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REPORT ON CURRENT STATE-OF-THE-ART ON MANAGEMENT OF MEDIEVAL RUINS AND BEST PRACTICES OF RISK ASSESSMENT

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Summary

Report on current state-of-the-art on management of Medieval ruins and best practices of risk assessment

1. INTRODUCTION

Conservation, in favour of the next generations, of our **CH_M_Ruins** (Cultural Heritage Medieval Ruins) is one of the main tasks of the societies, they represent the reference points of our identity, whether current or future.
The value of CH_M_Ruins is established case by case, by popular opinion, by organizations, by experts from the field and by the public body.
They are recognized, catalogued and inventoried; buildings, collections, archives, as well as individual objects of any size and of every age. The responsibility for objects is assumed by whom is in charge of their care and protection, whether they are these single individuals or institutions.
Which methods and means are the most appropriate for the protection of cultural heritage it is often the subject of discussions, opinions are divergent.
These guidelines are intended to be a look at the possibilities of protection from dangers through an optimum risk management, especially in case of catastrophe. These directions are directed personally to those who are directly or indirectly responsible of the conservation and protection of cultural goods.
About cultural goods, the term 'Protection' is complementary to terms such as 'Conservation', Restoration and Care.
The protection therefore constitutes the implementation of all the measures necessary to avoid damage before they occur (prevention), or, in the case of a lesion, to minimize it are to call the specialists of the cultural heritage (conservatives and restorers) or agents ready intervention (firemen, civil protection, etc..).
Well-coordinated intervention is the indispensable premise for the cultural good damage to be reduced to the least possible damage (recovery).

Cultural assets are threatened in different ways. These guidelines give some crisis management tip which may arise in the event of **fire**, **high water** and / or **other natural disasters**.

It is necessary, in principle, to split two categories of events that can cause damage:
at first the primary risks as fire / heat, smoke / soot, water / humidity, impact / pressure.
Secondly, risks such as biological attacks and chemical reactions. Besides these two first categories, you have to keep account of the possibility of disappearance (theft, dislocation).
The level of urgency is defined by the time it takes from the recognition of danger to the time when it is possible to act calmly. The time before urgency is the normal case. Next is the recovery phase.

1.1 Responsibility and priorities coordination in cases of urgency

In case of intervention by operators such as firemen, police, ambulance, etc., responsibility on the site is always in charge of the chief intervention team. Secondly it can be in charge of the manager of the police, firemen, ambulance, or the person responsible for the cultural goods. The head of cultural heritage must always stick to the principle: First save people, then animals, the environment and ultimately the material values. Therefore, fast rescue of cultural assets can be best achieved if coordination between the various actors is planned and exercised in advance.

1.2 Risk Management

The primary task of managing the risk is to avoid the risk. As it is impossible to avoid any risk, the objective is to minimize and keep below control the residual risk.

Greater security is achieved with optimization of the following factors:

- CH_M_Ruins environment and construction: protection of the site where the object is located, as well as analysis of features of the protected building or of what contains the protected object.
- Technical characteristics: they are understood as the technical components that are in the cultural heritage good to be protected. These can be functional to the good to be protected (alarms) or functional to the building itself (heating, electrical connections, telephones, etc.).
- Organization of education: this term indicates the kind of practical use and maintenance of the site/good.

The organization includes knowledge of the different responsibilities, that of the current management but also that of disaster safety, accidents, planning of interventions, etc.

In each case it is the responsibility of the manager to implement more measures suitable for the cultural asset in question as well as the most suitable for the institution represented. For an optimal development of risk management, it is necessary to set priorities, depending on cyclicity (frequency) and strength (intensity) of events which are possible causes of damage. The answers to these questions will be provided from the risk analysis.

1.3 The risk analysis

The risk analysis by the manager is the basis for the development of an adequate risk management.
It is therefore important in this area the answer, for example, to the following questions:

List of useful questions for the analysis of risks (example):

- Cultural property: Is there an inventory?
- What are the identifying elements of the object?
- In what category can you enter the cultural good?
- What are the conditions of the cultural good? How is it protected?
- Are you insured?
- The place: are there possible natural dangers (landslides, floods, earthquakes, etc…)?
- How is the road situation? How is it regulated?
- Are there nearby objects or situations potentially dangerous?
- Where are the fire extinguishers? And the nearest hydrants?

The construction:

- To what construction type the building belongs (castle, palace, little fortification village, etc)?
- Are there Static Peculiarities?
- Are there escape trails?
- Are there anti-fire walls? In which maintenance conditions are roofs, fixtures, doors, water evacuation channels?

Use:

- How is the building used? Who is responsible for it? In the premises are there possible sources of fire?
- Management: what parts are open to the public?
- How are the warehouses / stores organized?
- Are there work studios?
- What are the monitoring systems?

Device systems:

- What technical installations are present?
- Where are the heating systems located?
- How is water management organized?
- Are there fire alarm systems and / or extinguishers?
- Are electrical installations checked regularly?
- Is there a lightning rod?

Urgencies:

- Are there contact points of emergency (police, firefighters, ambulance, etc.)?
- Is there a plan intervention in the event of fire?
- Are the escape routes indicated? Are there known gathering places for people?
- Are there contacts with experts of cultural heritage protection?
- Is there an intervention file for cultural heritage protection?
- Are there experts in the field of CH_M_Ruins and / or restorers in the design of evacuation plans?

