage.

2.2.2. International instruments & activities

International organizations and bodies have issued guidelines and action plans for combating various types of natural and man-made disasters. The most important documents have been issued by ICOM, ICCROM, the Council of Europe and ICBS, together with the ICOMOS Charters, IFLA and ICA documents. They mostly do not directly help to coordinate international activities on protecting cultural heritage from natural disasters, but they promote such collaboration and are useful for training and awareness-raising campaigns.

The Council of Europe (CoE) has adopted several resolutions on Major Hazard Agreements (MHA) as open partial agreements on the prevention of, protection against, and organization of relief in major natural and technological disasters (EUR-OPA MHA)\(^22\). They marginally address protection of cultural heritage against disasters. The EUR-OPA MHA Centres supported by the CoE are significantly involved in relevant issues and cooperate on an earthquake-oriented EC-supported research project\(^23\). The recently organized international conference “Earthquake Engineering in the 21\(^{st}\) Century” in Skopje (Autumn 2005), with 263 participants from 45 countries, adopted a resolution which urges, among others, the governments of the Balkan countries i) to facilitate implementation of EuroCode-8\(^24\) and new earthquake-resistant regulations for safeguarding life and property in the Balkan countries, and ii) to ensure proper implementation of earthquake-resistant regulations in practice, with priority for schools, hospitals, cultural heritage and emergency buildings and facilities. Historically, several important recommendations have been elaborated within the framework of the CoE activities.\(^25\)


UNESCO has suggested an initiative: a Proposal for the Establishment of an “Inter-Governmental Platform Under the Aegis of UNESCO for Cooperation on Earthquake Risk Reduction in the Balkan Region”\(^28\).

ICCCROM\(^28\) has issued a management manual on risk preparedness for world cultural heritage, which gives a complete set of instructions on how to behave in emergency situations. The manual is a very useful tool for establishing local and national instruments, educational and

\(^22\) For example, a resolution adopted at the 9\(^{th}\) Ministerial Session of the Council of Europe’s EUR-OPA Major Hazards Agreement (Île De Bendor, Bandol, France, 3-4 October 2002), which agreed i) a Resolution on Euro-Mediterranean Synergy, ii) a Resolution on Risk Prevention Culture and iii) a Resolution on First-Phase Implementation of Risk Prevention Initiatives.

\(^23\) AEGIS Bucharest, CEPRIS Rabat, ECILS Skopje (further information e.g. 6th FP project PROHITECH).

\(^24\) European Code on protection of buildings against earthquake-induced damage and failure.

\(^25\) “On the protection of the architectural heritage against natural disasters” (1993) Recommendation No. R(93)9 is a basic document for further activities and recommendations.

\(^26\) http://www.unisdr.org/wcdr

\(^27\) www.icsu-asia-pacific.org/resource_centre/ISDR_Hyogo-framework-for-action_HFA.pdf

\(^28\) International Centre for the Study of the Preservation and Restoration of Cultural Property.
awareness-raising activities. It presents case studies selected from various world heritage monuments, but does not suggest international cooperation schemes except for information about the International Symposium on Risk Preparedness for Cultural Properties in Kobe (January 1997) and the Blue Shield.

The Kobe Declaration states clearly that measures to improve risk preparedness for cultural heritage involve i) strengthening the framework for cooperation at international, regional, national and local levels through, e.g., collaboration among governments responsible for both disaster preparedness and cultural heritage and integrated strategies for preparedness, response and recovery, before, during and after emergencies. The Declaration further recommended and proposed, e.g., support and active encouragement for the realization of an international initiative, modelled on the Red Cross, in order to improve the treatment and care available for damaged cultural heritage.

ICBS29 was created in July 1996 within the activities and ideas of the International Inter-Agency Task Force IATF for Risk Preparedness for Cultural Heritage, which was initiated by UNESCO, ICCROM, ICOMOS30, ICOM31, ICA32, IFLA33 and other organizations in 1994. The Czech Committee of the Blue Shield was founded in 2000 and has an agreement with the Ministry of Interior on cooperation within the Czech Integrated Emergency System. The two bodies helped to elaborate emergency situation plans in museums, unfortunately without provisions for disastrous events. ICBS acts internationally, mainly outside the EU, and its involvement has been important both in natural emergencies and in war emergencies.

In the framework of this report, the ICBS representatives were asked to contribute through a questionnaire to the discussion on improving the protection of cultural heritage from natural disasters. Only two items34 of European response have been received, and there appears to be limited interest in cooperating within the EU programmes and activities. This may be due to the organisation’s low level of international activities in Europe. ICBS tends to work nationally, helping in some countries with marking objects of the built cultural heritage with a special sign, or providing assistance to museums in preparing emergency plans. On the national level, the national ICBS committees act as important partners to the national rescue systems providing professional advice in emergency situations, organizing education, training and workshops and issuing publications and emergency manuals.

ICBS brings together five international organizations (CCAAA - Co-ordinating Council of Audiovisual Archives Associations, ICA, ICOM, ICOMOS and IFLA, see footnote above), and has a structure which could be exploited at least for educational and awareness-raising activities in the EU. Dr. June Taboroff35 reviews the blockages which prevent the Blue Shield from fulfilling its aims: “lack of adequate funding, ineffective coordination with international and national agencies responsible for disasters, and inability to respond in a timely manner to disasters. Blue Shield has yet to deliver tangible results.” They operate rather within the framework of some of the funding bodies, namely ICOM, where its International Committee for Museum Security (ICMS)36 is quite active, and ICOMOS. A very useful contribution to this

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29 International Committee of the Blue Shield [http://www.icbs.com](http://www.icbs.com)
30 International Council on Monuments and Sites.
31 International Council of Museums.
32 International Council on Archives.
33 International Federation of Library Associations and Institutions.
34 Czech Republic and Macedonia.
35 [www.icomos.org/iiwc/seismic/Taboroff.pdf](http://www.icomos.org/iiwc/seismic/Taboroff.pdf)
36 [http://user.chollian.net/~pll/public_html/icms](http://user.chollian.net/~pll/public_html/icms)
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Report has been submitted by Robyn Riddett, the Australian ICBS representative and at the Secretariat of the ICOMOS Int. Scientific Committee ICORP (Risk Preparedness), (Annex 4), which further illustrates one of the questionnaire structures used for preparing this report.

2.3. Good practices, problems & shortcomings

2.3.1. Efficient prevention & management strategies and measures

Prevention is essential to save cultural heritage. Management and investigations soon after the event in order to define the state of damage to movable and immovable cultural heritage is also very important. For example, the Italian Civil Protection Department (CPD) and the Ministry of Civil Protection have set up a special Committee which recently published on the CPD website a series of templates to be filled in by specially-trained teams after an earthquake; the templates enable a description of the damage, calculate the vulnerability indices and define the cost of intervention.

Most European countries have developed massive Internet-supported information and advisory systems for emergency cases related to natural disasters, especially floods. Unfortunately, these usually do not contain either specific instructions concerning cultural heritage or links to such guidelines provided by specialized international websites (as referred to in some paragraphs of this report).

Preventive measures involve regular inspections of the state and health of buildings in disaster-prone areas. Much of the reported experience refers to damage due to material and structural decay of the affected cultural heritage. Preventive measures are typically sorted into two categories: structural and non-structural. The first are difficult to materialize in the case of immovable and landscape cultural heritage protection, because they are mostly visible and ugly, and in many instances not very cost-effective. This subject needs further research and comparisons should be made with best practice non-structural measures.

Massive landslides in Venezuela in December 1999 severely damaged the historical city of La Guaira and destroyed many movable objects of historical and cultural importance. As a first reaction, a project called “Emergency Brigades for Cultural Heritage” was established. This intended to improve the management of the movable heritage not only in Venezuela but also in the other Andean countries (Toledo, 2003). It started with an exchange of ideas and experience between various organizations concerned with risk prevention and the management of emergency situations (government entities, civil defence services, research institutes, management of museums, national committee of ICOMOS) and subsequently established the National Technical Committee for the Management and Prevention of Risks to Cultural Heritage, with several thematic subcommittees (resource training, standards and legislation,

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37 Structural measures include physical protection of cultural heritage (barriers, dams, geophysical improvements, strengthening and reinforcing elements and interventions, shelters) including maintenance activities keeping the built heritage in appropriate health conditions.

38 Non-structural measures involve system measures, i.e. legislation, planning, management, incentive and supportive activities (including education and training, insurance, funding, etc., tools and instruments which mitigate the impact of natural disasters on mankind, the environment, cultural heritage and economy activities.

39 For example: Thomas Will from TU Dresden recently presented (at the ICOMOS Workshop “Cultural heritage and natural disasters – Risk preparedness and limits of prevention”, Denkmalmesse Leipzig, 27-28 October, 2006) the case of the historic town of Grimma, which suffered in the 2002 flood with 700 houses flooded up to 3,5m, damaged and some even destroyed, which should be protected by a 1200m long 3m tall concrete wall, but which is not acceptable from a heritage and landscape protection point of view.
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As far as structural measures are concerned, the application of standards to protect architectural heritage from natural hazards leads to the problem that the originality, authenticity and aesthetic qualities and values of historic monuments should not be compromised. At present, only one European Standard is in practice available for effective protection of cultural heritage against earthquakes.

In Italy, a Seismic Code was published in March 2003 containing rules for existing masonry buildings (minor historic architecture). From this code, the Ministry of Cultural Heritage derived guidelines for monuments.

However, the national seismic codes consider architectural heritage among the buildings with a higher degree of seismic protection. Let us illustrate this by an example from Bulgaria, (Annex 3). The Bulgarian Seismic Design Code includes no special provisions for the structural safety and stability of built CH objects, except a partial safety factor of importance $\gamma_{imp}$. The seismic Code states that for “monuments, museums and other facilities of national importance” (classified as Category A) the seismic design load should be assessed with partial safety factor $\gamma_{imp}=1.5$ which in theory means 50% plus on the safety side. For load-bearing structures of monuments and museum buildings of local importance (Category B) $\gamma_{imp}=1.0$ is to be used (i.e., as for other buildings). When a substantial part of the primary load-bearing members is replaced (sometimes together with re-arrangement of the structural scheme) the designer is obliged to prove that the mechanical resistance of a CH object under reconstruction and/or strengthening satisfies the Code requirements for seismic resistance. This, on the one hand, helps to develop a number of different strengthening techniques for monuments, mostly with support from EC joint research projects[^40], while, on the other hand, such a provision provokes discussions concerning the real need for a widespread campaign of structural interventions into European cultural heritage, in many cases accompanied by a non-compatible impact on monuments and especially on their historic structures.

Regarding landslides, since July 3/2001 the "Regulation for the design of geo-protective construction works, buildings and facilities in landslide areas" is part of the Bulgarian technical legislation (Annex 3). This standard is not directly focused on cultural heritage.

Recent experience with damage from excessive weather loads, namely wind and snow, together with real opportunities to adapt the architectural heritage to reduce this damage, has indicated that some amendments to the relevant standards might be suggested and accepted. In Ireland, for example, the Heritage Council gives very general requirements A1: A building shall be so designed and constructed that the combined dead, imposed and wind loads are sustained and transmitted to the ground safely, and without causing such deflection or deformation of any part of the building, or such movement of the ground, as will impair the stability of any part of another building. The standards often lack strong qualitative requirements. For example, the

Building Research Station suggested in 1968 that in historic structures where the designed lifetime of 200 years is not excessive and the risk is not accepted, the wind load design factor (see Feilden 2003) should be modified to 1.5.

Standardization of some preventive processes and procedures, e.g. mapping, monitoring, etc., would certainly bring further positive results.

National initiatives based on experience from disasters may supply other countries with useful pre-standardization documents. For example, the project “Protection of archival documents from natural disasters in the Czech Republic archives network” run by the Ministry of Home Affairs of the CR has been accepted by the International Archives Experts Committee as a working document for the EU general standard that this Committee is preparing.

2.3.3. Best practice examples

Best practice is usually difficult to generalize in a sufficiently informative way. Let us mention some basic principles which have proved to be efficient, and give references to more detailed information and case studies that have been published in various forms and media, (e.g. proceedings of specialized conferences, or the Internet41).

F. Krimgold, from the World Institute for Disaster Risk Management (USA), recommends four pillars for mitigating adverse natural disaster effects: i) improved quality of buildings or construction & land use management, ii) education & training, iii) incentives & regulations, and iv) enforcement42. Translated into the cultural heritage protection field, this means i) regular inspection and careful maintenance of the historical stock & improved land use planning and management, ii) raising awareness and regular coordinated training, iii) international cooperation and availability of funding, and, iv) legislative support. These principles are illustrated and further developed in the concluding chapters. In fact, all four are already applied in various EU documents and policies concerning civil protection, and cultural heritage aspects can easily be added.

Useful data on best practice can also be extracted from the experience of non-European countries, above all the USA and Japan. Many countries have concentrated their efforts on raising knowledge about emergency and early salvage procedures. As mentioned above, the U.S. National Task Force, in collaboration with the Getty Conservation Institute and the National Institute for the Conservation of Cultural Property (NIC), prepared the Emergency Response and Salvage Wheel. The wheel was designed to assist cultural institutions and agencies in the first 48 hours following an emergency. It is essentially a two-sided rotating chart which allows readers to gain critical response information in two key areas. One side leads readers through a sequence of nine basic emergency response steps, from safety precautions to salvage priorities. The other side identifies salvage techniques and responses appropriate for particular types of collections or objects. Advice focuses primarily on means for controlling and mitigating water and moisture action, perhaps the main source of damage to cultural heritage. The wheel has been sent free of charge to 45 000 museums, libraries, archives and historical societies within the USA. It was conceived to be of particular use to small and medium-sized institutions, which often lack the resources to maintain full-time professional conservation advisers or to develop complete emergency-response conservation plans.

41 http://www.worldbank.org/hazards/
42 www.worldbank.org/ieg/naturaldisasters/conference
Instructions on how to behave in emergency situations are numerous, and some have been mentioned above. The best cases include the Curriculum on Flood Assessment of Cultural Heritage Properties (Kelley, 1994), the Disaster Control Framework of the National Archives of Canada, implementation of which is based on training and awareness, regular drills, regular meetings of the controlling body, prevention and ongoing updating of guides, ICOM guidelines for disaster preparedness in museums, The National Trust’s Emergency Procedures at Historic Houses, with detailed guideline structures according to the hierarchy of staff responsibilities, and the Netherlands Handbook on Protecting cultural heritage in Emergencies (1991).

One of the most advanced national systems for improving risk-preparedness for cultural heritage is in Switzerland. The government has taken particular interest in developing an integrated set of policies, tools and mechanisms to improve risk preparedness for cultural heritage. The PBC (Protection des Biens Culturels), which operates under the symbol of the Hague Convention’s Blue Shield, was established to preserve the Swiss cultural heritage to the greatest degree possible from the consequences of armed conflict, to ensure respect for cultural heritage by the involved parties, and to ensure various protective measures in times of peace, e.g., development of cultural heritage inventories (priorities for protection) and development of shelters for threatened objects or building fittings. These efforts are supported by a series of preparedness manuals and training courses. The Swiss protection programme includes detailed maps on which inventoried cultural properties are located, and which depict properties in both urban and rural settings.

The Getty Conservation Institute has published a manual *Principles for the Conservation of Heritage Sites in China* (2004). It includes numerous important hints related to disaster prevention and preparedness, including maintenance, monitoring, response and rescue plans, disaster prevention and mitigation, disaster assessment and dealing with damaged remnants. It also considers principles for protective structures and interventions. Following approval and proclamation of the Principles by the national government department responsible for heritage, the conservation process stipulated in the Principles will become a requirement of heritage administration and management departments.

European cooperation in emergency situations proved its efficiency in several recent situations, e.g. in 1999/2000: windstorm Martin in France, in 2000: forest fire in Macedonia, in 2000: forest fire in Slovakia, in 2002: flood in Central Europe (Czech/Austrian cooperation), in 2003: flood in France. In all cases the old and new Member States cooperated without problems and the rescue teams started to operate within a few days, usually two days, after acceptance of the offer of assistance by the affected country. There are examples of useful cross-border cooperation, e.g. in the Nisa Euroregion, where Czech and German fire brigades operate in both countries without obstruction. During the vast floods in 2002 and afterwards, the international support was greatly appreciated and provided major encouragement in all affected countries. Volunteers from many European countries came to offer their aid. Material and financial help, and also help in the form of consultations, were offered to them. Support and/or advice were also provided by the national committees of ICBS. When there was a fire at the museum of Western Bohemia in the 1990s, Czech fire-fighting units worked alongside German fire-fighting units.

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43 www.archives.ca
44 http://www.icom.org/ICOM/
45 http://www.ukindex.co.uk/nationaltrust.
46 The first Central-East European cross-border region (D-CZ-PL) www.neisse-nisa-nysa.org
47 Annual report 2005 of the North Bohemia Regional Fire Brigade in Liberec.
48 J. Součková, Czech CBS President, Data from the questionnaire, 2007.
2.3.4. Problems & shortcomings

General problems: a real-time road management system based on good mapping of crossings of roads over rivers and in situ data together with Earth Observation monitoring during the flood is necessary for evacuation operations. In the event of flash floods, water levels rise suddenly and generally in small areas. During the Gard event in September 2002, more than 200 rescue vehicles were lost on flooded roads. Even a crude assessment of this type of hazard would considerably help Civil Protection services to manage road traffic and to coordinate rescue actions. Blocked roads and blocked access to endangered cultural heritage has been a frequent problem, and has caused many losses due to delays to evacuation or to the rescue operation.

R. Riddett from Australia formulated a very common problem that is also experienced in the European countries: The main issue is that cultural institutions variously have their own disaster plans which do not necessarily include the response in a major disaster. When a major disaster occurs only the police and fire brigade are allowed on site, until it is safe. By this time quite major damage could have occurred through inappropriate actions, e.g., too much water, unnecessary demolition of building fabric, not knowing what to save first if there is an opportunity to remove valuable items. The police and fire brigade have their own plans and procedures which do not take account of cultural heritage as a specific issue. Many regional (rural) disaster plans take account of animals, crops etc., but not heritage. Emergency organizations (police, fire brigade) do not talk to or understand curators, conservators, architects, etc. There needs to be more seamless integration, with everyone working together from the onset of the disaster. It is no good creating more damage in trying to respond to the disaster and then leaving everyone else to sort it out later (Annex 4).

A human contribution is unfortunately a frequent factor in landslide disasters. Infrastructure projects, such as roads and railways, deforestation and housing projects in hilly landscapes are often planned without a thorough analysis of their impact on the surrounding areas. Wide-ranging variability of difficult geological conditions must also be taken into account. Therefore, higher safety factors than usual for design and slope stability calculations should be required by the authorities if objects of cultural heritage may be influenced by construction activities in these areas.

Specific problems: it seems that in some east European countries, the transition from communist governments has resulted in confusion regarding laws on cultural heritage protection, and there has been greatly diminished funding and authority for heritage management. The lack of administrative continuity and government funding requires urgent action to integrate cultural heritage into disaster planning and mitigation (Revival, 1998).