1.4 Measures and partners

After the risk analysis, it is matter now to avoid the risks to the greatest possible extent. Neutralize, minimize, managing and financing risk is the final purpose of the exercise. Solutions like that can be found in the following fields:

- situation and construction
- construction, safety and security technology
- management organization, planning
- risk financing

After setting up a list of measurements to improve security, it is important to determine the financial need purpose. As a rule, financial means must be found outside the cultural goods sector in the strict sense. An excellent approach is to get in touch with all the actors involved in the protection, among which you can list: the owner, manager and / or storage manager, user, the security officer and / or, ultimately, the insurer.

Taking into account the possible solutions you have to go to the implementation plan. In case the cost of realization of selected projects is over the effective financial possibilities, there will be the need to optimize everything, prioritize and prepare a timetable.
The priority will be given to the higher risks, which are more probable and happen more frequently.
Even the already existing safety devices should be subject to periodic analysis and verifications. New solutions are to be followed in their development and possible new applications to be examined regularly. The risk management requires a constant commitment, which success also depends from co-ordination between the various managers of the various sectors touched, as it is advisable to collaborate with internal and external experts.

Earthquake **Flooding** **Fire** **Pollution** **Landslide and Soil erosion**

2. NATURAL RISK FOR CH_M_RUINS

A correct approach implies that States will support actions against disasters related to cultural heritage in close cooperation with institutions directly involved, police, fire-fighters, civil protection, etc. But, in general **CH_M_Ruins** legislation does not impose, in EU countries, implementing of measures for the prevention and mitigation of risks associated to natural extreme phenomena or climate change, but in general recommendations are used.
In the current practices, the main tools upon which the definition and protection concerning the risk for CH_M_Ruins assets, on large or regional scale are generally the "Risk Maps" such as *"Flood Hazard maps"*, *"Geological hazard maps"*, *"Geophysical risk map"*, etc., and data from specific projects like Maprisis (Interreg Italy-Slovenia 2007) and the collaboration with national institutions directly involved in implementing the measures for the prevention and mitigation of risks associated to Natural Disasters.
As already assessed, the current protection practices are oriented towards the defence against those Natural Hazards (NH) and climate change that actors perceive as most persistent at regional scale.
For example, generally in the countries of the south Europe basin earthquake risk is perceived as the main problem, while in central and northern Europe countries the actors perceive floods as a more persistent risk. Case by case, depending on the geographical location of the site, other risk factors of natural and anthropogenic character can be considered.
The following list shows the main natural risk factors that are usually perceived as most persistent at regional or local scale, also worsened by climate change:

- Earthquake
- Flooding
- Fire
- Pollution
- Landslide and Soil erosion

This list includes the Natural Hazards that are more perceived as a real danger for CH assets. It is necessary to highlight that the risk identification is strongly influenced by the nature and geographical location of the CH and by the typology of asset.
The first part of the present report analyses the general situation in Europe with specific information about the situation in Italy, as a case study country. In the second part of the report, the situation in the other countries participating in the RUINS project (Poland, Slovenia, Croatia, Czech Republic) will be described.

2.1 Earthquake [1]

Seismic activity threatens thousands of cultural heritage objects. Natural seismicity generates dangerous vibrations and displacements, and man-made seismicity, so called "industrial or technical" seismicity, has also been shown to cause severe damage, mostly to masonry. Technological man-made seismicity can result from quarry blasting, from transportation vibrations and shocks, and from micro-seismicity in mining areas.

Earthquake is understood to be a Natural Hazard with great relevance and impact on CH in the countries of the Mediterranean basin.

In Italy, for example, a specific Ministerial Directive: *"Linee guida per la valutazione e la riduzione del rischio sismico del patrimonio culturale con riferimento alle Norme tecniche per le costruzioni di cui al decreto del Ministero delle Infrastrutture e dei trasporti del 14 gennaio 2008"* (Guidelines for the evaluation and reduction of seismic risk of cultural heritage with reference to the technical standards for construction, referred to the Ministry Decree of Infrastructure and Transport, 14 January 2008), highlights this relevance.

The Directive provides guidance for the assessment and mitigation of seismic risk of the protected cultural heritage, with reference to the technical standards for construction. The Directive has been drafted with the intent to specify a path of knowledge, assessment of the level of security against seismic activity, and design of any appropriate intervention addressed to the needs and peculiarities of the cultural heritage. The aim is to formulate, as objectively as possible, the assessment of the safety and conservation of CH. It should be noted that the document refers to the safety of some cultural heritage masonry buildings against earthquakes.

To do this it is important to have analytical tools that allow the analysis of vulnerability and seismic risk assessment.

The current practices and the analytical tools for the management of CH assets against earthquakes are usually defined starting from the geological contest. In fact, the seismic ground movement is strongly influenced by geological and stratigraphic characteristics and local topography. In the presence of deformable mixed soil and as a function of different stiffness and continuity of the more superficial layers, as well as of the possible topographic irregularities, effects amplification of the seismic movements can be amplified, both in terms of maximum acceleration and in frequency; in these cases it is necessary to make specific analysis of the local seismic response.

In Italy, for example, a preliminary investigation can be carried out, for large areas, using data base of the *INGV* (*Istituto Nazionale di Geofisica e Vulcanologia* - National Institute of Geophysics and Volcanology). The main mission of *INGV* is the monitoring of geophysical phenomena in both the solid and fluid components of the Earth. *INGV* is devoted to 24-hour countrywide seismic surveillance, real-time volcanic monitoring, early warning and forecast activities. Another possibility is to refer to "Geological and geothematic maps" edited by *ISPRA* (*Istituto Superiore per la Protezione e la Ricerca Ambientale* – Superior Institute for Environmental Protection and Research). ISPRA acquired the function of State Cartographer's Office, previously hold by the Geological Survey of Italy, as provided by Law 68/1960. The Institute makes new surveys, updates and publishes the Geological Map of Italy at various scales (in the other European countries there are similar institutions with a similar approach in risk mapping for seismic impact).