Long term measures, such as combating desertification, may generate specific trans-boundary problems concerning water supply, which should call for internationally accepted codification and legislative support. No similar problems have been recorded during short term emergency operations.

49 In Prague during the 2002 flood, non-coordinated roadblocks and premature evacuation of citizens and personnel together with non-professional and failed information caused much higher losses in museums, (e.g. Roztoky 8.5m flooded) as well as in private archives (family photographs, etc.) in the Troja district (up to 7m flooded).

50 In Bulgaria in January 2000 a whole CH district in the southern town of Gotze Delchev burnt out because the fire fighting service could not make its way through snow cover in a mountain pass.
Problems that have been identified include several local shortcomings, e.g., the state of the architectural heritage and the situation of buildings near rivers, delayed response times and even the lack of a functioning electronic signal at fire alarm facilities, legal regulations that fail to distinguish between important cultural heritage and other properties, lack of data supporting the assessment of possible damage.

The questionnaire respondents presented the following improvement needs: settling priorities for cultural heritage protection in the legal regulations for crisis management in the case of an emergency; including representatives of cultural organisations in crisis managements at all stages; increasing financial support for cultural heritage institutions, so that they can consistently deal with risk factors; training staff of cultural heritage institutions in cooperating with rescue teams (including practical exercises) at regular intervals.

2.4. Funding

In response to major recent disasters, namely the floods between 2002 and 2005, the EU developed special instruments for funding rescue and remedial works. These are discussed in detail in the fourth chapter. Other schemes have also been adopted for financing preparedness for natural disasters and, therefore, some international experience is also presented here. It mostly concerns insurance and special bank programmes, both of which focus on enhancing preventive measures.

At very high wind speeds, windstorm damage to buildings and structures in urban areas is an extremely severe problem throughout Europe, and windstorms are the most significant natural hazard in terms of insurance losses (Berz, 1994; Berz, 1997). For example, in 1990 there were 8 major storm events, which caused widespread damage in at least 10 European countries and the total losses in this one year were estimated at ECU 15,000 million. One of the reasons for these large losses is that there are many densely built up areas with a concentration of wealth in regions that are relatively exposed to large storms that originate over the Atlantic Ocean. Structures in these regions can suffer from cumulative damage during their lifetime. How does insurance respond to such situations?

2.4.1. Insurance

European countries exhibit various approaches to insuring cultural heritage against natural hazards. Namely flood insurance is not popular in Europe, and in some countries it is not possible to insure property positioned in an area of potential inundation, (e.g., in the Czech Republic). A detailed study of flood insurance programmes in Europe and a comparison with the US National Flood Insurance Programme (further only NFIP) shows that the American system offers substantial benefits and has decreased federal disaster assistance approximately ten times, (Lasut, 2003). A. Lasut describes the situation in Europe as follows: France has a functional system of insurance protection against natural disasters, which is based on the mandatory purchase of insurance against natural catastrophes, together with classical property insurance. Reinsurance of risks is provided by the commercial institution with a governmental warranty. Insurance funds are subsidized by a fixed endowment from the central budget, and in order to make use of the insurance a state of catastrophe must be officially declared. In Germany, three classes of flood zones are declared, which correspond to the risk of flood occurrence, and insurance premiums depend on the location of the property in the zones. It is also impossible to insure property that generates only losses for the insurance companies due to repeated floods. As in the USA, there are some conditions that a property owner has to fulfill before the insurance can proceed. This situation means that in major catastrophes the state and local
governments are the main providers of flood reparations. In Britain, insurance policy changed in 2002 and flood insurance is becoming harder to obtain as agreements on providing household flood insurance at reasonable cost expire. In Poland, it is possible to purchase insurance against flood risks together with other risks. In Bulgaria there is no obligatory requirements to insure CH objects against natural or human disasters. Such insurance is arbitrary, depending on the decision of the administration of each individual CH object, but due to lack of funds insurance is in practice rarely taken out. Nevertheless, the European insurance companies are involved in advisory tools, namely in relation to floods. In contrast, the US NFIP was created as an alternative to disaster relief, and distributes the responsibility for floodplain management to all levels of government and the private sector, setting a national standard for regulating new developments in floodplains and materializing a comprehensive floodplain mapping programme. The details of NFIP can be studied from a description (FEMA, 2002) or from the literature, (e.g. French, 2002). In any event, insurance has proved to be a very efficient tool, reducing the annual damage costs substantially (80% for new buildings in flood-prone areas).

2.4.2. World Bank Programme

The World Bank’s Disaster Management Facility was established in July 1998 to provide proactive leadership in introducing disaster prevention and mitigation practices into development-related activities. A year later, this was followed by the first meeting of the Consortium on Natural and Technological Catastrophes, now called ProVention. Although the programme does not focus primarily on cultural heritage, many projects have helped to safeguard or restore important historical objects, because cultural heritage is often located in areas with a high concentration of poor population, particularly in historic city centres and near archaeological sites. The relation between poverty and vulnerability is one of the programme priorities. (There are some indicators that cultural heritage objects, ensembles and collections possess features of “poverty” from the socio-economic point of view.)

Most World Bank projects are supported outside Europe. However, Turkey has received 13 projects with total lending of almost US$ 3400 million, with four of the ten largest loans since 1993. These have been in response to major earthquakes and floods, including risk mitigation measures. 14% of all world natural disaster lending has gone to Turkey.

According to the World Bank’s Independent Evaluation Group (IEG, 2006), the cost of disaster damage is rising, and in the 1990s it reached US$ 652 billion, which is 15 times higher than in the 1950s. The number of events has grown by 400% since 1975 to 400 cases in 2005, and 2,6 billion people have been affected by natural disasters over the past ten years.

The largest number of projects (about 46%) have been in response to flood events, followed by drought and fire (about 19% each), then tropical storms, earthquakes, pestilence, landslides, tsunamis, volcanoes, and others. The evaluation report presents valuable experience, and points out some useful as well as some disastrous responses to disasters. Some of these are very relevant to cultural heritage protection, (e.g. proper maintenance: planning ahead, rather than reacting to a disaster).

A Catalogue of important problems and shortcomings is added in Annex 6.

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51 www.ciria.org.uk/flooding/
52 http://www.worldbank.org/ieg
Protecting the cultural heritage from natural disasters

3. KNOWLEDGE BASE FOR PROTECTING CULTURAL HERITAGE FROM NATURAL DISASTERS

3.1. Targeted EU research

3.1.1. Joint EC research – a short review

The European Commission has been supporting several international research projects on the triggering mechanisms and behaviour of natural and man-made disasters, their effects and possible preventive and remedial measures. These projects are of great value for this study because of their European dimension, the highly objective information, and the contacts that have been developed with end users.

More than one hundred projects have been completed with support from recent EC research programmes or have been running within the 6th Framework Programme (FP). They cover problems of floods, landslides, earthquakes, tsunamis, fires, forest fires, avalanches, volcanoes and multi-risk situations. Most of the projects study basic phenomena and mechanisms related to natural hazards, without explicitly focusing on protection of cultural heritage from disasters.

However, the results of several projects are applicable to an effective European strategy in this area. They mostly provide the EU with powerful tools for mapping, monitoring and predicting natural disasters and their territorial impact. Let us mention some of the projects:

There is a group of research projects within the 5th and 6th Framework Programmes that make detailed studies of the impact of natural hazards on the European cultural heritage, and investigate ways, strategies and measures to protect and safeguard it. The vulnerability of cultural heritage to natural disasters and similar threats were discussed within the ARCCCHIP project workshops (ARCCHIP Proceedings, 2004/2006). These workshops have revealed a number of examples of good and bad practice, and they have also revealed some gaps in knowledge.

Climate change has had a substantial impact on the frequency of occurrence of some harmful natural events, namely windstorms, floods and landslides. Triggering mechanisms, impacts and mitigation measures related to cultural heritage and cultural landscape have been investigated in the NOAH’S ARK project, which is still running. Reports summarizing results on vulnerability of cultural heritage to natural hazards and possible mitigation measures are published on the project web site (Drdácký et al., 2005, Drdácký et al., 2006).

Important results were produced by the EC 5th FP network project FIRETECH, coordinated by the University Gent and supervised by M. Chapuis. This network helped to build the international team for a recent COST Action C17 “Fire Loss to Historic Buildings” on the impact of fires on cultural heritage and on mitigating these impacts, which contributed substantially to this report. The contribution of the group of specialists working on the COST

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54 [www.unepci.org/pc/apell/events/senior-level%20meeting/pdffiles/INERIS.pdf](http://www.unepci.org/pc/apell/events/senior-level%20meeting/pdffiles/INERIS.pdf)
55 [www.arcchip.cz](http://www.arcchip.cz);
56 [http://noahsark.isac.cnr.it](http://noahsark.isac.cnr.it);
57 [http://noahsark.isac.cnr.it/deliverables.php](http://noahsark.isac.cnr.it/deliverables.php)
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Numerous projects have been devoted to problems of floods. They touch on problems of the built cultural heritage, but are mainly concerned with natural heritage, which exhibits similar vulnerability. For example, one particularly intriguing FP5 project, known as IMPACT\(^{58}\), used ground-penetrating radar to analyse structural weaknesses in historic dams and levees, and how these structures collapse once they have been breached. Studies of similar interactions and the contribution of reduced strength of historic materials and safety of historic structures to the overall risk assessment are quite rare, and present a challenge for interdisciplinary research. The results of the FloodMan\(^{59}\) project have provided users with data for operational near-real time monitoring of a flood area, and also for modelling flood situations. The tools developed in the project also give soil moisture parameters that are important for assessing the conditions in catchments, for flood development predictions and for landslide forecasting. The project takes advantage of previous EC supported projects, e.g. CLIFF\(^{60}\) (Cluster Initiative for Flood and Fire Emergencies), which generated guidelines and recommendations for flood and fire disaster management in the EU; EFFS\(^{61}\) (the European Flood Forecasting System), which developed short-term forecasting (up to 10 days) of flood situations and recommended the formation of a European unit called the European Flood Forecasting Centre to monitor and administer EFFS information; EnviSnow\(^{62}\) focuses on general Earth observation-based snow parameter retrieval algorithms for use in run-off and flood prediction.

A new 6\(^{th}\) FP project, CHEF, focuses on floods in relation to cultural heritage in all its complexity. This project started in February 2007. The largest ongoing integrated project, FLOODsite\(^{63}\), has some sections that take into account cultural heritage issues, namely in relation to socio-economic evaluations of flood damage.

The IRMA-SPONGE\(^{64}\) Umbrella Programme, funded by the EU, brought together 13 European scientific projects on flood risk management issues along the rivers Rhine and Meuse. It developed methodologies and tools for assessing the impact of flood risk reduction measures and scenarios, and supported the spatial planning process in establishing alternative strategies for optimal realisation of the hydraulic, economic and ecological functions of these transnational river basins. Another EC project, HarmonIT\(^{65}\), aims to develop, implement and test a European Open Modelling Interface and Environment that will simplify the linking of models and will enhance risk management.

Among national projects, we mention UK projects RASP, FloodRiskNet, and the Foresight-Flooding Project\(^{66}\), which is developing four co-evolutionary futures of socio-economic development, climate change, morphology response, land use as well as flood management response under four possible scenarios: World Markets, National Enterprise, Global Responsibility and Local Stewardship. The German project DISFLOOD\(^{67}\) (Disaster Information

\(^{58}\) http://www.impact-project.net
\(^{59}\) http://projects.itek.norut.no/floodman/Deliverables/URD_version1-01.pdf
\(^{60}\) http://styx.esrin.esa.it/cliff/docs/presentations/Frascati_risks_GW.ppt
\(^{61}\) http://effs.widelft.nl
\(^{62}\) http://projects.itek.norut.no/EnviSnow/
\(^{63}\) http://ec.europa.eu/research/environment/newsanddoc/article_3249_en.htm
\(^{64}\) www.irma-sponge.org
\(^{65}\) www.harmonit.org
\(^{66}\) www.hm-treasury.gov.uk/media/F80/19/climate_change_from_new_4.pdf
\(^{67}\) http://helmholtz-eos.dlr.de/platform/disflood_en.htm
System for Large-scale Flood Events using Earth Observation) contains elements which support the cultural heritage stock at risk inventory in flooded areas. This project focuses on urban territories. It involves many historic cities and cooperates with the United Nations University in Bonn.

Landslide events are frequently associated with floods, and this phenomenon has also been a subject of EC supported projects. Research has tended to focus on mechanisms of landslide initiation, monitoring taking advantage of EO and early warning systems, but there is no explicit relation to cultural heritage. In addition to the NOAH’S ARK project, which deals exclusively with protection of cultural heritage from natural disasters, there is another project dealing with landslides and multi-risk situations (together with earthquakes), which studies cultural heritage vulnerability and protection strategies. This is the large LESSLOS integrated project (Risk Mitigation for Earthquakes and Landslides), which assesses cultural heritage and namely historic bridges in accordance with European standards. However, this project mainly covers complex problems of seismic hazards.

Protection of cultural heritage against earthquakes has been studied in the ongoing 6th FP project PROHITECH68. This project has delivered several useful outputs in both the non-structural measures (guidelines and assessment tools) and the structural strengthening suggestions.

The cultural heritage issue was added to the SAMCO research agenda in 2006. SAMCO69, the European Network for Structural Assessment Monitoring and Control, consists of high level representatives of European and global stakeholders involved in monitoring assessment and control. Combined structural, environmental and safety monitoring systems provide data on deterioration processes and situations endangering historic materials and structures, and will support early warning systems to prevent the loss of Cultural Heritage.

The project “Management of Natural and Technological Risks” under the JRC Enlargement action within the 6FP investigated risk mapping practices and policy for priority hazards in several Central European countries. With the help of a questionnaire, the survey focused on several hazards, including landslides. Landslide risk is perceived differently in each country. For mountainous countries like Romania it represents a high risk, whereas for Hungary or Poland the threat is low. The respondents assigned a lower level of importance to cultural heritage exposed to landslide risk than to objects such as infrastructure or private property!

3.1.2. Relations to FP7 themes

FP7 devotes numerous research areas to natural hazards within Theme 6 “Environment (including climate change)”. No specific features are presented in relation to cultural heritage, pan-European or cross-border cooperation and integration policies in the first call for projects70. However, several areas intrinsically involve the problems mentioned above, (e.g. hazard assessment, risks, vulnerability, volcanic assessment and management, avalanche risk mapping, risks from drought). Experience from earlier projects shows that without an explicit indication of the problem in the task description no attention is usually paid to these factors, (i.e., to cultural heritage and European cooperation in emergency situations). Only the task dealing with European multihazard analysis calls for coordinated efforts and support actions aimed at

68 www.prohitech.unina.it/
69 www.samco.org
analysing European/regional/national natural hazard databases. In future calls related to natural hazards, cultural heritage issues should be indicated.

It is positive that area 6.3.2 “Protection, conservation and enhancement of cultural heritage, including human habitat” opens the door for research into damage assessment of cultural heritage due to environmental action, which involves weathering and climate change effects and, in principle, might also include damage from natural disasters. However, in this area, tasks focused on disaster prevention models of heritage buildings and monuments are planned for future years and future calls, in coordination with Theme 4 “Nano-sciences, nano-technologies, materials and new production technologies”. Here the consultants recommend that tasks be formulated on risk assessment related to individual natural hazards, in which cultural heritage and international cooperation issues will be explicitly defined in the relevant calls for research projects, including long term hazards (weathering and long-term repeated actions).

3.1.3. Gaps in knowledge

While new protection methods are infrequently introduced, most protection efforts remain conventional. The principle should be to employ the most cost-effective protection methods. However, there is a definite gap in knowledge as to how cost-effective the conventional protection methods, and also the new protection methods, really are. With various European databases and statistics (e.g. COST C17 and others) now emerging, evaluations are becoming feasible. It is fundamentally important to future protection of heritage that measurements of cost-effectiveness are made. Such an undertaking is beyond the capacity of any single country. However, a pan-European effort can be managed through a suitable research programme, and the results should have a profound impact on future practice.\(^{71}\)

New developments in European cities also naturally influence the load on particular historic objects that may not previously have been attacked by wind. The new activities may cause aerodynamic effects, and these must be taken into account by studies of the new conditions through wind tunnel testing or/and computer analysis. Similarly, further research is needed to supplement knowledge concerning eddies and flows around built complex forms.

Participants in the third ARCCHIP workshop “Vulnerability of cultural heritage to hazards and prevention measures”\(^{72}\) from 15 European countries, including Turkey, identified the following European research priorities. Definitions and harmonisation of the terminology of risk assessment and management in relation to cultural heritage are required; a proper recognition of the value of European cultural heritage is necessary for it to achieve its appropriate level of priority. Detailed tasks involve: i) a standard system for recording the existence, condition and threats to cultural heritage in Europe, ii) an up-to-date and updated inventory, iii) proper evaluation of the influence of cultural heritage on the European economy, iv) a multidisciplinary dialogue (and, ideally, consensus) on the best methodologies to be used in resolving the identified problems, v) guidelines based on this inventory and on the the agreed methods for a conservation policy at the national and European level, vi) rigorous risk management appraisal procedures and quality control for intervention assessment.

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\(^{71}\) Cost-effectiveness means invested money versus loss prevented, and 'loss' includes irreversible physical or aesthetical damages due to by protective measures. (This suggestion relates to any kind of protection, but fire is an obvious case).

\(^{72}\) EC 5th FP INCO Project of the ARCCHIP Centre of Excellence, ARIADNE 03 Workshop, e.g. [www.arcchip.cz](http://www.arcchip.cz)
Integrated research combining natural science studies with socio-economic investigations focused on altering vulnerability patterns due to human activities is highly desirable, see, e.g., the ESPON 1.3.1 report (below), with examples of forest fires in Northern Portugal and an evaluation of recent floods.

As regards COST C17, the task focusing on i) Hypoxic air venting offers a substantial potential to prevent losses in archives and similar objects; ii) Assessment of the inherent fire resistance of historical structures counteracts structural fire loss, and iii) Protection against conflagrations by dedicated minimum invasive measures, taking the heritage into account, helps to prevent and counteract urban fires. Possible research fields from the Bulgarian point of view include: a) Establishing a statistical database on the vulnerability of specific CH objects to natural disasters and failures; b) Development of scenarios to simulate the effects of accidents, in order to predict structural behaviour and to prescribe scientifically-based preventive and/or mitigation measures; c) Mathematical modelling of external fire dynamics in order to establish fire precaution measures for protected territories; d) Mathematical modelling of compartment fire dynamics in CH buildings with vertical and horizontal openings (air-controlled, fuel-controlled and localized fires) in order to provide temperature data for structural fire design and reconstruction (passive fire safety measures); e) An investigation into the fire properties of materials, fire simulation and fire hazard assessment; f) Development of transparent fire protective paints and/or coatings, together with the corresponding design procedures to provide the required fire resistance without changing the original appearance of the timber structures in CH buildings; g) Introduction of a structural categorization scale for CH buildings and facilities, together with a damage assessment scale; h) Introduction of a special section in the National Building Fire Regulations concerning CH objects; i) Introduction of a special section in the National Seismic Design Code concerning CH objects; j) Development of a handbook for post-seismic and post-fire investigations, and for repairing and strengthening CH buildings and structures.

The research projects mentioned above, and also Bulgarian national and international projects have identified numerous deficiencies in general knowledge and in specialised knowledge related to natural disasters and to the sustainability of cultural heritage. It is beyond the scope of this report to analyse all of them, but some will be further dealt with in this report. Integrated research on earthquakes, taking into account the enormous experience of the Mediterranean countries (including non-EU countries such as Turkey, Tunisia, Egypt and the Western Balkans) should be of great help for the EU countries. Databases, on-site assessments, research on strengthening techniques (particularly on failed techniques and failed structures), can be put together, and information can be made available to stakeholders in all countries.

The results of research carried out in some Mediterranean countries within the framework of National Contracts should be evaluated and integrated (e.g. recent Greek, Portuguese and Italian research on earthquakes). There is a need to develop projects dealing with practical issues in cultural heritage that are of common interest to the European and Mediterranean countries, similar to the projects in the framework of the INCOMED programme.

The Final Study for the European Parliament DG Research - STOA Unit has provided an exhaustive and very important list of topics for further research to improve the understanding of incidental and slowly-developing natural disasters.

3.2. International research

The United Nations Educational, Scientific and Cultural Organization (UNESCO) and the International Union of Geological Sciences (IUGS) have a joint scheme called the International Geological Correlation Programme (IGCP). IGCP-425 project has since 1998 dealt with Landslide Hazards in Cultural Heritage Sites (Sassa, 1999; Canuti et al, 2000). The structure of IGCP-425 is based on the results of national projects involving over 50 national and regional institutions and universities. It has contributed to the development of a public access landslide database in Japan, which enables data sharing among various interest groups (SLIDELinks). In 2002, IGCP-425 set up the International Consortium on Landslides (ICL), which, however, has been transformed into a profit lobby organization with an annual membership fee of 5000 USD (Int. consortium, 2006).

In 2001, the ProVention Consortium of the World Bank started a collaborative project on Identification of Global Natural Disaster Hotspots. The contributing members of the consortium were Columbia University, the Norwegian Geotechnical Institute and the UN Environmental Program (UNEP). One of the outputs is a general landslide hazard map of the world (Nadim et al, 2005). (The ESPON programme has also prepared a European regional landslide hazard map, see below). The ProVention Consortium functions as a network to share knowledge and to connect and leverage resources to reduce disaster risks. Its projects fall into three general categories: hazard and risk identification, risk reduction, and risk sharing/transfer. The World Bank contributes with experience in projects on the rehabilitation, reconstruction and conservation of historic sites and buildings after natural disasters, e.g., the earthquake in Lijang, El Nino Emergency Assistance in Bolivia, and the Georgia Cultural Heritage Project. The focus is on poor countries. In Europe there are cultural heritage conservation activities in Romania (Taboroff, 2001).

Many cultural monuments and sites are located in mountainous regions, where landslides pose a major threat. The UNESCO conference “World heritage mountain cities and natural hazards” was organized in Chambery, France in 2002. It brought together various stakeholders for the exchange of information and experience, and examined possible ways for future world-wide cooperation.

Since 1993, Ritsumeikan University in Japan has been organizing seminars, international symposia and workshops, as well as individual lectures, on cultural heritage disaster mitigation, mostly concerning urban cultural heritage. This programme is complemented by training sessions on actions during emergency situations (simulations of fires and earthquakes). The urban cultural heritage disaster mitigation programme was set up after the 1995 Kobe earthquake, during which the fire-extinguishing systems of two famous temples in Kyoto were disrupted and these systems went out of operation, although Kyoto is over 50 km away from the damaged area of Kobe. After the main shock of the earthquake, post-earthquake fires broke out in many places in Kobe, and more than 7,000 houses were burned out. All over the world, invaluable treasures have been damaged or lost due to natural disasters such as earthquakes and associated fires, floods and ground deformations. Unhappily, very few studies have been made, and few countermeasures have been proposed for disaster prevention in historical cities, though scientists and engineers have systematically developed tools to preserve lives, cities, buildings and individual facilities from often inevitable natural hazardous phenomena. The Japanese programme combines historical phenomenological research, technological research and socio-political research in multidisciplinary studies with the aim to develop integrated methods and tools for mitigating the effects of natural disaster on cultural heritage.
The Disaster Mitigation of Urban Cultural Heritage Center (DMUCH)\textsuperscript{74} of Ritsumeikan University has been organizing international courses on comprehensive risk management including risk preparedness, emergency response and recovery. The cultural heritage and Risk Management project of Rits-DMUCH aims to provide an international training programme and to develop a scientific support network, in order to build an institutional capacity to formulate comprehensive risk management plans based on characteristic features of cultural heritage in a regional context. Ritsumeikan University's Research Center for Urban Cultural Heritage Disaster Mitigation serves as the secretariat of the Joint Network in Cultural Heritage Disaster Mitigation, and has been recognized by the Ministry of Education, Culture, Sports, Science and Technology as a research agency with new ideas that link the fields of protecting cultural heritage and disaster prevention. It has been placed on the ministry’s excellence program for the 21st century as a hub of research on disasters in historical cities with a cultural heritage. The activities mentioned in this section are involved with very well organized international research into problems of earthquakes, which will be further mentioned below.

3.3. European Programmes

3.3.1. The ESPON programme

The ESPON programme (European Spatial Planning Observation Network - supported by DG REGIO) recently elaborated a very comprehensive report on the Spatial Effects and Management of Natural and Technological Hazards in Europe\textsuperscript{75}. This report states that the European regions are exposed to hazards in varying degrees, placing them in different “risk positions”, and the EU Policy instruments should help to even out these differences as a matter of European solidarity. Consequently, the role of risk management should be understood as an important task for cohesion policy. Natural hazards are hybrid phenomena, involving complex socio-economic and socio-ecological processes that bring together nature protection, civil protection and security policy, (again cultural heritage is not mentioned). The need for a risk management perspective is linked to the fundamental EU objective of balanced and sustainable development (Art. 2 EU Treaty), and it is in accord with Art. III-184, Section 5 (“Civil Protection”)\textsuperscript{76}. The report further summarizes and evaluates integrated risks over the territory of the EU, and includes a detailed discussion of existing EU Policy and future trends in relation to highly developed countries.

Regarding pan-European activities, the report divides risk monitoring systems into territorial categories in relation to individual natural hazards. Only avalanches are accommodated with local monitoring systems, while all other hazards call for regional and European systems. Only one global natural hazard monitoring system has been installed. The Global Fire Monitoring Centre (GFMC)\textsuperscript{77} is an early warning, monitoring and general information system that supports national and international agencies involved in land-use planning, disaster management and other fire-related tasks.

The report considers the Strategic Environmental Assessment (SEA) directive as of key importance for an integrated approach to environmental protection, including cultural heritage. The ESPON approach is strongly preventive, and makes use of spatial planning tools rather than

\textsuperscript{74} www.ritsumei.ac.jp/se/rv/coe/index-e.html
\textsuperscript{75} http://www.gtk.fi/projects/espon/
\textsuperscript{76} “the Union shall encourage cooperation between Member States in order to improve the effectiveness of systems for preventing and protecting against natural disasters within the Union”.
\textsuperscript{77} http://www.fire.uni-freiburg.de/
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civil protection measures. It calls for a holistic approach, which has clearly been missing until now. In accordance with its preventive orientation, it suggests laying emphasis on a broader strategy of vulnerability reduction, which is significantly dependent on human activities and behaviour. This requires a better understanding of the socio-economic processes that have put valuable assets in harm’s way. A need to minimise environmental risks, including natural disasters, is also demanded under the Framework for Action on sustainable Urban Development in the EU.

The report recommends that the establishment of a coordination unit for risk management be considered, similar to FEMA in the USA. This unit could be responsible for coordination tasks such as: i) coordinated observation and monitoring of hazards, including the given interrelationships between certain hazards in the Member States (MS); ii) coordination of cross-border activities among MS, and between MS and non-MS; iii) knowledge transfer from the scientific community into administration and politics; iv) development of guidelines and handbooks for regional and local mitigation activities; v) development and management of disaster related funds; vi) harmonising the methodological tools within the mitigation process (hazard maps, risk maps, weighting of risks, etc.), and vii) cooperation with international organisations working in the field, as well as other relevant EU organisations. The report also touches on the issue of international cooperation outside the EU, including measures to deal with hazards which EU citizens may face abroad (in agreement with the Barnier report).

3.3.2. The GMES joint EC/ESA initiative

Global Monitoring for Environment and Security (GMES) is a concerted effort to bring data and information providers together with users, so that they can better understand each other and make environmental and security-related information available to the people who need it through enhanced or new services. It is expected that prevention models and data for early warning systems will be generated within GMES. The targeted channeling of these systems will also enhance future MIC capacity. The first results on monitoring seismic activity provided promising achievements that can be utilized in European coordination of responses to natural disasters.

There are other projects under the 6th FP that support the development of GMES, e.g., TANGO (Telecommunications Advanced Networks for GMES Operations) or that use GMES results, e.g. ELLA (ELBE - LABE flood management measures by transnational spatial planning) and ODERREGIO (Transnational Action Program Spatial Planning for Preventive Flood Protection in the Oder Catchment). These projects do not explicitly focus on protecting cultural heritage from natural disasters. GMES has defined a product called Flood Risk Assessment to monitor the physical parameters that contribute to flood risks. Modeling

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78 Such an approach may be seen as different from but complementary to the new EU constitution effort, which seeks to encourage cooperation among Member States in the field of civil protection in order to improve the effectiveness of systems for preventing and protecting against natural disasters.


80 Researchers in Italy, including scientists, engineers, and first responders, have analyzed seismic signals from over 200 moderate to strong earthquakes, ranging from earthquake magnitude 4.0 to 7.4. They concluded that the waves generated in the first few seconds of an earthquake carry sufficient information to determine its magnitude and destructive potential. Earthquake early warning systems can help mitigate the effects of such earthquake-induced disasters as fires, explosions, landslides, and tsunamis, which can, in many cases, be more devastating than the earthquake itself. This study was funded through the EU-Seismic Early Warning for Europe (EU-SAFER) project. http://earthobservatory.nasa.gov/Newsroom/MediaAlerts/2006/2006120423790.html.

81 www.ella-interreg.org/ (Interreg IIIB CADSES).

82 www.oderregio.org/
techniques are used to provide flood predictions and give an early warning. Another product is called Flood Damage Assessment. It aims to derive the maximum extent of a flood and to estimate the damage caused by a flood, and for this purpose mapping of cultural heritage stock at risk is needed.

3.3.3. GALILEO

The new European Satellite Navigation System GALILEO\(^83\) will offer substantial help in positioning and identifying endangered cultural heritage objects in emergency situations, and then rescuing them. However, this is dependent on the existence of good quality maps of cultural heritage stock at risk. The system should be operational in 2010.

3.4. International Programmes

The Working Group on Environmental Monitoring and Assessment serves as an instrument for UNECE (United Nations Economic Commission for Europe) Member States to provide recommendations, to propose action plans and to improve coordination of international initiatives within the region. For example, the National Report on the State of the Environment in Armenia deals also with environmental impacts on historical and cultural monuments in the country (SNCO, 2002). It states that the most destructive impact is of natural catastrophes such as earthquakes and landslides. Slow downhill soil movements (creep) damage national architectural monuments as well as commercial and other buildings. Soil movements have been aggravated by extensive irrigation and related works.

\(^{83}\) [http://ec.europa.eu/dgs/energy_transport/galileo/intro/index_en.htm](http://ec.europa.eu/dgs/energy_transport/galileo/intro/index_en.htm)
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4. EU PROTECTION INSTRUMENTS

4.1. Community Civil Protection Mechanism

4.1.1. Role and relation to cultural heritage

The Community Civil Protection Mechanism (CCPM) was established by Council Decision No. 2001/792/EC, Euratom on October 23, 2001. It supports and facilitates mobilization of the emergency services to meet the immediate needs of countries struck by disaster. It improves the coordination of assistance interventions by defining the obligations of Member States and of the Commission, and by establishing certain bodies and procedures, such as the Monitoring and Information Centre.

According to Article 1 (2): *The mechanism is intended to help ensure better protection, primarily of people but also of the environment and property, including cultural heritage, in the event of major emergencies, i.e. natural ... accidents occurring inside or outside the Community, ....* The explicit reference to the protection of cultural heritage is also expressed in paragraph 9 of the preamble to the Council Decision.

The Civil Protection mechanism consists of the following four key elements:

- **Pre-identification of intervention resources.** *Aim:* to identify in advance the intervention teams available within the Civil Protection services of the Member States at very short notice (generally within a time frame of 2 - 24 hours after the emergency occurs) and that can be mobilised (their composition varies according to the type of emergency and the particular needs in that emergency).

- **A training programme to improve response capability.** *Aim:* to set up a training programme to improve the ability of these teams to work jointly and to promote optimum complementarity among them. This programme will encompass joint training and exercises, and opportunities for team members to be seconded for short periods to teams in other Member States.

- **Assessment and coordination teams.** *Aim:* make it possible to mobilise a small assessment and coordination team and dispatch it immediately to the scene. This should improve on-the-scene efficiency and coordination and enable rapid identification of the resources that are most appropriate for dealing with the emergency. Where appropriate, the teams should also liaise with the competent authorities of the country requesting assistance.

- **Establishment of a common emergency communication system.** *Aim:* to develop a common operational emergency communication system between the Civil Protection administrations of the Member States and the relevant services of the Commission.

The intervention teams are the core component of the mechanism. However, in managing emergencies there is always a substantial need for flexibility. Therefore, Member States and third countries will also be given the possibility of requesting other support, involving specialised personnel and specific equipment needed to deal with the particular emergency. Civil Protection authorities in the Member States, non-governmental organisations and other relevant entities could provide these resources.

Overall responsibility for emergency response measures remains entirely with the country requesting assistance to respond to a disaster. The Community mechanism can also contribute to
the Union's overall non-military response to crises in third countries under the common Foreign
and Security Policy.

CCPM is a sound and powerful instrument for protecting cultural heritage from natural disasters. Since 2001, several related acts have been introduced – Council resolutions, decisions and proposals which substantially enhance the role of the cooperation mechanism. COM (2005) 137 ("Improving the CCPM") and COM (2006) 29 – Official Journal C 67 of 18.03.2006 ("recast of Decision 2001/792/EC") are major improvements to the mechanism, and will help to provide better protection of cultural heritage in emergency events.

The suggested “modular approach” will give an opportunity to create specialized standby intervention teams with appropriate training and experience to safeguard cultural heritage from the adverse effects of natural (and man-made) disasters.

4.1.2. Monitoring and Information Centre

The operational heart of the mechanism is the Monitoring and Information Centre (MIC), which is based at the European Commission in Brussels. Through MIC, which is accessible 24 hours a day, the Commission can facilitate the mobilisation of civil protection resources from the Member States in the event of an emergency.

Any country affected by a major disaster - inside or outside the Union - can request assistance through MIC. MIC then immediately forwards the request to a network of national contact points. These inform MIC whether they are in a position to offer assistance. MIC compiles the responses and informs the requesting State about the available assistance. The affected country selects the assistance it needs and establishes contact with the assisting countries. MIC can also offer technical support, including improved access to satellite images, and acts as an information centre, collecting data and distributing regular updates to all participating countries.

The mechanism also works toward enhanced preparedness. It is supported by a database with information on the national civil protection capabilities available for assistance interventions. The mechanism also receives the contents of the military database, compiled by the EU Military Staff (EUMS), giving it a broad picture of all resources available to manage the consequences of disasters. A Common Emergency Communication and Information System (CECIS) has now been implemented to ensure efficient information sharing between MIC and the national contact points.

Candidate countries for EU accession can participate in the mechanism. Today 30 States - the EU-27, Iceland, Liechtenstein and Norway - participate in the Mechanism, which is funded on a year-by-year basis.

MIC has proved its operability and effectiveness during recent disasters in Europe. For example, during the floods in Central Europe in 2002 the Monitoring and Information Centre (MIC) for civil protection was fully engaged in channeling information and coordinating assistance (pumps, vaccines)\(^{84}\). Several other examples are mentioned in paragraph 2.3.3.

Recent proposals\textsuperscript{85} mentioned above to reinforce the analytical and assessment capacity of MIC offer a very progressive way to enhance the capability and actions of MIC in the area of cultural heritage protection. The consultants attach special importance to the possibility of improving disaster prediction and early warnings, as well as \textit{in situ} assessment and coordination activities, which are all key factors in the rescue of cultural heritage assets. The availability of a more stable cadre of well-trained and experienced personnel with powerful equipment (and a modular approach) will certainly increase the effectiveness of emergency measures and actions, which could also be utilized outside the EU, e.g. in the sense of the Barnier report.

\subsection{Civil Protection Service activities}

The approach and organization varies from country to country. The extent of this report does not allow for detailed description of national approaches, so two examples have been selected – one in an “old” Member State and one in a “new” MS. The examples are further complemented by the detailed Bulgarian presentation in \textit{Annex 3}.

In the Czech Republic, the Integrated Emergency System relies on the Emergency Fire Brigade, as far as natural disasters are concerned. For specific operations, mainly abroad, the emergency fire brigade has established a special Urban Search and Rescue Team (USAR) trained for work in areas damaged by earthquakes and similar phenomena. Other natural disaster rescue work is carried out by the regular staff of the fire service and by volunteers. The system is controlled from the Ministry of the Interior. The Civil Protection units are still a part of the army structure under the Ministry of Defence, and they are usually not involved in the emergency schemes unless the army is engaged.

As has been mentioned above, in Italy the civil protection services are engaged in mitigating damage to cultural heritage from natural disasters in the field of emergencies, anticipatory measures, prevention and international relationships. They cooperate in drawing up emergency plans and programmes at local and national level, including ongoing updating of emergency procedures, regular exchange of information, training and continuous education of personnel, on-site training, and increasing and improving protection facilities. These civil protection measures aim to speed up interventions substantially. Anticipatory measures are usually provided by a network that connects Civil Protection to research centres, to technological systems for collecting and elaborating data on the various types of risks, and on interpreting the data on the basis of simulation models. In this way the system can be alerted early, even before the event occurs. In Italy, this work is carried out by \textit{“Functional Centres”}, organised at national and regional level. Through precise local knowledge of the territory and of the possible risk phenomena, technologically advanced networks are used, e.g., radar networks for meteorological forecasts, the national network of seismographs, volcano monitoring systems, with the assistance of researchers and professionals. This enables areas at risk to be evacuated on time, as in the case of the recent flood in Piedmont (\textit{See Annex 2}).

Knowledge of the territory and of the risk levels helps the civil protection services to provide efficient assistance to the population. Civil protection has the task of finding and passing on information, e.g., hazard maps, to the authorities, so that they can take preventive action, reduce risks and prepare defensive measures in advance.

4.2. The European Union Solidarity Fund

The enlarged European Union has set up a Solidarity Fund\(^{86}\) (EUSF) so that it can respond in a rapid, efficient and flexible manner and come to the aid of any Member State in the event of a major natural disaster. The Fund has an annual budget of one billion euro.