The geological map is the cartographic representation of the information acquired during a long work on the ground. The process goes from the survey of data to the laboratory analysis and subsequent data processing. The information is then transferred to the corresponding topographic base in order to describe, through the use of conventional symbols, the exact stratigraphic position, age, petrographic characteristics

[1] Refence document from the *"STORM"* project.

of the investigated geological formations, in connection to the genesis and to the relationship with adjacent rocks.
For an intervention targeted to a single building, the knowledge about the type and size of the foundation system, together with the geotechnical characterization of the ground, are necessary elements for the assessment of the seismic action and its effect on the building.
All of the survey and verifications should be preceded by a thorough study of the documentation available for the building, his past and recent history. Thanks to these preliminary studies, it is possible to prepare an investigation plan to determine the shape, size and materials forming the foundation structures. Possible investigations will be preferred through non-destructive testing, such as geophysical and tomographic tests. Geotechnical investigations should enable the physical-mechanical characterization of the foundation soils, through in situ tests or/and laboratory tests, aimed at identifying geotechnical models adapted to local seismic response analysis of soil-structure dynamic interaction.
As said, the perception of seismic risks is particularly relevant in the countries of the Mediterranean basin. A recent work (Silva et al. 2014) reports an overview on projects. (Image 1 – Image 2).