This instrument is applied without delay, and has proved to be a very effective means for safeguarding cultural heritage in natural disaster situations. No administrative barriers have hindered its practical application. Clearly, this instrument exhibits a very high European added value.

Positive experience with EUSF has even led to the idea that, in some cases, the creation of a fund for repairing and restoring works might be more effective and less harmful to historic environments than building expensive and ugly fixed barriers (walls) along river banks in historic territories, namely historic cities. In such applications, the one-year deadline for using the grant may not be adequate, due to the combined technological and climatic impacts on architectural heritage.

4.3. Relation to foreign EU activities

4.3.1. A European civil protection force

Issued after various proposals had been discussed, The Conclusion Report of the recent Austrian Presidency states that improving the Union’s responsiveness to emergencies, crises and disasters inside and outside the Union remains a political imperative. While Member States are responsible for managing emergencies on their own territory and assisting their citizens abroad, the EU can, in a spirit of active solidarity, play a role by coordinating the political response and by helping to organise and coordinate available assets when requested to do so.

The European Council (15/16 June 2006) endorsed the Presidency Report on “Reinforcing the Union’s emergency and crisis response capacities” (10551/06), which sets out practical steps and decisions taken to improve coordination and delivery of available assets. It also welcomed the Barnier\(^{87}\) report on a “Europe Aid” civil protection force\(^{88}\). Such an EU programme to provide security for European citizens outside EU territory can easily and favourably be linked to action to protect and safeguard cultural heritage.

The Barnier report does not discuss issues of cultural heritage protection, as it focuses on humanitarian issues. However, the very well elaborated and clearly presented proposal for a European civil protection force – “Europe Aid” - is well structured and prepared to include modules on protecting and rescuing cultural heritage in emergency situations. In this way, the European civil protection force initiative further increases the capacity to safeguard cultural heritage from natural disasters.

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\(^{88}\) Remark: From the Barnier report, the relation between the proposed “Europe Aid” force and the existing programme “EuropeAid” is not clear. [http://ec.europa.eu/europeaid/promotion/index_en.htm](http://ec.europa.eu/europeaid/promotion/index_en.htm)
4.3.2. Contribution to European added value

Cooperation among the EU Member States in combating natural disasters, and acts of solidarity in recent emergency situations, have borne witness to the added value offered by the European Union. The foreign activities suggested above make this added value more visible.

The consultants believe that amendments to humanitarian and civil protection aid integrated with interventions to safeguard cultural heritage will not only raise the visibility of the EU, but will also substantially improve the durability and sustainability of the added value of the EU and of “Europe Aid” worldwide.

Success and effectiveness in emergency situations is strongly dependent on experience, and on learning lessons from previous events. Emergency situations mostly do not recur in the same place or even in the same country within a short period of time. Joint interventions by international teams are therefore a particularly valuable way to learn from disasters. Personal experience is crucial, and creates a solid background for improved, timely and correct decisions. This fact, together with the economic advantages of maintaining only limited personnel and equipment on permanent alert shows the European value of jointly coordinated, controlled and operated actions to protect cultural heritage from natural disasters.

4.4. Comments on EU policies and programmes

4.4.1. Introduction

Generally, there has been no holistic and uniform approach for dealing with natural hazards and cultural heritage, nor for dealing with natural hazards only. Hazards are addressed in heterogeneous ways, under various headings and at different levels by existing Community instruments. It seems that EU policy offers better protection for heritage in relation to technological hazards than in relation to natural hazards. Cultural heritage protection is frequently treated as if it were an environmental issue, though the reasons for this are unclear, and there are many inconsistencies. Spatial and urban development documents tend not to include provisions for the protection of cultural heritage, though most cultural heritage is located in settlements. Cultural landscapes and trans-boundary issues also need to be considered.

Several Community documents supporting the development of an integrated EU strategy on prevention, preparedness and response to natural, man-made and other risks are mentioned in other chapters and paragraphs of this report, e.g. the Commission Work Programme 2002, the communication on “The EC response to the flooding in Austria, Germany and several applicant countries”, the INSPIRE (Infrastructure for Spatial Information in Europe) framework, the Water Framework Directive, etc.

4.4.2. Cohesion Policy

The EU Structural Funds, which play an important role in cohesion policy, are potential instruments for preventive measures. Environmental protection, including support for cultural heritage and risk prevention, has been given much greater emphasis in the new cohesion policy...
Under all three objectives risk prevention is mentioned as a priority, namely within territorial cooperation, which acknowledges risk prevention at cross-border, transnational and interregional level. The themes include protection against flooding, earthquakes and avalanches, and involve supplying equipment, developing infrastructures, transnational assistance plans and risk mapping systems. On the EC level, a coordinated approach to some thematic tasks would be highly effective, both from an economic and from a professional point of view.

4.4.3. The Sixth Environment Action Programme

The EAP\textsuperscript{93} covers disasters and civil protection, and states that the Community needs a coherent and consolidated policy to deal with natural disasters and accidental risks. The Community can assist Member States with long-term preventive measures, giving support for example to land-use planning instruments, assessment and early warning tools and improved emergency management, using, e.g., satellite surveillance (via the Galileo navigation satellite system) and exchange of experience. Only industrial risks and hazards are presented in detail, without any links to cultural heritage. Community co-ordination is needed for action by Member States on accidents and natural disasters. This includes landscape. EAP wants Community policy to ensure that landscape is protected, preserved and restored, and that it is properly integrated into the objectives, measures and funding mechanisms.

It should be mentioned here that the 6\textsuperscript{th} EAP requires the EU to prepare measures aimed at adapting and mitigating the consequences of climate change by 1) reviewing Community policies, in particular those relevant to climate change, so that adaptation is addressed adequately in investment decisions; 2) encouraging ... measures such as water resources management, conservation of biodiversity, prevention of desertification and flooding, and support for awareness raising among citizens and the business community. Again, no explicit requirement on cultural heritage is included, and this should in future be put right. Conservation of non-renewable resources needs to be dealt with, and not only hazards. It is also very important to include climate change issues, which have the character of a long term continuous natural hazard with fatal consequences for many elements of cultural heritage. Measures against the degrading effects of climate change are similar in nature to other types of natural disaster. Thus, some cultural heritage related capacities established for emergency situations can also be advantageously exploited in “peaceful” periods.

4.4.4. The INTERREG initiative

The Interreg programmes can address spatially relevant hazards with trans-boundary dimensions, helping to overcome the discrepancy between ecological regions and administrative jurisdictions. They can be used for horizontal networking and information exchange on various levels. According to the ESPON 1.3.1 Report (see above), the potential of the Interreg initiatives has not been appropriately exploited for natural hazard risk prevention. In fact, hazards and risks are mentioned in fewer than 14\% of the Interreg programmes, mostly in very general and vague terms in relation to environmental protection. Only 6 out of 66 programmes make clear references to risk management in emergencies caused by natural hazards, e.g., floods (Mecklenburg-Poland; Euregio Maas-Rhein; North West Europe; CADSES), fires and civil protection (Sardinia-Corsica-Tuscany) or general prevention of disasters (Alpine Space). This last-mentioned programme (Alpine Space), involving France, Germany, Italy, Austria, Slovenia,

\textsuperscript{92} COM 2004, 492-496.

Switzerland and Liechtenstein, is the only one which explicitly focuses on cultural heritage in its Priority 3: *Smart management of nature, landscapes and cultural heritage, promotion of the environment and the prevention of natural disasters*. Key actions focus on good management and promotion of landscapes and cultural heritage, including water resources, and on the prevention of natural disasters. Only one out of 24 projects within this programme priority combines cultural heritage protection with natural hazards (CulturAlp). Some other topics can contribute significantly to the stock at risk, especially natural hazard mapping, e.g. ALPS-GPSQUAKENET (see programme footnote link).

The Interreg programmes should be encouraged, because they provide a space for creative projects on measures to protect cultural heritage from natural disasters, and they involve the most relevant stakeholders and governmental bodies. They may also be the best sources of good and bad practice experience for the enlarged MIC.

### 4.4.5. Role of procedures

Recently adopted assessment methods, namely EIA (Environmental Impact Assessment) and SEA (Strategic Environmental Assessment), also play an important role in planning and decision making processes for protection against natural hazards. However, they do not address cultural heritage as a key element in the human living environment. Moreover, implementation of the SEA Directive is variable in Europe, being greatly dependent on the choices made by individual Member States. This may decrease the effectiveness of the Directive in relation to protection of the environment (including cultural heritage) from natural disasters.

### 4.4.6. Euro-Mediterranean Partnership

Protection of cultural heritage from natural and human made risks was also discussed at the workshop “Cultural Heritage within the Barcelona Process” in 2005, with a clear conclusion that cultural heritage must be properly tackled in the new European Neighbourhood Policy. The cross-border character and the need for international cooperation were underlined.

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95 [http://www.culturalp.org](http://www.culturalp.org) The aims of the project are to protect and enhance that common heritage, improving the knowledge on characteristic features of historical Alpine settlements and promoting integrated sustainable policies for interventions, taking into account different aspects of cultural, historical, social, economic and environmental identity, according to the spatial and economic context. Main project activities: 1) cataloguing and cartographic representation (databases, Geographic Information Systems) of Alpine Cultural heritage components, based on harmonised methods; 2) defining harmonised analytical methods to evaluate strengths and weaknesses (SWOT analysis); 3) promoting pro-active policies to protect and enhance cultural heritage components (best practices, guidelines); 4) disseminating positive experiences and supporting integrated policies using information society technologies.

96 2001/42/EC

4.5. New & Proposed Directives

4.5.1 Directive on the assessment and management of flood risks

The aim of this recently adopted Directive is to establish a common framework for assessing and reducing the risk that floods within the European Union pose to human health, the environment, cultural heritage and economic activity (Article 1). The document covers all types of floods, both along rivers and in coastal areas. There are also other risks, such as urban floods and sewer floods, which must also be taken into account.

The proposed prevention and management measures are organised by river catchment districts (which may cover several river catchments), as established by the Water Framework Directive. The measures involve a preliminary assessment of risks (Art.2), including cultural heritage risks, and the establishment of maps of areas at risk and flood management plans.

Thanks to the Council Common Position, the adopted proposal contains measures focusing on safeguarding cultural heritage. Cultural heritage issues are not understood only as a part of the “environment” and “property”, but are explicitly considered in the requirements for preliminary flood risk assessment (Article 4) and for the flood risk management plan (Article 7). The Directive focuses on protecting territories against flooding, and this includes historic settlements, where protective measures with insensitive technical solutions could pose a threat to cultural heritage values.

The risk maps required in this Directive should contain an inventory of cultural heritage interests, including archaeological sites and cultural landscapes, though this is not explicitly mentioned. The risk management plans have to involve specific measures for taking cultural heritage adequately into consideration in the affected territory, and this would not be possible without knowledge of cultural heritage assets.

The Directive is methodologically very well designed and justified. It is an example that should be followed when preparing a possible Directive for protecting cultural heritage from natural disasters, since this issue exhibits similar trans-border characteristics and there is a need for internationally coordinated actions.

4.5.2. The INSPIRE Directive

During the conciliation procedure, the European Parliament and the Council reached an agreement on the INSPIRE Directive (Infrastructure for Spatial Information in the European Community) on 21 November 2006. The Directive will require EU member states to improve the administration of their map services and other spatial data services according to common principles. The data includes protected sites and potential hazards.

This will trigger the creation of a European spatial information infrastructure that will deliver integrated spatial information services to users. These services will enable users to identify and

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101 http://www.ec-gis.org/inspire/home.html
access spatial or geographical information from a wide range of sources, from the local level to the global level, in an inter-operable way for a variety of uses. The target users of INSPIRE will include policy-makers, planners and managers at European, national and local level, citizens and citizens’ organisations. This directive aims to promote and facilitate the creation of maps of cultural heritage stock at risk, maps of natural hazards and risk maps on various levels.
Protecting the cultural heritage from natural disasters
5. EUROPEAN CO-OPERATION

5.1. Awareness raising

Awareness in relation to protecting cultural heritage from natural disasters consists of at least three elements: i) awareness of natural hazards and risks, ii) awareness of the specific vulnerability of cultural heritage to natural hazards, and of techniques for limiting the impact of natural disasters, in general, and iii) awareness of possible measures and emergency procedures for mitigating the impact of natural disasters on cultural heritage. Of course, there are also other influences, e.g., understanding cultural heritage values, assessing rescue priorities, differences between the approaches and background of professionals and of the general public, etc.

European cooperation has a great potential for fundamental research, and for gathering, evaluating and disseminating best practice examples as well as bad experience, especially for emergency professionals. This potential has not yet been adequately exploited. Dissemination of knowledge and awareness-raising activities are mainly a matter for the individual states, especially where there are language barriers in targeting the general public.

Early and accurate information is vital for damage reduction. For example, the Etna volcano in Sicily is the most active in Europe. Every year, eruptions threaten houses and villages built in the vicinity. Two years ago, the funicular railway station was destroyed by lava. Thanks to the Italian Civil Protection Department, the activity of the volcano is continuously monitored, and the local population is kept well informed. European monitoring systems are needed to enhance similar services.

Awareness raising is firmly linked to educational and training programmes, which are discussed below. In addition, media-supported and voluntary activities can advantageously use the European dimension to increase the impact, namely when young people and the internet are involved.

In the EU states, several governmental and non-governmental or international bodies provide advice for the public through their web sites. They also publish good practice case studies. The impact of such information can be enhanced if the search is directed from a central, thematically-structured, well-presented communication point.

The ESPON Hazards project, mentioned above, developed a typology of regions that clusters areas in Europe that are threatened by similar hazards in space and time. The project also created hazard interaction maps, and linked them with climate change effects. The maps help users to understand the threat of climate change, which has a significant influence on the occurrence of natural disasters.

When politicians and governments are well aware of the problems of cultural heritage in emergency situations, decision making will be accelerated and international operations will be promoted.

5.2. Prevention, mitigation & relief of disaster damage

Protection of cultural heritage from natural disasters on a European level is the subject of some ongoing joint research projects (e.g., NOAH’S ARK, CHEF). These will produce guidelines on the European dimension for cultural heritage damage mitigation and relief (first results will be
available in June 2007). Some projects take into account not only short-term natural disasters but also long term effects (NOAH’S ARK).

Some world organizations, e.g., ICBS, are involved in internationally coordinated activities. However, they mostly do not focus on European added value, and tend to be active on a national level.

In recent years there has been a strong move to invest in preventive, mitigation and preparedness measures. At the same time, non-structural measures have been preferred to structural methods, especially in connection with the protection of cultural heritage. Both structural and non-structural approaches allow space for innovative solutions and techniques, and for breakthrough concepts. Critical mass provided within EU research, planning and development programmes can contribute to this process.

The specific features of certain natural hazards require preventive measures to be developed and adopted in a harmonized way by several European countries. On the non-structural level, bilateral or multi-lateral agreements are usually signed, and these agreements include a coordination process. The EU central coordination unit – MIC – has proved to be a very efficient and useful instrument in emergency situations and its role in early warning and preventive functions should be strengthened and enhanced.

The importance of a suitable and well-devised insurance system as a preventive measure has been explained in previous chapters. An EU incentive or facilitating initiative might be extremely fruitful here.

5.3. Identifying and marking stock at risk

Lack of appropriate knowledge about the cultural heritage stock at risk has probably been one of the most widely mentioned drawbacks and shortcomings in relation to effective protection of cultural heritage against natural and man-made hazards. Many European professionals (Kåks (2003) from Sweden, Taboroff (2000) from the UK, Stuive (2003)) have stressed in their statements and papers an urgent need for harmonized or even standardized and comprehensive mapping of European cultural heritage.

The mapping of affected areas obtained from natural events observed over an extended period of time can be used in the absence of current hazard maps as a surrogate representation, or at least as a first approximation. The assumptions derived from them are acceptable until the historical records are sufficiently extended into the past to ensure statistical significance (at least one hundred years).

The available maps of natural hazards are prepared in accordance with technical requirements that differ from those related to the protection of cultural heritage (they are usually for civil protection or urban planning regulation purposes). This often results in a good coverage of the territory, but in a lack of relevant information. Maps obtained for different purposes often fail to provide the specific data needed to develop cultural heritage protection plans, recovery initiatives, etc. For example, flood risk maps usually report only the areas affected by a given flood event (with a measure of the associated probability of occurrence) and the predicted water depth. However, since the main objective of such products is to define the territory affected by the flood, water depth is only approximately provided and there is usually no information about
flow velocity. These two pieces of information are, however, of great importance for protection of cultural heritage protection against floods.

European programmes and documents, including existing or proposed directives, are generally in support of mapping natural disaster targets, but unfortunately they mostly do not explicitly include cultural heritage. This needs improvement, and the consultants consider that, for a truly innovative approach, a special harmonized pan-European cultural heritage inventory mapping initiative is essential. This can be done in three steps, starting with a research and development project, supported by the design and selection of the best methodology. This will be followed by a standardisation procedure and finalised by an EC-supported mapping campaign.

Experience from the advanced European countries should be evaluated and learned from, e.g., from the Italian Civil Protection Department, which together with the Italian Ministry of Cultural Heritage is organizing the inventory and mapping of the risk and vulnerability of all historic centres in the country. The work will take a long time, but it can be assigned to the municipalities in each location.

It should be emphasized that such mapping has other positive economic side effects, namely for tourism, education and awareness raising, security improvements, scientific work, historical studies, development of intelligent and interactive GIS systems, and protection against various threats, e.g., climate change and pollution from new emission sources, mainly cars. Therefore, it might qualify for support from the structural funds.

A suitable European marking system should be applied for emergency situations. Use can be made of the existing Blue Shield visual mark, which should, however, be upgraded for better performance at night and in low-visibility situations.

5.4. Research

European collaborative research in the field of protecting cultural heritage from natural disasters plays a decisive role, and is essential for successful measures to deal with natural hazards and their consequences. Unfortunately, many projects dealing with natural hazards have omitted or only touched on cultural heritage. As a result, the proposals made in them need not comply with conservation principles and requirements, and can even - unintentionally - harm or destroy cultural heritage.

Therefore, more attention should be to cultural heritage in the EU research programmes, and also in the complementary national research programmes and projects on natural hazards and disasters. This issue should be strengthened in the priorities of the ERA NET projects, and in the planned research activities of the European Construction Technology Platform – Focus Area Cultural Heritage.

Safeguarding cultural heritage from natural (and man-made) disasters has not been integrated into the themes of EU security research, though monuments and historic complexes are quite frequent targets of terrorist attacks. Terrorism and armed conflict have not been the explicit subject of this study. However, they share many similarities with natural disaster emergencies, and it is appropriate to make more efficient use of resources by harmonizing research in these fields. Moreover, the results will be ready for EU activities outside Europe, including rescue of EU citizens and tourists in danger.
5.5. Education and training

General education programmes including evacuation training and other exercises in preparation for natural disasters have proved to be very effective in countries with a high degree of natural hazard threat (e.g. Taiwan, with earthquakes). Such measures are usually successfully taken at local level. For international assistance, it would be useful to have pan-European support for selected simple expressions and terminology, signs and signals for use by foreigners in communicating with the local population. The measures should include items for use in rescuing cultural heritage.

There is a need for courses and training sessions to raise people’s awareness of the risks, on how to prevent disasters, and how to react to an event (e.g., how to behave during the event, where people should assemble) etc. Some Mediterranean countries (Italy) have already made an effort to provide courses and publications at primary and secondary school level on responding to earthquakes.

The training and education of professionals, especially in the construction industry, must focus on improving the quality and robustness of repair work after a disaster, as well as maintenance and other repairs that will enable cultural heritage to better withstand any exceptional loads in a natural disaster.

European collaboration is necessary in educating and training professionals to cooperate and to participate in coordinated actions. Such activities involving neighbouring countries already exist, and may include competitions with public participation aimed at increasing public awareness and preparedness. Training programmes focusing on specific cultural heritage problems are still, regrettably, quite rare in most countries.

After the Seismic Code was published in Italy, series of training courses for professionals were organized by the Universities and by the Civil Protection Department. Historic buildings were included in these courses, within the framework of Continuing Education, in order to help in applying the code.

For specific cultural heritage rescue tasks, good supervision and in situ decision making by specially trained professionals will surely reduce losses due to inappropriate interventions. Due to the complexity of the cultural heritage field, it seems to be more effective to train conservation specialists, rather than emergency workers, in complex and difficult rescue operations. On the other hand, short-term situations can be managed by properly trained members of fire brigades or civil protection teams, according to the national organisation and structure of the emergency services.

5.6. Cost effective capacity building

Let us return for a moment to the lessons learnt from natural disasters. The harm to cultural heritage further increases in the absence of adequate risk estimation, evaluation, and minimization measures, according to Taboroff, (2000). The threat posed to cultural heritage by natural disasters has been well documented both in historic records and by word of mouth. The myth of Atlantis clearly embodies the fear of losing a whole civilization and its huge multi-faceted heritage due to some tremendous natural event. The destruction of Pompeii and the nearby settlements is probably the most widely known natural disaster affecting our cultural heritage throughout History, while the case of Venice, frequently flooded by the “Acqua Alta”...
tide phenomenon, is of topical interest today. Other recent outstanding disasters with a heavy impact on moveable and immoveable heritage include the floods in Florence in 1966, the 1997 earthquake in Assisi, the 1996 earthquake in Lijang city (China), the 2002 floods in Central Europe, etc.

What innovation and development has there been in relation to cultural heritage? “However, although there is a long tradition of devastating natural disasters that have destroyed irreplaceable cultural resources, awareness of the need to reduce risk is low, and memory is short, and costs have been incurred because of lack of preparedness” (Taboroff, 2000). Indeed, the impression when looking at media reports on recent events is often that of “déjà vu”, where emergency measures deal with repairing damaged cultural assets, while effective risk management is rare. As an illustrative example, pictures taken after the Florence flood in 1966 and after the flood in Prague in 2002 are compared, in both cases illustrating the actions taken to save moveable assets from important national libraries in the two countries. The change from traditional black and white to digital color photographs seems to be the main improvement after a period of 40 years, as far as addressing the protection of cultural heritage against floods is concerned.

Example of books being saved after a flood: left, 1966 (Florence) and right, 2002 (Prague)

There are many reasons for such a lack of effective risk management in the case of cultural assets, including the difficulty of putting a value on the non-market nature of many cultural heritage objects. This often results in reluctance of decision makers to invest in protective measures, disaster management plans, mitigation actions, etc

In any case, without appropriate value assessment we are not able to decide whether a certain “primitive method” is not, by hazard, the most cost effective, namely in some particular situations.
Protecting the cultural heritage from natural disasters

Moveable cultural heritage affected by floods: Florence 1966, left, and Prague 2002, right

The various types of natural disasters have individual features from the physical point of view, and the differences between them are really significant in terms of predictability, protection, mitigation and recovery actions. For example, earthquakes cannot be predicted and are a rapidly evolving phenomenon, so only post-disaster emergency interventions can be made. By contrast, floods on major rivers can be anticipated with lead times of hours or days, and the extent and evolution of the event can be reasonably predicted. Actions can therefore be taken even in the course of the event. Moreover, the territory damaged by an earthquake cannot be predicted, while maps of flood prone areas can be prepared with reasonable accuracy. Under such circumstances it is obvious that a specific attitude is necessary for building capacities to safeguard cultural heritage in emergencies.

Awareness, public education and systems and facilities that provide advice are tried and methods for reducing cultural heritage losses. It is also important to recruit properly instructed volunteers with basic knowledge of cultural heritage and the ability to help in rescue operations during and after a natural disaster emergency. European information systems and a European database, together with innovative use of available means of communication, e.g., mobile phones and mass media, would greatly enhance overall preparedness and operability in emergency situations.

Strengthening the capacity and role of MIC is undoubtedly a cost-effective way to improve awareness, to give early warnings, to predict disasters, to coordinate international activities and to safeguard cultural heritage, and to ensure timely pan-European operability. Of course, the recommendations made in this report should also be taken into account.

It has been shown that the capacity of emergency teams dealing with cultural heritage issues can be considerably increased by cooperating on site with cultural heritage specialists. In the case of large European museums, archives, libraries and historic complexes, an employee of the institution usually takes on this role. Her/his professional knowledge is usually assured by the disaster plan, by training courses organized by various bodies, e.g., national ICBS, and by various written guidelines (which are to be studied on a regular basis). Unfortunately, this is not the case when minor heritage structures, namely churches, suffer from a natural disaster. Due to the lack of permanently employed specialists, there is a need for a system to recruit professionals from specialized institutions or university students to help on site. This may be difficult in practice, due to safety regulations. There is a lack of engineers qualified and certified to give an
access permit to the owners and users of affected and damaged buildings. This delays the interventions needed for rescuing moveable cultural heritage and works of art from buildings.

In complicated situations, emergency teams should be supplemented by specialists in cultural heritage emergency conservation. Such specialists should be identified and made available to rescue teams all over the EU.

5.7. Exchange of knowledge & experience

Facilitating exchange of knowledge and experience on protection of cultural heritage from natural disasters is the most important added value of pan-European activities in the field. Natural disasters can occur in areas where they have not been experienced for a long time, or not in living memory. The role of transfer of knowledge and experience therefore needs to be emphasized, and the adequate tools should be developed and offered for use. This concerns practical issues as well as the outcomes of research and investigations.

Within the framework of the RELUIS Project, mentioned above, the Italian Civil Protection Department is collecting and harmonizing all the research carried out in recent decades in earthquake engineering on existing historic masonry structures and materials. All the collected information is being digitized and will be made available on a website. Similar research should be carried out in all the European countries, and should form the basis of a state-of-the-art report at European level. Networks should be organized on various aspects of protecting cultural heritage from natural disasters, in order to deal with gaps in research and in practical applications.

5.8. Standardization

The only existing European structural standard (EuroCode-8) on resistance of structures to earthquake loads does not reflect the specific needs of cultural heritage objects. As we have already discussed, the importance of cultural heritage objects is usually accommodated within national assessments of the safety factor. However, this can be disadvantageous for historic buildings, which usually do not exhibit features justifying a high safety factor. On the other hand, there are many historic buildings which have survived quite severe earthquakes without major damage thanks to their structural details and their combination of materials and technologies, which can hardly be apprehended in mathematical models. Modern structural standards are generally difficult to apply in historic environments.

Some standards concerning fire protection and the reduction of fire risks in historic buildings, and also extinguishing products and technologies, would be welcome.

There is an urgent need and wide demand\(^\text{103}\) for non-structural standards and harmonized European recommendations focusing on a range of problems, from data collection, damage assessment and evaluation, inventory and mapping of hazards and stock at risk to creation of thematically-oriented Geographic Information Systems, warning systems and similar management tools, in order to make progress in combating natural disasters. These standards will further support the development of technical standards for prevention and mitigation of damage from individual or multiple hazards, which some national standards have already started to provide, e.g., the Bulgarian code on construction in landslide prone areas (Delev, 2006).

Standardization should be based on well-defined, well-targeted research.

5.9. **Resources & equipment**

Protection of cultural heritage from natural disasters is an interdisciplinary task, with all the typical problems of complex, interdisciplinary tasks. However, both financial/material and human/intellectual resources are available for this difficult matter. There have been examples of successful international or national agreements and partnerships in support of mutual understanding between emergency bodies and cultural heritage managers or conservationists.

As far as financial support is concerned, in addition to EUSF (described in detail in Chapter 4), there are other financial sources available for effective natural disaster and climate change impact prevention, and for mitigation measures related to cultural heritage. They include the European Regional Development Fund (ERDF), the Agricultural Guidance and Guarantee Fund (EAGGF) and the LIFE Financial Instrument for the Environment.

Substantial reserves for financial support for both preventive and remedial measures lie in the new European insurance policy toward cultural heritage and natural disasters. Again, non-market value assessment and damage valuation established as a standard procedure would be a major contribution, as would tools for insurance rates based on probabilistic models of disaster occurrence.

National emergency services operate special rescue teams, e.g., the Czech Urban Search and Rescue Team (USAR). These are specially equipped, trained and able to operate under various conditions. They may be used for special operations and tasks, and the core units may be supplemented by specialists. The teams can be transported by land or by air, and the logistic operations can be supported through cooperation with the Ministry for Foreign Affairs, when a team is sent abroad. For special cultural heritage safeguarding tasks the units need to be equipped with relevant facilities, which do not necessarily require permanent storage. Here, well-negotiated cooperation with permanent laboratories and with research, testing and university institutes may be a good and cost-effective solution. The activities are coordinated in cooperation with MIC and bilaterally with the corresponding ministries.

Within the programme for building a European research infrastructure, it might be possible to support laboratories equipped with mobile devices that can serve in emergency situations as specialised “fleets”, while in quiet periods they are used in research or restoration tasks related to the conservation of non-renewable resources. As has been previously mentioned, it is also very important to include climate change issues, which have the character of a long-term continuous natural hazard with fatal consequences for many elements of cultural heritage. Measures against the degrading effects of climate change are similar in nature to those used in other types of natural disaster.

5.10. **Cross-border cooperation**

European cross-border cooperation in protection of cultural heritage threatened by natural and man-made disasters is not supported by any specific legal document. The emergency cooperation functions quite effectively within general schemes, as shown in numerous examples from recent

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104 In January 2004 the Italian Ministry of Home Affairs (National Fire Service Department) and the Santa Maria della Scala Foundation (representing Siena Municipal Administration) signed an agreement aimed at improving the understanding of fire protection issues relating to the cultural and historical heritage. (Maxwell, 2006).
disasters. This cooperation is mostly based on bilateral or multi-lateral agreements. For example the Czech Republic has such agreements with all neighbouring countries, and with Hungary. The rescue teams in individual countries are approved to operate on the territory of the cooperating country, and to cross the border in a simplified regime. Requirements for assistance are decided on the regional level only, and the state coordination unit is then informed. The agreements further define joint training sessions, exercises, exchange of information, use of radio, repairs to damage, use of aircraft, etc.

Such agreements also operate between EU member states and non-member states, e.g. Bulgaria – Greece – Macedonia – Turkey on cooperation in combating forest fires (Delev, 2006).

In general cross border rescue activities, there is no evidence of administrative barriers that hinder cross-border cooperation.
Protecting the cultural heritage from natural disasters
6. PRIORITIES FOR ACTION

6.1. Integrated approach

6.1.1. Introduction

Collaborative protection of cultural heritage from natural disasters requires that integrated multi-hazard risk management be included in EU policy, supported by three dimensions of integration: horizontal integration of policies and financial instruments, horizontal integration of various geographically and physically diversified aspects of hazards and risks, and vertical integration of local to EU level managements.

Natural hazards cannot be simply understood as environmental phenomena, because of their significant socio-economic impact. Their impact on cultural heritage and on combating adverse effects brings together various institutions and stakeholders, and involves many fields of action, e.g., cultural heritage protection, civil protection and even security policy. Here, social, cultural and economic cohesion is closely linked to territorial cohesion, and this should be reflected in EU policies. Spatial planning plays an important role in risk management related to natural hazards.

In addition, preventive measures to protect cultural heritage from natural hazards should be balanced by post-event efforts to respond to disasters, and by rescue and recovery measures. This in practice involves developing an appropriate strategy for vulnerability reduction. In the case of immoveable cultural heritage, this means establishing or developing mechanisms to control human and societal activities in ways that reduce the risk of damage. Here, spatial and urban planning should be seen as key instruments.

It is important to recognize that public policies to mitigate the impacts of extreme events differ in their approaches to risk reduction and vulnerability reduction. Vulnerability reduction is a human rights issue (Sarewitz et al., 2003) and therefore also a political issue. Moreover, vulnerability has various dimensions – economic, social, cultural, ecological – which may be weighted in many ways, all of which should be addressed when attempting to reduce vulnerability to natural (and technological) hazards.

The EU is relatively well prepared to sustain some types of hazards – namely flood, fire and earthquakes – where various governance, financial and operational instruments have been developed to salvage lives and vital infrastructure. However, no adequately prepared and agreed measures exist for protecting cultural heritage from damage and loss due to natural disasters. Appropriate steps should be taken to improve this situation and minimize gradual loss of cultural heritage.

6.1.2. Research

The previous pages clearly show that there has been little research into cost-effective protection of cultural heritage from natural disasters, despite the considerable number of projects concerned with natural hazards as phenomena. This tendency is apparently set to continue in the 7th FP, where numerous fragmented research areas related to natural disasters are planned, but without any clear linkage to cultural heritage issues. The only envisaged task linking cultural heritage and disasters is mono-disciplinary, in the area of materials.
As has been pointed out in this report, only research that integrates natural and technological sciences with social and economic studies will produce results that can be further developed into cost-effective measures. There is a need to set up a specification for such Integrated Projects. This specification should be based on a detailed evaluation of research results achieved within ongoing or terminated projects, and should take into account the identified problems, shortcomings and deficiencies. It seems useful to concentrate efforts separately on non-structural (system) and structural (physical protection) measures, the latter being advantageously investigated in close cooperation with the European Construction Technology Platform, especially its Cultural Heritage Focus Area.

Salvaging cultural heritage items from natural (and man-made) disasters will also be integrated into the themes of EU security research.

For the state-of-the-art and best/bad practice evaluation stage, international networks or forums should be set up. These should be open to partners from third countries all over the world, especially to international bodies and institutions working in the field. Such widely-based open platforms should seek joint financial support from the EU and from cultural heritage foundations.

6.1.3. Non-structural measures

EU policy initiatives on cultural heritage protection against adverse effects of natural disastrous events need to be supported by enforcing instruments on all government and management levels.

It is necessary to act without delay. What policy options are available on the highest EU level? In the consultants’ opinion, there are three non-binding options, i.e., i) Commission Communications, ii) an EU Action Plan on protecting cultural heritage from natural disasters, and iii) the Open Method of Coordination[^105], and there is one more powerful option, i.e., a new directive. Some actions can be taken by amending new directives that have already been prepared, namely those described on page 41 (the directive on the assessment and management of floods, and the INSPIRE directive). The optimum solution is probably a combination of suitable instruments and exploitation of the directives that have already been prepared. The OMC approach might have some advantages, since natural hazards and associated risks occur in various combinations over various different regions or clusters of regions across borders, and measures can gradually be developed and coordinated[^106]. On the other hand, a new directive would have the strongest enforcement power, and it would be a highly reliable tool for effective harmonization of coordinated efforts and actions. Moreover, it would provide substantial support for instruments that have already been established, namely CCPM and its MIC, and it would enhance the importance of some relevant ongoing European programmes, (e.g. GMES, Galileo).

In the area of legal measures, it would be very helpful to define and explain some terms in existing legal documents where “natural heritage”, “environment” and similar terms are used and can be interpreted as referring also to cultural heritage issues. Definitions of buildings of public interest, e.g., schools, hospitals, etc., which are usually placed in such a category in national standards for seismic protection and cultural heritage, can also be redefined and re-explained.

[^106]: The OMC application for civil protection and natural disasters issues was recommended in 2004 by I. von Homeyer et al.: Exploring the EU Open Method for Cooperation. Paper commissioned by the Austrian Min. of Agriculture, Forestry, Env. and Water Management. [http://eucenter.wisc.edu/OMC/Papers/Other/environment.pdf](http://eucenter.wisc.edu/OMC/Papers/Other/environment.pdf)
With the use of such explanatory notes, all relevant EU documents and policies concerning civil protection can be amended to include cultural heritage. Problems associated with business risks should also be treated here.

The non-structural measures can be implemented to deal with several of the deficiencies identified in the report. First of all, an accurate information system about cultural heritage at risk needs to be created and kept up-to-date through regular monitoring and recording of changes. The GMES system should be adapted for this purpose, and the relevant measures should be adopted in the GALILEO system.

Standards for harmonized mapping of cultural heritage and natural hazards need to be issued, as well as standards for the establishment of a purpose-built GIS (Geographic Information System) for protecting cultural heritage against adverse effects of natural disasters. International and national research projects should work on standards defining and regulating structural measures for protecting cultural heritage from the impact of natural disasters.

A Commission recommendation with a disaster planning guidance document should be issued. Planning is a major element in the cultural heritage protection system, and losses of European heritage can be reduced by a planning methodology that ensures good European cooperation in emergency situations. Advance planning significantly shortens the time necessary for international interventions. The principles of disaster planning have been summarized, e.g., by Taboroff (2000):

1. Disaster planning for a cultural heritage site should be conceived for the whole site, including its buildings, structures and contents, and landscapes.
2. The planning should integrate relevant heritage considerations within a site’s overall disaster preparedness and mitigation strategy.
3. Preparedness requirements should be met in heritage sites by means that will have least negative impact on heritage values.
4. Documentation of heritage sites, their significant attributes and any history of disaster response is the basis for appropriate disaster planning.
5. Maintenance programmes for historic sites should take into account a cultural heritage at risk perspective.
6. Property occupants and users should be directly involved in the development of emergency response plans.
7. During emergencies, securing heritage features should be a high priority.
8. Following a disaster, every effort should be made to ensure the retention and repair of structures or features that have suffered damage or loss.
9. Conservation principles should be integrated where appropriate in all phases of disaster planning and mitigation.

Insurance systems need to be reformed to ensure that cultural heritage is much better covered than is now the case in most European countries, and recent adverse movements in the insurance market need to be resisted. In this respect, lessons from the successful US Disaster & Federal Funding for Cultural Institutions should be analysed and learned from.
6.1.4. Structural measures

Structural measures vary significantly according to the natural hazard, the cultural heritage typology and the location. Several guidelines have been prepared within recent EC supported research projects, and further useful data has been collected following recent disastrous events. Best/bad practice evaluation and the creation of an integrated guiding document would also need an international team of professionals, sufficient time and an agreed methodology for assessing cost effectiveness.

Generally, any recommendation for protecting cultural heritage objects should emphasize three elements: i) regular inspection and regular maintenance, ii) careful repairs to damaged or deteriorated structures, so that they will withstand possible extreme loads in emergency situations, and iii) strengthening of structures with insufficient resistance, as revealed by observed behaviour under high loads or by structural analysis.