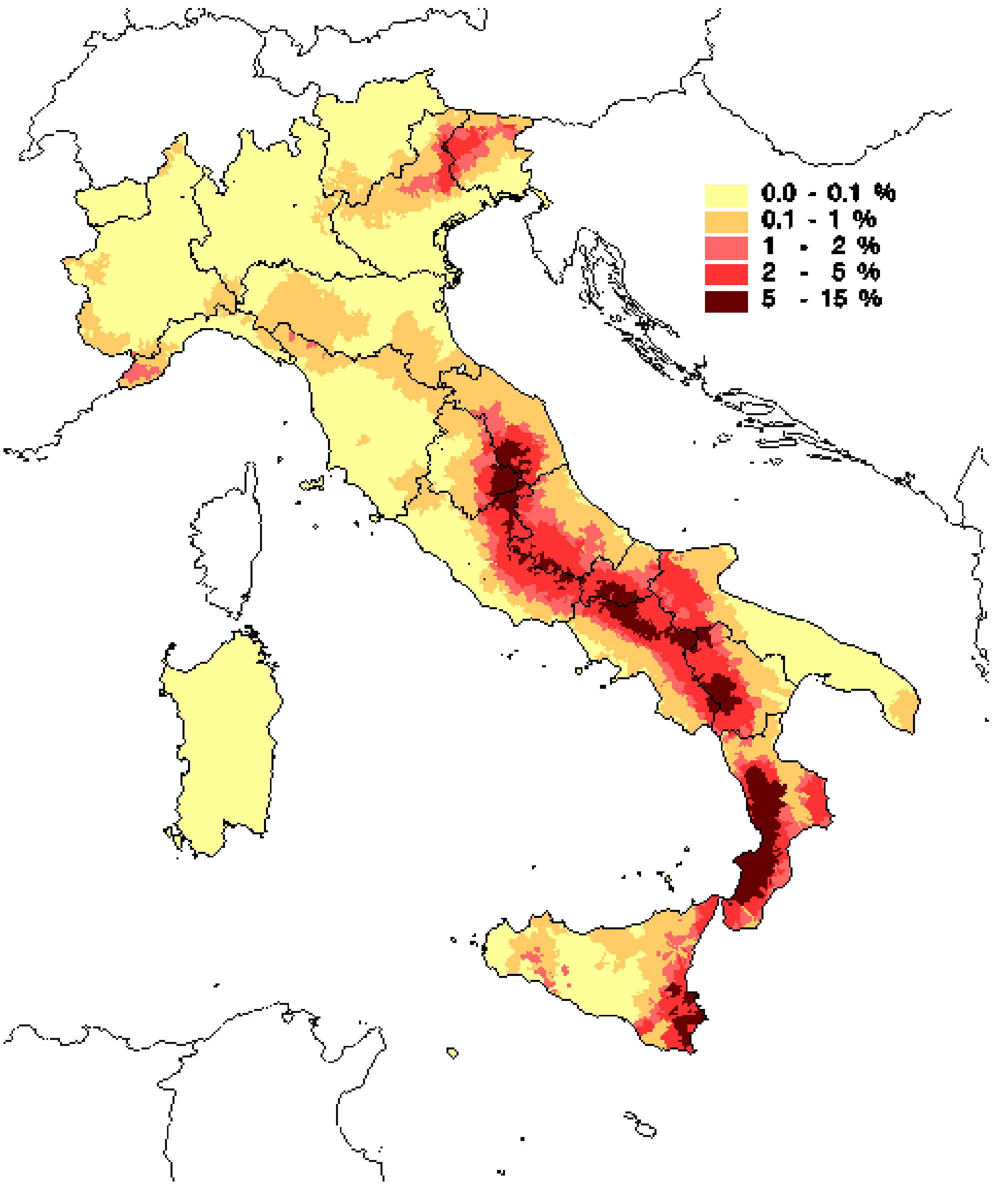


Image 1 Italy seismic risk map

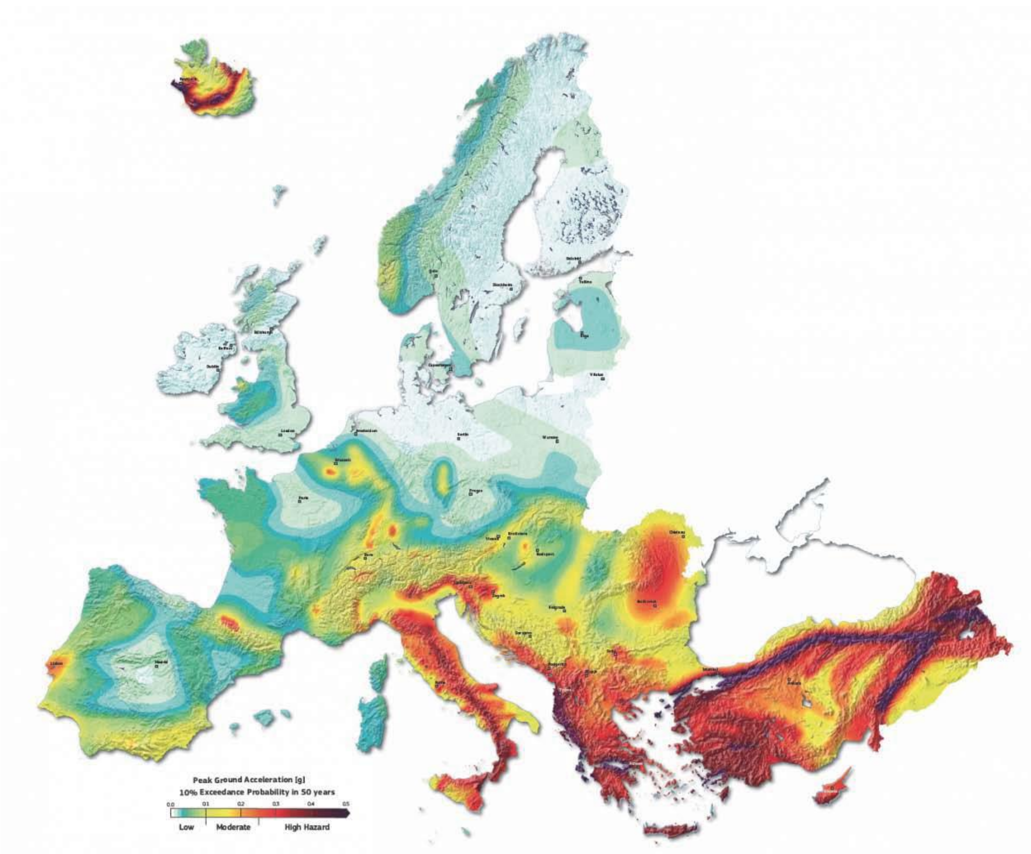


Image 2 Europe seismic risk map

The National Disaster Risk Assessment and Analysis Working Group have developed guidelines for assessing the above-mentioned hazards following methodologies in line with international standards.

In general, current practices of detection and reaction against seismic risk can be described as follows:

- **Building identification**. The first step is the correct and complete identification of the building and its location on the territory. This phase also includes a first schematic survey of the building, able to describe the location of elements particularly sensitive to damage. At this stage it must be analysed the relationship between the building and its surroundings, through the description of the "architectural complex", isolated or not isolated, and the characterization of the spatial and functional relationships between the building and any nearby objects. The study should provide constructive hierarchy and relationships between the building and the environment; the survey can be effectively conducted through the use of stratigraphic techniques.

- **Functional characterization of the building and its spaces**. The knowledge of the building cannot ignore the historical analysis of the evolution of the building functions, finalized to recognize the uses occurred over time. The result of this analysis leads to even understand the reasons for the structural and geometric changes occurred over time, to motivate any signs or information about disruptions, with the aim of reducing the seismic risk.

- **Historical analysis of the events and actions**. For a correct identification of the state of the building stress it is important to know the construction history, that is, the construction process and the successive changes of the building along the time. Moreover, building's history can be used as instrument for controlling and verifying the building's response to the earthquakes occurred in the past. Therefore, events and corresponding effects should be identified with the study of iconographic or historical sources. The knowledge of the construction response to a particular traumatic event can allow identify a qualitative model. The consultation of the numerous existing seismic catalogues and direct retrieval of archives documents related to seismicity of the places and the harm suffered by the buildings, constitutes a basic fundamental reference. The data acquisition of the related damage suffered from the building in previous seismic events is configured as an indispensable method for the identification of vulnerable elements.

- **Architectural and structural survey**. The survey should include both the overall geometry of the building and the construction elements, and furthermore the relationships with other close buildings. The representation of the results of the survey will be exposed through plans, elevations and sections, also with architectural details. As the geometric survey will be used to define the geometry of the model to be employed in the seismic analysis, all necessary information should be verified. It is necessary to detect and represent the cracking map, so as to allow to identify the causes and the possible evolution of the structural problems of the building. The lesions will be classified according to their geometry (size, width) and their kinematics (detachment, rotating, sliding, moving out of the plane).

- **Survey of materials and construction techniques**. This survey aims at identifying the constituent materials of the architectural elements of the building, and the construction techniques. It is necessary to know the artefact building phases, and to have a complete knowledge of the construction characteristics of the artefacts in relation to its different historical periods.