In special situations, it is useful to supplement these measures by monitoring or by early warning systems, which may be equipped with automatic fire-extinguishing systems. These systems should be supported by appropriate standards or guidelines agreed with conservation bodies.

6.2. Resources

CCPM has a database recording information on the available capacities of national civil protection authorities. This database should be extended to include the names and abilities of professionals, and also equipment available for rescuing cultural heritage in emergency situations.

Cultural heritage specialists should take part in exercises on salvaging cultural heritage. This will help the Member States to reveal weaknesses or gaps in the system. Present measures facilitating cross border interventions seem to be adequate, and they facilitate pooling of personnel and equipment resources when there is cooperation in regions that are not identical with local emergency service regions. Some problems might arise when conservation specialists are working abroad and conservation approaches and methodologies are not mutually known and agreed. However, there is no experience available in this matter.

Mobilization of financial resources for rescuing cultural heritage would be substantially improved by the adoption of a suitable European insurance policy.

6.3. European coordination & harmonization with foreign affairs

CCPM and its operations centre, the Monitoring and Information Centre (MIC), fulfil a coordination function for international assistance. CCPM also acts as an information centre, collecting data and distributing regular updates to all participating countries. It works toward enhanced preparedness and acts as an intermediary in connecting civil protection and intervention by the armed forces. The Common Emergency Communication and Information System (CECIS) ensures efficient information sharing between MIC and the national contact points.
MIC has demonstrated its operability and effectiveness during recent disasters in Europe. Recent proposals\(^{107}\) to reinforce the analytical and assessment capacity of MIC deserve support, because they offer a very promising way to enhance the capability and actions of MIC in the area of cultural heritage protection. The consultants attach special importance to the possibility of improving disaster prediction and early warnings, as well as \textit{in situ} assessment and coordination activities, which all are key factors in the rescue of cultural heritage assets. The availability of a more stable cadre of well-trained and experienced personnel with powerful equipment will certainly increase the effectiveness of emergency measures and actions, which could also be utilized outside the EU, in the sense of the Barnier report. However, the relevant documents, cited in paragraph 4.1.2, do not contain references to cultural heritage. MIC representatives should attempt to rectify this situation.

The Barnier report does not discuss issues of cultural heritage protection, as it focuses on humanitarian issues. However, the very well elaborated and clearly presented proposal for a European civil protection force – “Europe Aid” - is well structured to include modules on protecting and rescuing cultural heritage in emergency situations. In this way, the European civil protection force initiative further increases the capacity to safeguard cultural heritage from natural disasters.

Cooperation among EU Member States in combating natural disasters and in acts of solidarity in recent emergency situations has borne witness to the added value offered by the European Union. The foreign activities suggested above make this added value more visible. The consultants believe that amendments to humanitarian and civil protection aid, integrated with interventions to safeguard cultural heritage, will not only raise the visibility of the EU, but will also substantially improve the durability and sustainability of the added value of the EU and of “Europe Aid” worldwide.

6.4 Priorities

Development of European policy, legislative and institutional frameworks for protecting cultural heritage from disaster risks and impacts. This involves strengthening CCPM with wide-ranging cooperative support from the individual Member States.

Integration of protection of cultural heritage into European strategies and operational procedures, to ensure timely and effective rescue in emergency situations.

Development of EU capacity-building plans and programmes for meeting present and future requirements for cost-effective protection of cultural heritage from natural disasters.

Allocation of EU resources for the development and implementation of measures to protect cultural heritage from natural disasters.

\(^{107}\) See p.30 (4.1.2 Monitoring Information Centre) and relevant documents, namely COM (2005) 137 (“Improving the CCPM”) of 20.4.2005) where several important amendments are suggested, including : i) a modular approach which enables involvement of cultural heritage specialists in the intervention teams, ii) reinforcing analytical and assessment capacity, particularly MIC capabilities and actions, e.g. on site assessment and coordination or early warning capability. This report should be sent to the MIC representatives with a request for relevant cooperation.
Mobilisation of MS Governments to demonstrate strong political determination and willingness to promote and integrate cultural heritage protection measures into national policies and programmes.

Raising public awareness and promoting community participation in protecting cultural heritage from natural disasters by adopting specific policies, managing volunteer resources, attributing roles or responsibilities, and providing education and easily understandable information on cultural heritage disaster risks and protection options.

Identification and mapping of cultural heritage stock at risk and natural hazards, followed by the development of periodically updated vulnerability maps for decision makers, the general public and communities at risk.

Development of early warning systems centred on people and cultural heritage, integrated into relevant policies, decision making processes and emergency management systems at all levels. Systems that provide timely and understandable warnings, that support effective rescue operations, and are subject to regular testing and performance assessment.

Support for integrated scientific and technological research, including the establishment of research infrastructures that will enhance knowledge about the impact of natural disasters on historic materials, structures, and territories and that will help to develop cost-effective protection and damage mitigation measures. Weather and climate change phenomena are considered to be an integral part of the threat of natural disasters to cultural heritage.

Establishment of databases on natural hazards, disaster impacts and losses. Development of monitoring systems for recording changes in cultural heritage stock at risk.

Development of standards for assessing the safety of architectural heritage subjected to excessive loads during exceptional situations.

Development of structural measures and practical guides to protect cultural heritage from natural disasters, including timely maintenance and strengthening interventions.

Inclusion of disaster risks for cultural heritage in relevant education curricula at all levels, and the establishment of channels to provide information for young people and children on integrated protection of cultural heritage in emergency situations.

Collection, digitization and diffusion of the results already collected in countries (Italy, Greece, Turkey, etc.) with recent experience of natural disasters. Experience gained through investigations, critical reviews of repair techniques, modelling and prevention measures.
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Secours (France), BCEOM (France/Bulgaria), Environment Agency (UK), Ministry of Transport, Public Works and Water Management (The Netherlands), 2005.


Protecting the cultural heritage from natural disasters
ANNEX - 1 LIST OF CONSULTED PROFESSIONALS & BODIES

Civil Protection Service
Mr. Attilio Dannibale, Civil Protection Department, Presidency of Council of Ministries, Rome, Italy
Mr. Jaroslav Hüttl, Dipl.Ing., Emergency Fire Brigade, Specialist on Cult.Heritage, Czech Republic

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Mr. Konstantin Delev, Professor, University of Forestry, Sofia, Bulgaria
Mr. Miloš F. Drdácký, Assoc.Prof., Head, ITAM v.v.i. Czech Academy of Sciences, Czech Republic
Mr. Luca S. Lanza, Professor, University of Genoa, Italy
Mr. Jaroslav Pollert, Professor, Czech University of Technology in Prague, Czech Republic
Mrs. Ana Virsta, Assoc. Professor, University of Bucharest, Romania

Landslides
Mr. K.-J. Bakker, Delft University of Technology, The Netherlands
Mr. P. Canuti, Dr., Dpt. di Scienze della Terra, Universita degli Studi di Firenze, Italy
Mr. Jordi Corominas, Professor, Dpt. de Ingenieria del Terreno, ETS Ingenieros de Caminos, Canales y Puertos, Universita Politecnica de Catalunya, Spain
Mr. Felix Darve, Professor, l'Institut National Polytechnic de Grenoble, France
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Mr. Minna Karstunen, Professor, (temporarily University of Strathclyde), Finland
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Mrs. Suzanne Lacasse, Norwegian Geotechnical Institute, Norway
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Protecting the cultural heritage from natural disasters

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Mr. Zbigniew Zembaty, Professor, Faculty of Civ.Eng, TU Opole, Poland

Dipartimento della protezione civile, Italy

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Mr. Stanislav Pospíšil, Dr., Deputy Head, ITAM v.v.i. Czech Academy of Sciences, Czech Republic
Mr. Christian Sacré, CSTB Jules Verne Climatic Tunnel, Nantes, France
Mrs. Christane Schmuckle-Mollard, Chief Architect of Historic Monuments, Paris, France

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Mr. Konstantin Delev, Professor, University of Forestry, Sofia, Bulgaria
Mrs. Monika Hajpal, Dr., Laboratory of building physics, TU Budapest, Hungary
Mr. Sjur Helseth, Directorate for Cultural Heritage, Oslo, Norway
Mr. Kristian Hertz, BYG DTU, Lyngby, Denmark
Mr. Christian Karlsson, National Property Board, Denmark
Mr. Stewart Kidd, Loss Prevention Consultancy Ltd., United Kingdom
Mr. Wolfgang Kippes, Director, Schönbrun Castle, Vienna, Austria
Mr. Stefano Marsella, Ministerio Interno, Dipartimento Vigili del Fuoco, Roma, Italy
Mrs. Maire Mattinen, National Board of Antiquities, Helsinki, Finland
Mr. Ingval Maxwell OBE, Director, Historic Scotland, United Kingdom
Mr. André de Naeyer, Professor, Antwerpen University, Belgium
Mrs. Marideja Petrova, Head of Centre for sustainable value, Ohrid, Macedonia
Mr. Simon Singer, Direction de la prevention et de la protection, Mairie de Paris, France
Mrs. Kerstin Westerlund, National property board Sweden
Mr. František Wald, Professor & Head, Czech Technical University in Prague, Czech Republic
Mrs. Irena Wasserman, Dr. National Building Research Institute, the Technion, Haifa, Israel
Mr. Dieter Wohltan, Dr., Funk International, Austria

Research

Mr. Michel Chapuis, Principal Administrator EC DG Research Directorate I “Environment”
Mr. Denis Peter, Science Programme Officer Natural Disasters, EC DG Research
All coordinators of research projects dealing with natural disasters and supported from the 5th and 6th Framework Programmes were addressed with a special questionnaire. Only few answered:
Mr. James C. Bathurst, Professor, Newcastle University, United Kingdom
Mr. Kyriazis Pitilakis, Professor, University of Athens, Greece
Mr. Jiří Zahradník, Professor, Charles University of Prague, Czech Republic
International organizations

Mr. Dinu Bumbaru, ICOMOS Secretary General
All representatives of the International Committee Blue Shield were addressed with a special questionnaire. Only three answered:
Prof. Krste Bogoevski, President of Macedonian National Committee ICBS, Institute of Ethnology and Anthropology, Skopje, Republic of Macedonia
Ms. Robyn Riddett, Associate Director Lovell Chen Architects & Heritage Cons., Secretary of ICOMOS International Scientific Committee for Risk Preparedness
Dr. Jana Součková, Director, President of Czech National Committee ICBS, National Museum – Náprstek museum of Asian, African and American cultures, Prague, Czech
Protecting the cultural heritage from natural disasters
ANNEX 2 - ITALIAN EXPERIENCE AND APPROACH

The vulnerability of the huge cultural, historic and artistic heritage in Italy to the risks associated with flood waters was brought home to public opinion and to researchers during the floods in Florence in 1966. The images of Cimabue’s crucifix 80% damaged, and of the frescoes by Paolo Uccello and Botticelli, are still alive for us, together with the 1400 works of art and documents damaged in the Museum of Santa Croce and 1500 others in the National Library. The event was also associated with 18 casualties, 20 000 people made homeless, and financial losses estimated at 60 million dollars in the productive sector.

Cimabue’s crucifix after the flood (1966), left, and after complete restoration (2006), right.

Many other flood events have threatened the historic and artistic heritage throughout Italy in the last 100 years. Nearly 7500 such events were surveyed and catalogued by the Italian CNR within the AVI Project, which concluded in 1996 with the production of a synoptic map of flooded sites.

Florence flood in 1966 (left), a damaged church in Northern Italy (right).

However, in spite of the shock following the Florence episode in 1966, only a limited amount was done in Italy in terms of effective and extensive defensive measures to protect cultural heritage against flood threats. Even in very exceptional and well-known cases such as Venice, where risk awareness is well established, implementation of the designed structural solutions still encounters enormous difficulties and political problems.
References


Problems of safeguarding movable and immovable Cultural Heritage (further CH) in Italy have nevertheless begun to be taken into account since the Florence and Venice floods in 1966. The Florence flood caused enormous damage to movable CH, particularly library documents and wooden objects. On that occasion, there was large-scale international collaboration from volunteers to recover the damaged objects. Considerable help was given, but this episode also revealed the lack of preparation of the volunteers in the specific field of recovering cultural heritage. The same lack of knowledge was also revealed in the army, the fire services and others involved in the operations. Since 1966, safeguarding the Cultural Heritage has become one of the main tasks of the Civil Protection Department at the Italian Council of Ministers.

In 1980, after the Irpinia earthquake, a special Superintendency was set up, and it started its work just five months later. In 1986, the first National Conference was organized with support from the Ministry of Cultural Properties to study emergency interventions to protect the library and archive patrimony from 1966 to 1986. In 1994, after the Piemonte flood, the Civil Protection Department collaborated with the Central Institute for Restoration (of the Ministry of Cultural Properties) to recover the damaged books of the Fondo Pavese in St. Stefano Belbo. In 1995, a National Conference was held in Venice under the title “Volunteers and Institutions for Cultural Properties”. In 1996, a Conference was held in Florence on “National planning for emergencies in the Arno and Serchio rivers area: Civil Protection and defense of Cultural Properties in the areas at risk”. The Conference was followed by a direct application of collaboration in the Arno river basin.

In 1997, after the Umbria Marche earthquake, for the first time in Italy two Commissioners were nominated by the Ministry of CP for the two regions. In 1998, the Council of Ministers established Section VIII: Defense of Cultural Heritage from natural and man-made risks. In 1999, the Working Group for the protection of CH from natural risks (G.la.be.c.) was set up. It was composed of representatives of the Civil Protection, the Ministry of CH and the National Corps of Firemen. Practical applications of collaboration were carried out in various exercises on monumental buildings in Pisa, Catania, and, on an international level, at the archaeological site of Somma Vesuviana. In 2006, templates for damage surveys for palaces and churches were also approved and published on the website of the Civil Protection Department at the Council of Ministers.

References


Protecting the cultural heritage from natural disasters
1. Introduction

The Bulgarian Monuments of Culture Act states that cultural heritage (CH) objects include movable and immovable products of human activity, which document material and learning culture and are of scientific, artistic or historical importance or concern historic events.

All CH objects in Bulgaria are under the general supervision of the Ministry of Culture. Movable CH items like paintings, sculptures, manuscripts, books, coins, arms, tools, carts, costumes, furniture, etc. are under direct management of the Ministry of Culture, which is also responsible for organizing exhibitions abroad. Immovable built CH objects (public/residential buildings, monasteries, temples, cloisters, castles, bridges, towers, etc.) are under technical supervision of the National Institute for Monuments of Culture.

In the case of natural and human disasters, a newly established Ministry of Calamities and Failures is responsible for state policy in the field.

2. Earthquake vulnerability and resistance

The Bulgarian territory is part of the Mediterranean (or Trans-Asian) seismic region where, according to statistical data, 15% of all earthquakes on the planet occur.

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National seismic statistics have been kept since 1901, but there is no purposely-collected data on earthquake damage/failure affecting CH objects. As a rule, after an earthquake of destructive magnitude the national Seismic Design Code and the Instructions for Post-seismic Repair and Strengthening are revised and improved on the safety side, on the basis of an analysis of the damage and of structural behavior.

The Bulgarian Seismic Design Code includes no special provisions on the structural safety and stability of built CH objects, except a partial safety factor of importance $\gamma_{imp}$. The seismic Code states that for “monuments, museums and other facilities of national importance” (classified as
category A) the seismic design load should to be calculated with the partial safety factor \( \gamma_{\text{imp}} = 1.5 \), which in theory means 50 % plus on the safety side. For load-bearing structures of monuments and museum buildings of local importance (category B) \( \gamma_{\text{imp}} = 1.0 \) is to be used (i.e., as for other buildings). When a substantial part of the primary load-bearing members is replaced (sometimes together with re-arrangement of the structural scheme) the designer is required to demonstrate that the mechanical resistance of a CH object under reconstruction and/or strengthening satisfies the Code requirements for seismic resistance. Each year there are several earthquakes with a 3 – 5 intensity level, causing slight damage even to buildings with modern structures.

It is natural that tall CH objects have been damaged due to seismic activity. A sad example is the temple of the Holy Trinity in Svistov (ancient Roman Sistova, on the bank of Danube) – a masterpiece of Bulgarian renaissance architecture. The temple was seriously damaged, but survived and was repaired (seismic action from an earthquake in southwestern Romania). Masonry cloisters with insufficient or inappropriately detailed corner bonds usually crack vertically, and are strengthened with horizontal steel tension ties (a typical example - Lozen monastery, near Sofia). In August 2001 an earthquake in south-eastern Bulgaria (epicentre intensity \( I_o = 4.3 \)) caused damage to many buildings, including the CH temple in the village of Cabile.

![Figure 1 Seismic regions in Bulgaria (MSK scale of epicenter intensity)](image)

### 3. Landslides

There are 950 active landslides in Bulgaria (see Figure 2), about 350 in settlements and 300 adjacent to the state road network. Landslide activity is kept under observation by the Permanent Commission for Disasters and Emergencies at the Bulgarian Council of Ministers, and also by the Civil Protection Service. Substantial national funds and occasionally funds from abroad are expended in order to stabilize or stop this disaster phenomenon.

Since 1995, intensive landslide measures have been taken along the Black Sea coast, in reaction to a practically national-scale disaster. A substantial number of residential and recreational buildings with modern structures, located in resort areas, were destroyed. The south-to-north panoramic road connecting settlements and resorts between Varna and Cape Kaliakra was ruptured in sections, and traffic had to be diverted to a by-pass road 30 km inland. The seaside
village of the world-famous opera singer Nikolai Gyaurov (adjacent to the road) was totally destroyed and fell into the sea.

In 1999, a battalion of the US Army Corps of Engineers, together with Bulgarian troops, carried out substantial construction works along the Black Sea coast in an attempt to stop further development of the most active and dangerous landslide sections, and to demonstrate the joint actions that can be taken in the event of a natural disaster.

A specially-created department at the Ministry of Regional Development and Housing Policy (former Ministry of Construction) coordinates practical activities against landslides, and is also responsible for a survey of landslide technology, together with a mitigation policy. Since July 3rd, 2001 the "Regulation for the design of geo-protective construction works, buildings and facilities in landslide areas" has formed part of Bulgarian technical legislation. This is the first normative document in this field in Europe.

The major difficulty is that 90 % of the landslides are in seismic regions, which means that two accidental design situations need to be taken into account simultaneously. Beside natural landslides, Bulgaria also suffers from landslides due to human activity - because of bad, old or lacking drainage and canalization systems in small towns and villages on mountain slopes. However, these local landslides do not at the present time affect CH objects.

The Department of Strategies, Accession Programs and Projects at the Bulgarian Ministry of Environment and Water is working on foreign-aided projects and programs against landslide development from the viewpoint of environment damage. However, these programs do not include specific measures concerning CH objects in landslide regions.

An example of built CH landslide damage is the famous Preobradjenski Monastery, near the ancient Bulgarian capital Turnovo, which was partially covered up and destroyed as a result of sudden landslide activity.