This recognition requires the collection of information often not immediately visible (covered by plaster, or from layers of paint, etc.), which may be executed through indirect non-destructive investigation techniques (thermography, ground penetrating radar, etc.) or direct non-invasive or minimally invasive inspections (endoscopies, removal of little portions of plaster, etc.)

Concerning the artefacts in museum or art galleries, some precautions have to be taken, even if the earthquake could not potentially cause damage to the structure of the building. In case of earthquake, in fact, it is possible that the exposed objects fall, slip, or detachment can occur (McKenzie et al. 2007; Saunders 2008). From some studies of the J. Paul Getty Museum (Lindvall 1984; Agbabian et al. 1990; McKenzie et al. 2007) basic criteria for stability have evolved. For example, the response of a rigid object to earthquake induced forces and motion can be sliding or, if the friction between the object and the supporting plain is high enough, rocking and eventual overturning. Rocking and overturning are based both on the nature of the earthquake and the object's (or object assembly's) geometry and mass distribution, additional strength can be provided by introducing supportive mounts that cradle and restrain the object on display.

In the works of Getty, detailed solutions for mounts are reported with specification about dimensions, loads, and materials. As general suggestions, mounts should always be made of stable materials that are non-abrasive, non-corrosive, stable, non-staining, and free of corrosive vapours.

A special attention is paid to the design and planning of interfaces and contact points between objects and mounts.

In conclusion to this paragraph a short mention about climate change should be made as factor increasing the effect of various natural hazards to CH contexts. Extreme weather events and their associated hazards are predicted to become more frequent and damaging under all proposed scenarios of climate change (Hewitson et al. 2014).

The term "climate change" (CC) generally means a change of the sum of the prevailing atmospheric conditions: heat, cold, dryness etc., of a place over a period of time. Such change causes variations in adverse atmospheric conditions as for example rain, wind, sleet etc., which influence weathering damages substantially. It is possible distinguish between "global", "regional" and "local" climate changes. However, in the last years, the term "climate change" is understood as a change on global, i.e. on the Earth scale level. Nevertheless, it is reasonable to develop and apply policies, strategies and measures mitigating such a global CC impact on cultural heritage on the three levels mentioned above, too. Human activity is the primary cause of CC at any level.

At *global scale*, it is a result of deterioration of atmospheric protection layers against cosmic negative agents, first of all against sun radiation causing the so called global warming.

On the *regional level*, the mass industrial production generates a high air pollution affecting large states and regions. Transport, heating of houses, local industries etc. produce concentrated local or indoor climate changes; the climate change results in physical, chemical, biological, effects on cultural heritage. It causes events with disastrous or catastrophic features, as e.g. high winds, heavy rains and snowfall, floods, landslides and avalanches, and increases a danger of large fires. Physical and chemical effects are significantly associated with threats to material cultural heritage objects, mostly immovable.

At regional and local levels, it is important to promote the creation of vulnerability maps for the region and sub local regions and provide guidance on the monitoring programmes that might be appropriate for CH sites in the region which might be affected differently by different climate change parameters. Thematic groupings of local sites likely to face similar threats such as archaeological, movable, coastal, mountainous or marine sites, could also be developed (Lefèvre and Sabbioni Eds. 2016).

To identify the greatest global climate change risks and impacts on cultural heritage, the scientific community uses climate parameters such as those published by UNESCO.

In order to mitigate the impact of CC on CH, preventive measures should be adopted and, in case of damages derived from CC effects, reactive approaches are needed.

The best preventive strategy consists in removing the causes of CC. It is obvious that, on global level, such a task lays beyond capacity limits of contemporary profit driven and a heavy consumption-oriented society. Nevertheless, preventive measures on lower levels are in hands of local governments or even individual citizens and therefore possible and desirable. Their success is dependent on the scale of problem and it is generally experienced the smaller problem.

In the second case, it is advantageous to know possible mechanisms of degrading or damaging cultural heritage in order to be able to plan adequate and effective preventive measures.

Reactive approach is concentrated on remedial works removing damages or other impacts from the cultural heritage after the action caused by climate change.

Monitoring is a key factor for the sustainability of cultural heritage in the face of climate change. Remote sensing, such as the use of satellite technology, non-destructive techniques, bio-sensing to assess biological damage to materials and the use of simulation tools to predict the impact of climate change on the behaviour of cultural heritage materials, are needed.

2.2 Flooding

Flooding is a global phenomenon as recently highlighted by the major catastrophic events in Central and Northern Europe. These catastrophes left hundreds of peoples dead and caused enormous damage leading to high economic losses for the whole community. Europe has to face further flood catastrophes due to the change of climate and due to further building activities in flood-prone regions.

Emergency plans and guidelines, which must take into account not by only all categories of cultural heritage assets but also movable heritage, can substantially reduce damage and losses. In recent floods, most of the damage to cultural heritage has been related to movable heritage, which could have been totally saved if proper evacuation plans had been elaborated, if the warning had functioned reliably, and if the objects had been removed to a safe location.

Flood events have the potential to undermine the EU’s drive towards sustainable development and the flood risks are increasing. In response to the severe floods in 2002, the European Commission therefore took the initiative to launch concerted action at Community level to help reduce the severity of flood events and the damage caused by these floods.

In the Communication on Flood risk management, Flood prevention, protection and mitigation (COM 2004, 472 final, 12.7.2004, http://ec.europa.eu/environment/water/flood_risk/com.htm) the European Commission proposed to develop and implement a concerted EU Action Program on flood risk management. It proposed that the Member States and the Commission shall work together to develop and implement a co-ordinated flood prevention, protection and mitigation action program.

On 18 January 2006 the Commission adopted its proposal for a Directive of the European Parliament and of the Council on the assessment and management of floods (COM 2006, 15 final, 18.1.2006, http://ec.europa.eu/environment/water/flood_risk/com.htm). The legal instrument is proposed to be ambitious in its scope but not prescriptive in its tools. It intends to translate the approach outlined in the Communication on Flood risk management of July 2004 and the discussions during the stakeholder consultation process into operational actions. First of all a preliminary risk assessment for flooding is necessary and strictly connected the elaboration of a flood risk map. This map serves as base for flood risk management plans to be developed and implemented at river basin/sub-basin level to reduce and manage the flood risk.

Clearly the appropriate level of protection will vary from river basin to river basin and even within each river basin. For example, high levels of protection might be required in the vicinity of major cities, or near sites of particular cultural or historic significance. Within each river basin the Member States will determine the level of protection most appropriate for each locality.

As flood risks may change over time due to climate change and changes in land use, it would be important to regularly review and where necessary update the three elements of the legal instrument.

The international interest for flood risk specifically addressed to CH, is evidenced by numerous initiatives and projects focused on the topic. CHEF Project (Cultural Heritage Protection Against Flooding), for example, proposes the integration of multidisciplinary research as scientific support to European policies. This project highlights some strategic points in relation to flooding risks. One of the main objectives concerns the necessity of classifying all movable and immovable CH items and of specifying their vulnerability to flood. A throughout analysis damage processes in relation to different materials is also a relevant objective together with the possibility of applying methods and sensors for non-destructive testing and monitoring of material and structural parameters.

The project deals also with the analysis of preventive and emergency measures, the restoration and repair operations taking into account case studies.

2.3 Fire

Fires were more dangerous in settlements in the past than they are nowadays. However, wildfires may become even more disastrous for many cultural heritage sites that are already threatened and may also threaten other sites that historically—before the onset of climate change—were less prone to fire (Giannakopoulos et al. 2009; Good et al. 2008; Moriondo et al. 2006). In fact, reports of damages caused by wildfires on historical sites are becoming more frequent and alarming.

But the primary concern of the fire authorities is the safe evacuation of the building occupants and the provision of adequate fire-fighting equipment. On the other hand, the conservationists are primarily concerned with maintaining the authenticity of the building itself and are reluctant to see the introduction of preventive measures that have any degree of negative impact on the structure and aesthetics of the building (Emery 2008; Jensen 2006).

In general, national and international fire regulations are primarily concerned with life safety and less concerned with protecting assets (Watts 2008). Fulfilling these life-safety regulations and the associated building codes is, of course, mandatory. However, the number of national regulations and guidelines related to asset protection is steadily rising.

The European technical documents are usually guidance with no legal authority. The content of these documents includes fire performance of historic materials and assemblies,

fire protection measures, such as *Thatched Property Safety Guide21*, the *Guidance for fire protection strategies, emergency plan and the configuration and management of fire protection measures to Historic Buildings, and a series of Technical Advice Note (TAN)*.
More recently, the European Fire Protection Associations decided to produce common guidelines in order to achieve similar interpretation in European countries and to give examples of acceptable solutions, concepts and models. The Confederation of Fire Protection Associations (CFPA) in Europe has the aim to facilitate and support fire protection activities across Europe.
These guidelines are intended for owners, managers, caretakers and other responsible for safety of historical buildings. They should provide knowledge about basic, simple, low-cost actions, which can be done to protect the historic building from fire. They also indicate routes to more advanced ways of protection (CFPA 2013).
Fire was one of the most serious threats for the buildings and sites through the centuries. This threat is omnipresent and causes irreplaceable losses.
Although most of historic buildings have built in periods when very poor, if not at all, Fire Codes and Standards were applied, many of them exist now in their original condition after such a long time. That happened because, on one hand the traditional builders and architects applied several sophisticated fire protection measures based on the state of the art at that time as well on common sense and on the other hand, after major fires and conflagrations the authorities put in force more severe and more developed fire protection legislation.
Although fire safety objectives have been expressed in different ways by various authorities and in different countries, generally there are two main accepted aspects of fire protection for modern buildings: *life safety and property protection.* For historic buildings it must be added the *protection of cultural values* either for the buildings or for their contents. It is not possible to achieve an absolute fire safety. In most cases, a proper fire safety design assumes that some limited unwanted fires will occur and means shall be provided to minimize the losses from fire till an acceptable level (Papaioannou 2003).
The building regulations and codes prescribe the minimum fire safety requirements (Jensen 2006).
In planning for fire protection of historic buildings the following main steps should be proceeded by the designers:

- make a risk assessment;
- develop fire safety criteria;
- identify fire hazards;
- consider building’s arrangement;
- plan a fire protection strategy;
- specify passive fire protection;
- specify active fire protection;
- develop a fire safety management plan (Papaioannou 2003).