4. Fires

4.1. Building Fires

The vulnerability of CH buildings to fire hazards depends on the following considerations: a) the presence of a substantial number of combustible exhibition items (temporary fire load) and of interior combustible materials (i.e., high value of the permanent fire load); b) the operation of
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supplementary premises - workshops, laboratories, stores; c) the existence of service systems (electrical, conditioning, etc.), that help fires to spread; d) the existence of souvenir and food shops that pose an additional fire hazard; e) an abundance of timber structures; f) disobedience of the fire safety rules by visitors/employees; g) the extremely high risk when repair and restoration work is in progress.

It should be emphasized that the fire dynamics and fire temperature regimes in CH buildings are more intense and more severe than the standardized fire parameters introduced in structural fire design codes. On the basis of an investigation, procedures should be established for predicting fire development and fire hazard parameters in built CH objects, and precautionary measures should be taken and fire safety measures introduced.

As an example, in January 2000 a whole CH district in the southern town of Gotze Delchev burned out because the fire service could not make its way through snow cover in a mountain pass. Another example: on July 23rd, 2001, the 200-year old Madjarova house (timber structure) in Koprivstiza, a masterpiece of Bulgarian Renaissance architecture, burned out totally in one hour because there was no local fire station, although the town as a whole had been declared a National CH Reserve. The famous Bachkovo Monastery, at the foot of the Rhodope Mountains, also caught fire, but fortunately fire-fighters were only 30 km away. The national fire service is short of funds and equipment, and cannot maintain the necessary permanent fire points to cover all historic settlements or CH objects.

4.2. Forest Fires

Since 1990 the number of forest fires in Bulgaria has grown considerably, with a big increase in criminal arson. The fire statistics are very grave - a total of 20 000 forest fires have broken out. About 1750 km² of protected territory forest areas in the Rila, Stara Planina, Rhodope and Strandja mountains, with specific plantations and animal populations, have burned out, including sites registered in the UNESCO Red Book (e.g. the Parangalitza and Srebarna protected territories). According to US satellite data, one half of the forest regions in Bulgaria have been lost due to fires.

The government has implemented a long-term restoration program, but it will take decades to recover the forest plantation and population.
Criminal forest fires are inspired by private trade companies. The aim is to buy and export raw material at a low price, claiming that a burned forest provides timber of poor quality. After 306 criminal forest fires had been set within a period of three days in August 2001, the Bulgarian Government decided that logging in burned forests is to be carried out only by the state forestry authorities, which are also responsible for fire surveys.

There is a European program to help to design and construct fire-observation towers in planted areas. Several army helicopters are to be modified in order to provide fire-fighting capabilities in forest areas.

5. Floods

Floods occur on Bulgarian territory due to intensive rain, snow/ice melting, partial or total destruction of dam structures (there are 30 large dams and 600 small dams in Bulgaria). The valleys and lowlands along the Danube, Maritza, Toundja, Rositza and Mesta rivers are flood-prone areas.
In March 1942, due to a rise in the level of the Danube, a water column 1.5 to 2 metres in depth covered the streets of Vidin. Since 1950, the Bulgarian Government has realized and maintained a program to stabilize the bank of the Danube, in order to protect adjacent settlements and agricultural lands. The engineering system (anchored retaining walls, canals, earth banks, etc.) has proved to be effective, and the flood risk along the Danube has been minimized. In the late 1990s, high spring water slightly damaged the house in Vidin where the world-famous impressionist Jules Paskin was born. The disaster was mitigated by the local civil protection service.

In the spring and summer of 2005 there were unusually heavy rains. Not having been cleaned out for decades, the river and canal beds could not contain the water flows, and substantial areas were flooded. Many buildings were totally ruined, and bridges were swept away. Dams overflowed and added to the intensity of the disaster. Domesticated and wild animals were drowned. The disaster also claimed human lives. Railroad and automobile traffic was impossible for one month. Pollution of water sources led to restricted drinking water supplies. A number of CH built objects were also impacted. Perperikon, a unique Thracian town and castle in southwestern Bulgaria, amazingly well preserved and recently discovered by a national archaeological expedition, was heavy flooded. Several other smaller Thracian sites in the region, also of high CH value, were also destroyed.

In 2006 another substantial river flood invaded several areas along the bank of the Danube. Men and equipment from Belgium helped the local civil protection service.

High waves due to winter sea storms, tide and/or underwater earthquakes also pose a physical threat to built CH objects along the Black Sea coast (e.g., in the mid 1990s, winter waves flooded a church in the coastal town of Pomorie and also the remains of ancient Greek temples in the resort town of Nessebar).

6. Drought

In the period from 1978 to 1995 there was an extreme lack of precipitation. Water supply dams fell below the sanitary level, and wells ran dry. Water rationing was introduced almost nationwide. Many buildings, including CH objects, suffered from foundation displacement, and subsequently from heavy cracking on the upper structure.

7. Degradation of CH due to air pollution

Since 1990 extremely high levels of air pollution have affected Bulgaria, due to: i) the climatic features of this part of the Balkan Peninsula; ii) substantial concentration of industry; iii) intensive automobile traffic; iv) lack of efficient state pollution control. There is also trans-border air pollution due to Romanian industry along the left bank of the Danube. Most of the built CH objects are situated in settlements. Winter creates powerful inversions and fogs, which help the pollution to persist in the atmospheric layer adjacent to the ground surface. The continuous hot period in summer increases dust pollution. The rise in temperature in the central part of the cities (areas with a high concentration of CH objects) inflicts convective circulation resulting in winds blowing towards the center, where vertical air draughts are predominant. In this way, pollutants from human activity are transferred from the periphery, where industry is concentrated, towards the settlement centers. Although there is little industrial activity in the town centers, the pollution of the atmosphere layer adjacent to ground surface can
be higher than the allowable limits due to transfer from the periphery and due to intensive traffic (in the period from 2000 to 2006, the number of personal vehicles grew by 1 000 000).

Air pollution is a public disaster. The industrial smoke level is sufficient to cause acid pollution of rainwater. Particles and non-specific air containment lead to increased corrosion in metals, building materials and even in clothing. Fine-grained particles settle on walls, ceilings, curtains and furniture. A minimum concentration of gaseous hydrogen sulfide takes the color away from surfaces treated with lead-based paints. Limestone corrodes under attack from abnormal levels of carbon dioxide (CO$_2$), and when there is high air humidity carbonic acid is created. Facade degradation due to smoke and soot is inevitable. It should be emphasized that there are no national statistics on CH degradation due to the deteriorating environment.

The Beautiful Bulgaria II Project is being executed at a total cost of EURO 4 500 000. The aim is to carry out façade/roof repair and protection against environment degradation on 1350 built CH objects. Examples of successful activities in this project include the birth-houses of the world-famous opera singer Boris Christov and the national poet Ivan Vazov, the Military Club in Sofia, the St. Ivan Rilsky National Seminary, etc.

With financial assistance from UNESCO, the world-famous Rider of Madara, a 1200-year-old stone bas-relief (in Shoumen, northeastern Bulgaria) has been strengthened and covered with a transparent waterproof coating that is resistant to atmospheric destruction and protects the basic rock formation. A drainage system to remove surface water has also been executed.

Construction work, uncontrolled use of forest products (mushrooms, fruits and herbs), animal and reptile poaching cause further damage to planted ecological systems. There has been no scientific assessment of natural CH degradation processes, but it is clearly necessary to provide unified management of the protected territories in order to improve the environment and to decrease degradation. The European ecological program Nature 2000 came into action on January 1$^{st}$, 2007, providing special requirements and special preservation of protected territories.

9. Wind effects

Windstorms (and even tornadoes) with a velocity up to 120 km/h occasionally invade the country, destroying weak structures and even solid buildings. In 1998, a windstorm lifted and destroyed the steel sheet roof insulation of Sofia University (the building was a gift from the American Carnegie Foundation in the early 1920s).

10. Traffic seismicity

The drastic growth in number of the motor vehicles and also the intensive traffic of heavy-loaded trucks has resulted in seismic action on CH objects located adjacent to roads. Even buildings with a modern structure have been disastrously impacted.

As an example, a tram line without rail electrometric pads induced soil vibrations which, in 1998, caused cracking and partial rupture of a wall of the CH building in which the Sofia University was founded in 1882.
11. Military conflicts

During the NATO - Yugoslavia military conflict, a number of air-to-surface missiles fell in the frontier regions adjacent to Serbia, and even in the western suburbs of Sofia, destroying several private buildings. Fortunately there were no human or CH victims. The malfunction of a missile guidance system is a probabilistic event, but this example demonstrates that there is always a threat of damage to built CH objects damage, even in a local conflict with sophisticated weapons.

12. Joint scientific and practical ventures

12.1. Landslides

A financial agreement with the European Bank of Investment for a loan for the project “Bulgaria - protection of the river banks and the seacoast against erosion and the connected landslide processes” was ratified in 1999. Since 1995, a Bulgarian-German initiative on landslide monitoring along the sea coast has been in action, with sophisticated measuring devices committed by German institutions.

12.2. Fire-fighting

Agreements have been signed with Greece, Turkey and Macedonia for mutual help against natural disasters and joint fire-fighting operations.

13. Risk assessment

The preliminary condition for comparing and analyzing risk situations and hazards is to provide the detailed geometrical and physical data necessary to carry out modeling of the structural behavior of built CH objects under the effects of natural phenomena. Such data is lacking.

14. Insurance

In Bulgaria there are no obligatory requirements for CH objects to be insured against natural or human disasters. Insurance on CH objects depends on the decision of the administration of each individual CH object. However, due to lack of funds CH objects are in practice almost never insured.

15. Computer-based general data on built CH objects

Whatever the reason for the failure, computer-based data on built CH objects requires: a) a survey to collect the geometrical parameters of the built CH objects and their primary and secondary structural members; b) a detailed in-situ investigation or model of the structural schemes; c) data on construction material properties; d) data on the actual fire load (i.e. combustible contents) - origin, properties, density, combustion and fire behavior; e) geotechnical data on the sites; f) statistics on CH failures.

The Bulgarian Internet Directory (www.dir.bg) includes CH object sites (monasteries and cloisters, bridges, caves, museums, forest territories, archeological remains, etc.), with a short historical description of each object and a characteristic photograph. Perhaps this can form the basis for a future detailed database from the architectural and structural viewpoint.
16. Research activity proposals

Possible research fields include:
a) establishment of a statistical database on the vulnerability of specific CH objects to natural disasters and failures; b) development of scenarios to simulate the effects of accidental actions, in order to predict structural behavior and to prescribe scientifically-based prevention and/or mitigation measures; c) mathematical modeling of external fire dynamics in order to establish fire precaution measures for protected territories; d) mathematical modeling of compartment fire dynamics in CH buildings with vertical and horizontal openings (air-controlled, fuel-controlled and localized fires) in order to provide temperature data for structural fire design and reconstruction (passive fire safety measures); e) investigations of material fire properties, fire simulation and fire hazard assessments; f) the development of transparent fire-protective intumescent paints and/or coatings, together with a corresponding design procedure to provide the required fire resistance periods, without changing the original appearance of CH timber structures; g) the introduction of a scale for CH building/facility structural categorization together with a damage assessment scale; h) the introduction of a special section in the National Building Fire Regulations concerning CH objects; i) the introduction of a special section in the National Seismic Design Code concerning CH objects; j) the development of a manual on the structural features of built CH objects; k) the development of a handbook for post-seismic and post-fire investigations, repair and strengthening of built CH objects.

17. Preventive measures

Seismic activity. Individual structural preventive measures can be taken for CH objects under restoration only, with obligatory built-in supplementary stiffeners. However, this makes re-design and construction difficult and expensive.

Landslides. It is technically rather difficult and economically inefficient to stabilize an individual CH object against landslide action. The only way is to execute general projects and programs for regional landslide stabilization and mitigation.

Floods. General preventive and mitigation measures for each potentially dangerous region, formulated by the Ministry of Calamities and Failures, should be followed.

Fires. Timber structures in Bulgarian built CH objects are partially protected by semi-transparent paints to upgrade and transfer the material into the group of hardly flammable/combustible (Class C reaction-to-fire). However, the required fire resistance periods cannot be achieved. Visible fire protective linings with mineral wool or gypsum-based plates are not a suitable technical solution, because the lining will change the original appearance of the CH object. Implementation of transparent intumescent coatings is a suitable way to provide the required fire resistance. The required thickness of the intumescent coating can be calculated in dependence of the section factor of the timber member.

18. Conclusion

Bulgaria is a country rich in CH objects, but until the government program for economic stabilization is fulfilled, vulnerability assessment and prevention measures for the impact of natural and human disasters on CH timber structures will concentrate on individual CH damage/failures, gradually passing toward general mitigation programs. The best hope is that, following accession to the EU on January 1st 2007, the European community will actively intervene in Bulgarian state policy on CH objects.
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Web sites – Civil Protection Service, National Fire Safety Service, Bulgarian Government, etc.
### ICBS experience in protection of cultural heritage from natural disasters

<table>
<thead>
<tr>
<th>Type of natural disaster (Select appropriate items from those listed in the letter).</th>
<th>Typical in Australia are floods, wind effects, land slides, fires, drought.</th>
</tr>
</thead>
</table>

**Country**

Australia

**Name of reporter**

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**ANNEX 4 - AUSTRALIAN EXPERIENCE AND APPROACH**

**ICBS experience in protection of cultural heritage from natural disasters**

<table>
<thead>
<tr>
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**Can you list other specialists from your country who can significantly contribute to the discussion on protection of cultural heritage against natural disasters (including email or other contact address)?**

ANCBS is relatively new so we have not undertaken any activities yet. We intend to:

- Have training for Disaster Preparedness: Response, Recovery etc. – Identify existing training exercises, formal courses.
- Promote integrated emergency response: integration of fire brigade, police, State Emergency Services, architects, curators, individual disaster plans etc.
- Raise disaster awareness among custodians of cultural property (buildings, places, collections etc.)
- Survey the level of preparedness in Australian heritage places and cultural collections.
- Internationally participate in ICOMOS ISC projects and others as relevant.
- Conduct regional training in disaster preparedness.

**List recent activities of the national ICBS related to mitigation cultural heritage damage from natural disasters in your country (or internationally). Could you kindly estimate the costs related to the damage, if possible and list references, if available.**

ANCBS will contribute to the 2006-7 ICOMOS Scientific Council project on Global Climate Change and its Effects of Cultural Heritage.

**According to the ICBS objectives would you kindly identify concrete actions which your National Committee of BS or International Committee carried out or received in recent years in relation to:**

- a) international response to threats to cultural heritage
- b) to promotion risk preparedness
- c) training experts to prevent, control and recover from disasters

**According to the methods of work of the ICBS would you kindly list concrete measures taken by your National Committee of BS or International Committee in recent years in relation to:**

- a) collecting information on threats to cultural heritage
- b) identification of resources for disaster prevention and rapid intervention

**What problems and shortcomings in protection of cultural heritage you or relevant stakeholders (responsible staff from libraries, archives, museums, historic sites, firemen, civil protection forces, technical assistance forces, specialised firms etc.) experienced. Focus on action before, during and after the disaster under discussion. Estimate the effectiveness.**

The main issue is that cultural institutions variously have their own disaster plans which do not necessarily include the response in a major disaster. When a major disaster occurs only the police and fire brigade are allowed on site until it is safe. By this time quite major damage could have occurred through
inappropriate actions e.g. too much water, unnecessary demolition of building fabric, not knowing what to save first if there is an opportunity to remove valuable items. The police and fire brigade have their own plans and procedures which do not take account of cultural heritage as a specific issue. Many regional (rural) disaster plans take account of animals, crops etc, but not heritage. Emergency organizations (police, fire brigade) do not talk to or understand curators, conservators, architects etc.

There needs to be more seamless integration and with everyone working together from the onset of the disaster. It is no good creating more damage in trying to respond to the disaster and then leaving everyone else to sort it out later.

What could improve the protection of cultural heritage against damage from the disasters under discussion on national as well as international level? Present your opinion or opinion of other professionals or managing and responsible bodies.

Comments as above.
Regional training where disaster awareness is low or where there are few funds to provide appropriate equipment. This might be applicable in the EU.
More pro-active leadership shown by ICBS: conferences, training, reports on disaster response and recovery etc. Check the outcome of the recent (September) meeting in The Hague.

Is the protection of cultural heritage against natural disaster specifically supported or guided by means of existing national instruments or guidelines issued by the national ICBS? If yes, please, list them (and, if possible, send enclosed a photocopy of the relevant articles, electronic files on a CD or at least thorough references) – in case of the absence of specific instruments, please, mention this and mention also any system measures taking care for cultural heritage before, during and after a disaster under question.

Australia is well-prepared for the regular types of natural disaster which we have annually e.g. floods, fires, cyclones, storm damage and the like. We have almost no civil commotion and no warfare (Hague Convention needs to be updated) and few earthquakes. The problem is that in all the national/state/regional disaster plans cultural heritage is not specifically recognized. It is recognized in personal evacuation plans in flood and bushfire (wildfire) prone areas – people are urged to take family photos, valuables etc.
We need to raise the profile of cultural heritage as a specific category like animals (cows, sheep, kangaroos etc.) and crops all of which are especially recognized in rural disaster plans.

What is your experience with international help, cross-border cooperation and European cooperation in protection of cultural heritage against disaster under discussion?
Very little. Other than the Australian Red Cross is interested in working with us because we are not on their radar. We can learn and train in site response from them and integrate ourselves into their teams. This would have been useful post-tsunami.

What could help to protect cultural heritage on the EU cooperation level? Your opinion about useful and reasonable measures on the EU level and integration with other international activities.
In Australia the various states and nearby countries help each other when there is a need like now with huge bushfires in Victoria and Tasmania – help is coming from New South Wales, New Zealand and California. The EU states parties could work together across borders and have similar procedures and approaches – like Medecins sans Frontiers. They could train together in advance to ensure that this would happen. Cultural heritage people (architects, curators etc.) could train with the emergency responders like in the Netherlands so that they can work simultaneously together, not sequentially, in times of disaster.

What is your experience with national and European Civil Protection Force in relation to protection of cultural heritage?
None.

Does your country have a special inventory of cultural heritage at risk from natural disasters? Do you have stock at risk maps? If yes what part of the state territory they cover?
Throughout Australia we have lists and maps showing cultural heritage places but they are not mapped for risk. We have risk maps which do not highlight cultural heritage places. There are some small Heritage @ Risk lists but they are by no means universal.

What is the role and engagement of local governments and citizens into protection of cultural heritage against damage from the disaster under discussion?
All local governments have their own disaster plans. These are not made available to the public unless
you insist – they are suspicious of one’s motives. We have a highly developed system of volunteer emergency responders particularly in rural areas (State Emergency Service, Country Fire Authority in Victoria and similar names elsewhere). The whole emergency response plan depends upon these trained volunteers being able to arrive when they are needed. Employers are generally co-operative in letting staff take time from work for this purpose. To some degree this has grown out of our rural traditions of helping each other and being self-reliant in a large country where many areas have few people. Local untrained citizens also help particularly if it is a very big disaster such as our present fires. Generally speaking in Australia if you ask citizens and governments to help in a disaster they will do so immediately.

**Can you identify the most vulnerable cultural heritage objects (movable and immovable, including landscape and archaeology) in your country in relation to the disaster under discussion?**

Not readily. Most places and objects have a degree of protection by virtue of location and/or management.