Fire measures in historical buildings should be chosen taking into account the peculiarities of the edifice; in fact, for the majority of historic buildings traditional approaches could not be applied due to undesired results about the historical and architectural character of buildings, which is often unacceptable for the conservators (Iringová and Idunk 2016).
Fire protection measures can be divided into passive measures and active measures.
Passive (structural) measures can be generally associated to building's resistance and endurance after a fire has developed, while active measures are aimed at preventing the outbreak and spread of fire. The majority of passive protection measures are related to the building structure, construction methods and materials used. Such measures include the fire compartmentalization of a building, the use of materials to prevent building collapse, fire-resistant construction elements to limit the spread of fire and smoke, the provision of fire-resistant escape routes/exits/staircases/elevators, the selection of materials to reduce the fire load and the selection of materials to prevent the generation of toxic vapours (for more information

see: https://www.downloads.siemens.com/download-center/Download.aspx?pos=download&fct=getasset&id1=A6V10859638)
For new museums and art galleries constructions, most of these measures are defined by national or local building codes, especially for larger art centres, which may have complex escape routes. In the case of historical buildings, however, it may often prove difficult to improve effective passive protection without undertaking drastic reconstruction. Any intervention of this nature is generally in contradiction with the requirements of the conservation lobby, who wish to preserve the character and authenticity of the original building as far as possible.
Active protection can be divided into organizational, detection, alarm and evacuation, and extinguishing measures.
From an organizational point of view, during public opening hours the majority of museums and historical buildings will be able to summon professional help relatively quickly in emergency situations.
Organizational measures include:

 staff training (prevention and intervention);

 provision of alarm and emergency plans;

 periodic maintenance and checking of firefighting equipment;

 keeping escape routes accessible and unobstructed;

 enforcement of good housekeeping rules;

 correct storage of flammable materials used for cleaning or restoration work;

 no portable heating equipment permitted;

 no smoking in any part of the building or in the immediate vicinity

Concerning the detection measures, the main tasks of an automated fire protection system are to detect (an incipient stage) fire, sound an acoustic alarm, notify the fire service and activate the pre-programmed control functions. Such a system consists of a control unit with peripheral input devices (such as manual call points and automatic fire detectors), output devices (such as sounders and beacons) and output contacts to control other systems (such as smoke control systems, heating ventilation and air-conditioning systems, elevators, automated extinguishing systems, etc.). To minimize the danger to life and the damage to property, it is important to detect a fire as early as possible.
Alarm and evacuation measures should be activated when a fire breaks out: prompt warning is essential and buildings must be evacuated within minutes to protect people's lives.
In the case of a historical building, museum, or archaeological site three distinct target groups are addressed:

 visitors for whom a hazardous situation has been detected;

 staff who should coordinate the evacuation;

 the people who should deal with the fire.

In addition to the type of alarm and evacuation system provided, evacuation plans, escape route identification, emergency lighting systems and smoke venting systems (where feasible) are essential to ensure a fast and safe evacuation of all persons.
As concerns the extinguishing measures, the following systems are usually employed:

 the hand-held fire extinguishers situated at strategic points throughout the building allow staff to suppress incipient fires quickly and effectively;

 automatic systems such as sprinklers generally react directly to the heat generated by the fire, releasing water from those sprinkler heads closest to the seat of the fire. The major objective is to prevent fire from spreading to other areas of the building.

As stated above, the awareness of how fires start and how they spread can help to reduce quite significantly the risk linked to them.

The basic fire protection objectives are to try to control all three of these factors:
- reduce the probability of fire by controlling potential ignition sources;
- minimize the potential effect by reducing the "fire fuel";
- inhibit fire development by limiting the oxygen supply (for more information see: https://www.downloads.siemens.com/download-center/Download.aspx?pos=download&fct=getasset&id1=A6V10859638).

On the basis of these three simple factors, it can be defined the current practice against fire in historical buildings, library, museum, archaeological site, etc.
Most common causes of fires in historic buildings are arson, electrical faults, open fires, smoking materials, candles, heating equipment, lighting, hot works such as welding, cutting, and similar uses during works of renovation, etc. (Watts 2008).
Regular cleaning, proper storage and disposal of litter, and other rules of good housekeeping are basic actions to prevent fire spread in the room of origin. Fire extinguishers, blankets and other basic equipment are at hand to allow people to extinguish an initial fire (Jensen 2006).
Arson is the most frequent cause of fire in historic buildings, fires can start outdoors and then be transferred into the building (CFPA 2013, 8). To avoid this problem, simple safety measures are adopted in the common practice. These measures prevent waste or flammable objects to be accumulated near the building, on the secondary entrances, exits, windows, and that waste containers to be not stored below a window or in front of doors, especially on escape routes.
The electrical installations in historic buildings are often outdated and can be causes of fire. Therefore, generally, some precautions are taken such as the upgrading of electrical systems with the standards set by law; setting safety distance of spotlights to the combustible materials; checking that electric light fittings are not equipped with overly powerful bulbs; verifying that electric light fittings are stable and are properly fixed; prohibition for staff and users to introduce unauthorized electrical items (for example portable equipment for heating, mini fridge, etc.
To avoid fire in electrical equipment, it should also be checked that:
- technical space is not used as storage facility;
- cables are intact and not pinched, and areas surrounding heat radiating equipment are clean and clear;
- lids and doors to distribution boxes, controller cabinets and switch bays are closed;
- distribution boxes and other electrical installations are not exposed to humidity;
- electrical heating equipment such as electric radiators, heating units, are not covered or placed in an unsuitable environment.