**How the citizens, minorities and intangible heritage have been impacted by the disasters under discussion?**

Many citizens lose their homes and properties each year due to natural disasters. For them the loss is great. Sometimes a heritage place is lost. We do not have minorities such as a whole cultural group which might be threatened or impacted upon. Those groups in dangerous areas usually have a degree of protection – early warning, evacuation etc. We have no comment on intangible heritage.
Protecting the cultural heritage from natural disasters
ANNEX 5 - EXAMPLES OF DAMAGE TO CULTURAL HERITAGE

FLOOD

**The Central European Flood in 2002**

Between 1998 and 2004, Europe suffered over 100 major floods, including the catastrophic floods along the Danube and the Elbe in 2002. These floods caused some 700 fatalities, the displacement of about half a million people and enormous economic losses. The flood events in the summer of 2005 in Austria, Bulgaria, France, Germany, Romania and elsewhere, pushed these figures even higher. The flooding in central Europe in the summer of 2002 caused considerable damage. The cost in human terms and the damage to infrastructure and to the natural and cultural heritage were particularly severe in Germany (EUR 15 billion), Austria (EUR 2 billion), the Czech Republic (EUR 2 to 3 billion) and Slovakia (EUR 35 million). The severity of the threat of floods is illustrated by the fact that most of the 250 World Bank supported projects, mainly in non-EU countries, have addressed floods.

The 2002 flood severely damaged numerous cultural heritage objects – architectural, artistic and written documents and drawings. The illustrative examples below show typical damage in the Czech Republic: damage to the World Heritage medieval bridge in Písek, (the parapet walls and some sculptures were destroyed), the baroque castle at Veltrusy with damaged pavilions in the park, the baroque castle at Liběchov with damaged frescoes and interior wall paintings, the renaissance castle at Roztoky with many museum objects, the baroque Troja castle in Prague, and Zwinger in Dresden. (The map of flood hazards was elaborated within the ESPON programme – see p. 31).

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Protecting the cultural heritage from natural disasters

Liběchov

high water level

Roztoky

Prague Troja Chateau

Dresden Zwinger Chateau
LANDSLIDES

**Historical Examples**

Historical examples show the disastrous consequences of large landslides, e.g. partial destruction of the historic town of Plurs (Piur) in 1618, as well as large changes in the settlement of landslide-prone areas, e.g., recently abandoned agricultural land and changes in the cultural landscape in Sicily\(^{111}\). (The landslide-prone regions are marked in the attached ESPON map).

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**Recent Examples – a fast landslide (a debris flow) in 2000**

The Stockalper Tower in Gondo\(^{112}\) (Switzerland) was built between 1666 and 1685 and controlled the Simplon road between Wallis and Italy. A debris flow (i.e. a fast landslide) after heavy rains partially destroyed the tower and surrounding buildings in October 2000\(^{113}\). The village was protected against landslides by a reinforced concrete wall located above the residential area. However, the volume of the sliding ground mass was greater than anticipated and, the foundation of the wall had been eroded by water flow, which resulted in the wall collapsing. The event caused 14 deaths.

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\(^{112}\) [http://www.gondo.ch/stockalperturm.html](http://www.gondo.ch/stockalperturm.html)

\(^{113}\) [http://www.crealp.ch/de/contenu/crealp_gondo_photos.asp](http://www.crealp.ch/de/contenu/crealp_gondo_photos.asp)
WIND STORMS, HURRICANES, TORNADOES

**Historical Examples**

**London 1703** (21 deaths, £2m damage – all UK £100m)
“the streets lay so covered with Tiles and Slates, from the Tops of the Houses, especially in the Out-parts, that the quantity is incredible, and the Houses were so universally striped, that all the Tiles in Fifty Miles round would be able to repair but a small Part of it”.

**Bohemia 1614-1929**
around 50 roofs and attic gables collapsed and 8 outlook towers were torn down (1890-1916) in the country (see the upper part of the figure below). In 1852 a menhir tumbled to the ground due to a hurricane. Damages to the architectural heritage due to strong winds in 1897 (the roof on the church tower collapsed, as did some light timber houses; most of the roofs lost their cover – see the bottom part of the figure below).

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The Great Storm in France in 1999\textsuperscript{115} (MARTIN)

A powerfull storm with wind velocities up to 180 km/h raged through France on December 26\textsuperscript{st}, 1999 and caused great devastation to the architectural heritage and to forests from Brittany to Alsace. The Paris region was particularly badly hit, with the worst damage to the large 18\textsuperscript{th} and 19\textsuperscript{th} century Paris hospital complexes, which were in some cases poorly maintained. Namely Hospice de Charenton (built between 1830 and 1860) suffered considerably. Five weeks after the storm the damage to the buildings was estimated at 102 million Euros (roof coverings and roof structures, church towers and stained glass windows) and to historic parks (trees, paths, walls, water basins etc.). 324 historic monuments were damaged, 48\% them suffering light damage that could be repaired at a cost of less than 15 000 Euros per monument. Throughout Europe the storm caused 125 fatalities, affected 4 million people and caused damage to property and forests estimated at 6.7 billion Euros\textsuperscript{116}.

At the Hospice de Charenton the storm destroyed 5000 m\textsuperscript{2} of roof structures, 50\% of them totally. It was observed that the storm in 1999 damaged the same parts as had been affected by an earlier storm 1990 and subsequently improperly repaired. On the other hand, a central part of the building, properly restored shortly before the storm, held up well.

The storm knocked down about 10000 trees in the park at Versailles Palace which were more than 100 years old and had survived the violent storm in 1990. Many important architectural monuments were severely damaged: six stone pinnacles of Notre-Dame-de-Paris Cathedral fell on to the nave and the sacristy, 30 lead sheets weighing 100 kg weight were blown away or rolled on to the roof of the Panthéon, the pinnacles of the Saint Chapel collapsed and damaged precious stained glass windows. Hundreds of monuments in the country suffered substantially, including the Abbey du Mont-Saint-Michel, Chateau Chambord, the cathedrals in Strasbourg, Rouen, Bordeaux, areas of Saint-Claude, Rambouillet, Saint-Germain-en-Laye and many private objects.


\textsuperscript{116} According to the European Environmental Agency which elaborated also the attached map illustrating the area affected by four disastrous windstorms: Anatol, Lothar, Martin (1999) and Jeanet (2002). EEA Environmental issue report No.35 “Mapping the impacts of recent natural disasters and technological accidents in Europe”, 2003.
Protecting the cultural heritage from natural disasters

A recent example – Hurricane Kyrill

On January 18, 2007 Hurricane Kyrill blew across Europe, causing fatalities, destroying many forests and damaging numerous buildings. The attached pictures illustrate damage to a historic crucifix (broken by the wind blow) on the World Heritage bridge in Písek (Czech Republic)\(^\text{117}\). The crucifix had survived the flood in 2002 (see above p. 66).

\[^\text{117}\text{ }http://www.icpisek.cz/docs/cz/20070122130439.xml; \text{http://cs.wikipedia.org/wiki/Kamenny\_most\_v\_Pisku}\]
Protecting the cultural heritage from natural disasters

**EARTHQUAKES**

**Historic examples**

Earthquakes are very frequent events – events of magnitude 5 and higher, i.e. powerful destructive events – occur on an average 1319 times per year, (based on post-1990 records). The most disastrous European earthquake was in 1908 in Messina (up to 100 000 victims, accompanied by a tsunami). The second strongest was in Lisbon 1755 (70 000 victims, with a tsunami), then in Sicily in 1693 (60 000 victims), Calabria in 1783 (50 000 victims). Illustrative examples are given below (Messina 1908 (left), Noto-Sicily 1693 (right)).

Maps of seismic hazards according to ESPON (left) and according to the European Environmental Agency (right), for Italy. The maps for Romania and Bulgaria were created by the authors from national data on seismic activity.
Recent examples

The earthquake that struck the Umbria and Marche regions in 1997 occurred only 18 years after the earthquake in 1979 in Val Nerina (part of Umbria). In this part of Umbria some historic centres had been retrofitted and were again damaged in 1997. The 1997 earthquake provided an opportunity to learn about the effectiveness of repair and retrofitting techniques.

Most retrofitting, mainly performed with upgrading interventions (timber floors and roofs replaced by reinforced concrete, jacketing, etc.), led to unforeseen and serious out-of-plane effects (major collapses, local expulsions), due to the “hybrid behaviour” activated between the new and old structures.

Some of the buildings had earthquake-proofing interventions made before the 1979 seismic event. These buildings exhibited various repair techniques, e.g., the use of timber rods with steel connections to the walls, steel rods, buttresses or buttressed walls. These techniques can be defined as “traditional”, and were commonly and efficiently applied in the past, before the use of reinforced concrete.

Buildings repaired according to the regional plan were also identified. The following repair techniques were applied: stiffening or substitution of timber floors with reinforced concrete beams or plates, tie concrete beam insertion in the walls, cement-based grout injections, reinforced injections, roof substitution, jacketing, local replacement in the walls, joint re-pointing, etc. The survey showed up many failures of more recent repairs due to the incompatibility of the new materials or techniques with the existing materials or techniques.

Some examples are presented below – the central upper figure shows the Church of St. Francesco in Assissi after the earthquake in 1997-1998, the other pictures illustrate damages from the earthquake in Umbria 1997 (cracks and partial failures resulted from incompatible previous preventive measures).
INTERNATIONAL FIRE INCIDENTS – ILLUSTRATIVE EXAMPLES

In the USA, it is estimated that over the period 1980 - 1993 some 30,000 heritage related fires occurred, amounting to a level of loss in the region of $40 million in value. In these properties, only one third had detection apparatus, and less than 10% were fitted with sprinkler protection. In Canada, with an average of 30 incidents per annum, some 316 museum, art gallery and library fires occurred between 1982 and 1993, creating an estimated loss of almost $17 million. Other incidents, such as that at St George’s Church in Halifax, Nova Scotia revealed the vulnerability of major historic structures to fire. Here, arson by children caused $3 million worth of fire damage in June 1994. In line with other countries, the Canadian authorities are concerned about the level of loss.

Recent example from Switzerland: Flims Old Town, Graubunden, Eastern Switzerland - A quarter of the old town – 14 buildings (7 houses and 7 stalls: 1 listed building of historic significance destroyed, estimated value €10 million (10-15 million Swiss Francs), on 7 June 2006.

The map below illustrates recent major fires in the countryside in Europe (1998-2002).

OTHER RECENT EUROPEAN EXAMPLES OF CATASTROPHIC FIRES IN CULTURAL HERITAGE OBJECTS:


A medieval castle at Pernstein in Moravia (Czech Republic) – next page (2005)
Statistical data from recent years – example from the UK

During the course of COST Action C17, (see p. 25), survey work was carried out to try to establish an estimate of the real scale of losses by fire to historic buildings in United Kingdom. For practical purposes, a period of four and a half years from January 2002 until June 2006 was taken. The aim was to perform a search of fire and rescue services press releases, local and national press archives, internet articles and community websites for fire loss and damage to historic buildings. This was then recorded in a database and combined with existing fire loss statistical collation projects by the UK heritage bodies such as Historic Scotland and English Heritage.

Overall, almost four hundred separate incidents involving fires to historic buildings were recorded in the database between January 2002 and June 2006. As the figure below indicates, an average of about seven UK heritage buildings are lost or damaged by fire each month. This rose to 10 over the last year of the survey from mid 2005 – mid 2006, and 13 over the first six months of 2006. The more recent averages are more reliable than the earlier ones. This is due to the retrospective nature of the survey resulting in less data being available from earlier in the survey. This accounts for the apparent, but almost certainly misleading, rise in fire events over the period. Even the most recent data is most likely a significant underestimation.

Projecting forward on the basis of all the data available, and assuming a linear rate of growth, we arrive at a figure of some 2 000 buildings damaged by or lost to fire by 2026.

Unpublished COST C17 Report, Chapter 3 (private communication I. Maxwell).
OTHER HAZARDS

TSUNAMI

The map below summarizes historically recorded tsunami events associated with earthquakes, volcanic activities or submarine landslides (red circles) and terrestrial landslides (blue circles). The historic Calabria (1783) earthquake followed by a tsunami illustrates the phenomenon – (above).
VOLCANIC ACTIVITY

Historical examples
The most famous examples of the destruction of large historic territories involve the region around Vesuvio and Etna in Italy, (where eruptions have occurred frequently in the course of centuries), the Greek Islands (Santorin 1866), Hekla in Iceland (1878), and Asama in Japan. The illustrative example shows the case in 1796 when a huge stream of lava completely destroyed the city centre of Torre del Greco, next to Pompei which was destroyed in the year 79 AD (on the left).

Volcanic eruptions cause more damage to cultural landscapes and villages than to famous historical monuments. In special cases (Napoli) the ash and fine sand, together with harmful gases, endanger historic collections and objects of art. However, there is no cost-efficient protection for such cases. Recent examples from Sicily (Etna) illustrate the extent of the threat, and the local damage.
This illustrative map shows the aggregated natural hazard typology based on 11 single hazard indicators. Each indicator has a value from 1 to 5 depending on the magnitude of the hazard in the NUTS3 area. For the “no data” class the value is 0. These values are then weighted on the basis of expert opinions (Delphi method questionnaire). The sums of the 11 weighted indicators are then classified on the basis of a percentile ranking order. For instance, NUTS3 areas that are in the 90-100 percentile have a score greater than or equal to 90% of the total of all the summed hazard values, (Schmidt-Thomé, 2005).
Protecting the cultural heritage from natural disasters
### ANNEX 6 - CATALOGUE OF PROBLEMS AND MEASURES

<table>
<thead>
<tr>
<th>Problems or shortcomings</th>
<th>Measures</th>
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<tbody>
<tr>
<td>Direct load or action on cultural heritage objects during natural disasters</td>
<td>Technical or structural preparedness, risk management plan</td>
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<tr>
<td>Incorrect prediction of a natural disaster</td>
<td>Research, improved data collection and modelling</td>
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<tr>
<td>Neglected long term threats, e.g. rising sea level, landslides</td>
<td>Structural measures, well planned protecting barriers, monitoring</td>
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<tr>
<td>Neglected and deteriorated buildings</td>
<td>Knowledge based inspections and maintenance</td>
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<tr>
<td>Material degradation</td>
<td>Preventive maintenance, protective measures</td>
</tr>
<tr>
<td>Increasing human exploitation of land</td>
<td>Land use planning and regulation tools</td>
</tr>
<tr>
<td>Development and building activities in zones of threat</td>
<td>Land use planning and regulation tools</td>
</tr>
<tr>
<td>Landslides activated by erroneous geotechnical activity – construction, excavations</td>
<td>Supervision of design, construction and excavation works</td>
</tr>
<tr>
<td>Landslides due to erosion</td>
<td>Land use planning and agricultural control</td>
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<tr>
<td>Sudden landslides associated with climatic effects</td>
<td>Early warning systems, monitoring, GIS with specialised landslide threat assessment modulus</td>
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<tr>
<td>Inadequate or lacking knowledge of positioning and contents of cultural heritage objects</td>
<td>Mapping and inventory, GIS, relation to GMES</td>
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<tr>
<td>Inadequate knowledge of data for cultural heritage valuation and damage assessment</td>
<td>Survey, data collection ad mapping, GIS</td>
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<tr>
<td>Lack of disaster vulnerability classification</td>
<td>Survey, inspection, harmonization of approaches, GIS, mapping</td>
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<tr>
<td>Slow response to sudden events, e.g. flash flood, inadequate warning times</td>
<td>Alert of specialised intervention teams, early warning systems, prediction models, coordination</td>
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<tr>
<td>Missing prevention measures</td>
<td>Risk management planning</td>
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<tr>
<td>Little or no experience with disasters</td>
<td>International cooperation, exercise, training</td>
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<tr>
<td>Inadequate evacuation, e.g. blocked access, lack of knowledge of contents, insensitive transport</td>
<td>Coordination of intervention activities, mapping and navigation (GMES)</td>
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<tr>
<td>Damaging remedial action, e.g. fast pumping of water from subsoil, biological attack</td>
<td>Education, in situ control of works by professionals</td>
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<tr>
<td>Inadequate post-disaster work</td>
<td>Education, training, technical equipment</td>
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<tr>
<td>Failure of preventive and emergency measures in relation to cultural heritage, (not designed properly for the rescue of cultural heritage assets)</td>
<td>Education, coordination, lessons from failure, improved data flow, specialised professionals in preparedness team, risk management plan</td>
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<tr>
<td>Failure of crisis management – lack of abilities</td>
<td>Risk management plan, international help, coordination and in situ control, guidelines and tools</td>
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<tr>
<td>Low professional knowledge</td>
<td>Education, specialist in the rescue team</td>
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<tr>
<td>Lack of standards, e.g. for mapping, GIS contents, monitoring, early warning</td>
<td>Establishment of standards and harmonization measures</td>
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<tr>
<td>Lack of statistical data on disaster parameters and damage</td>
<td>Survey, recording and evaluation systems</td>
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<tr>
<td>Human mistakes – incompatible remedial works or preventive measures</td>
<td>Research, education, dissemination of knowledge</td>
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<tr>
<td>Insensitive intervention methodology – no difference in approaches between cultural heritage and other property</td>
<td>Change in approach, education, specialists in intervention and rescue teams</td>
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<tr>
<td>Neglecting risk declaration in balance sheets of relevant cultural heritage managing legal entities</td>
<td>Risk management planning, damage limitation planning, business continuity planning, training and management, …</td>
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<tr>
<td>Issue</td>
<td>Recommended Action</td>
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<tr>
<td>----------------------------------------------------------------------</td>
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<tr>
<td>Cultural heritage not treated in relevant legislative documents</td>
<td>Monitoring of issued legislation and inclusion of cultural heritage issues</td>
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<tr>
<td>Cultural heritage not involved into emergency, risk management and evacuation plans</td>
<td>Improvement in risk preparedness, set priorities including cultural heritage</td>
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<tr>
<td>Inadequate insurance instruments for cultural heritage in natural disaster threat</td>
<td>Improvement in insurance strategies and programmes</td>
</tr>
<tr>
<td>Disaster plans of cultural organizations not prepared for major disasters</td>
<td>Improvement of disaster plans taking into account major disasters, coordination with civil protection</td>
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<tr>
<td>Limited or no access of cultural heritage specialists (conservators) on site during events</td>
<td>Inclusion of cultural heritage specialists into rescue teams, joint training, education</td>
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<td>Lack of functioning of alarm facilities</td>
<td>Regular inspections and checking</td>
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<tr>
<td>Coordination and control of emergency interventions without cultural heritage representatives</td>
<td>Inclusion of cultural heritage representatives into coordinating and controlling teams</td>
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<tr>
<td>Minor cultural heritage frequently underestimated in disaster plans or unknown</td>
<td>Improvement of risk management planning, mapping, GIS</td>
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<tr>
<td>Public not familiar with cultural heritage in danger</td>
<td>Education, dissemination of knowledge, signs</td>
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<tr>
<td>International organizations partially or not involved into joint emergency interventions</td>
<td>Harmonization and agreements on joint activities</td>
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