Defective or overloaded electrical installations can cause overheating or a short circuit that may cause a fire. Early instrumental detection of such defects can be fundamental in saving the building.
In case of old electrical installations thermography survey is carried out to detect hot areas in electrical equipment and circuits (CFPA 2013, 9).
These types of scans are used as routine safety checks to prevent problems that could lead to fire.
An important aspect is related to the so called "hot works", occurring during renovation and/or maintenance, as this can become a common cause of fire (CFPA 2013, 10). This kind of work could develop heat or cause sparking due to operations such as such cutting, welding, soldering. Fires start when the hot surface comes into contact with combustible material. For this reason, hot works should be performed under strict control.
In the same way, in case of restoration, it should be controlled that solvents, acids, and other materials used by restorers, are maintained according to the standards of safety and fire prevention.
Similar preventive measures are contemplated in case of restoration and diagnostics laboratories (with equipment, materials, and flammable chemicals), located in historic buildings, museum, etc.
Generally, fire compartmentation prevents spreading of fire from the origin room to other parts of the building. But in case of historic buildings usually a suitable fire compartmentation is not possible due to the peculiarities of the edifice.

In the case of modern structures, the spread of fire is usually restricted because of the proper distance between the rooms and the fire walls. When speaking of historic buildings, this often cannot be easily achieved.

Fire protection measures like fire detection systems, sprinkler systems and similar are installed to detect a fire in its early stage and to limit its spread. Besides the usual there are additional requirements for fire systems in historic buildings. They should be minimally invasive, sensitively integrated and reversible.

In this regard, some technological solutions have been developed for minimizing the invasive characteristics of fire detectors in historical buildings such those proposed in the project "Minimum Invasive Fire Detection for Protection of Heritage" (Jensen 2006).

Also, the employees and visitors can prevent spread of a fire with a fire extinguisher or other suitable manual firefighting equipment. It is essential to choose fire extinguishers that have sufficient extinguishing effectiveness for the expected fire and not give irreversible damage to the building and its content; portable fire extinguishers are placed in a prominent location and be clearly signposted.

Protection of cultural heritage buildings clearly starts from the protection of human life; for this reason, the responsibility of the evacuation lies on management of the building and the staff are trained to organize the evacuation, help people when needed and to alert fire fighters.

Escape routes in historical buildings often do not match the standards that today are required for fire safety or evacuation procedures. An assessment of capacities and dimensions of elements, such as doors, corridors, staircases, stairs, ramps, etc. is required in safety standard procedures, so in historical buildings, where sometimes it is impossible to reach these standard requirements, other kinds of measures need to be adopted. For example, in extreme cases a restriction of access to visitors should be put in place. Possible measures, often adopted to reduce risks for visitors and for CH, are the reduction of access to limited number of people and only by guided tours, providing additional support for disables.

Fire risk can be associated also to archaeological areas. In fact, a lot of archaeological sites, especially in the Mediterranean region, are covered with vegetation or situated close to forests. Therefore, they are exposed to increased risk of forest fire. Such fires may break out from within the site and spread towards nearby forests and other wooded land, or conversely start in nearby forests and spread to archaeological sites.

Wildfires are one of the main causes of the destruction of cultural monuments in recent years. The increase in seasonal temperatures caused an explosion in the number of self-ignited wildfires in forested areas. Fanned by the dry winds, and fuelled by dry vegetation, some of these fires became disastrous for many cultural heritage sites. Thus, beyond taking precautionary measures to avoid a forest fire, early warning and immediate response to a fire are the only ways to avoid environmental and cultural heritage damages.

In the current practices the actions for protecting archaeological sites are usually the following:

- create fire breaks near/around sites;
- remove potentially combustible objects close to the archaeological assets;
- remove vegetation and shrubs close to the archaeological sites;
- periodically cut weeds, especially in the warmer months, in the site and around its perimeter;
- wrap structures in fire proof materials to protect them from fire;
- for any building within the archaeological site, it should be adopted precautions as described above.

Often fire protection measures, like fire detection systems, sprinkler systems and similar are not installed to detect a fire in archaeological contexts. Fire alarm systems are generally installed only in the buildings.

Security staff employees can prevent spread of a fire with a fire extinguisher or other suitable manual firefighting equipment. In fact, portable fire extinguishers are placed in a prominent location and clearly signposted. In some cases, the site has a fire extinguishing system with water cannons in various points clearly signposted.

Another monitored aspect regards the storage of flammable materials used in temporary works of restoration and renovation. These materials must be stored in compliance with fire regulations, finally the hot work have to be monitored by the same criteria expressed above.

Regarding the archaeological excavations, inside the site, it is made prescription to do not store flammable materials, and to use flame retardant material for temporary cover of archaeological layers.

As a general rule for fire prevention, a fundamental aspect is the timeliness for alarm. In this regard, the FIRESENSE Project (Fire Detection and Management through a Multi-Sensor Network for the Protection of Cultural Heritage Areas from the Risk of Fire and Extreme Weather Conditions, www.firesense.eu) is interesting to note.
FIRESENSE aims to develop an automatic early warning system to remotely monitor areas of archaeological and cultural interest from the risk of fire and extreme weather conditions.
The FIRESENSE system will be based on an integrated approach that uses innovative systems for early warning (Figure 4).
The main aim of FIRESENSE project is to remotely monitor areas of archaeological interest from the risk of fire, and contemporary to provide weather data that can be used for efficient protection and preservation of cultural heritage assets. The project takes advantage of recent advances in multisensory surveillance technologies. The key idea is to place a Wireless Sensor Network (WSN), capable of monitoring temperature, and optical and infrared cameras on the sites. The signals collected from these sensors are transmitted to a monitoring centre, which will employ intelligent computer vision and pattern recognition algorithms as well as data fusion techniques to automatically analyse sensor information. The system will be capable of generating automatic warning signals for local authorities whenever a dangerous situation arises.

The approach proposed in the FIRESENSE project could become a current practice in monitoring fire in archaeological sites. According to this approach, multimodal wireless sensors can be deployed at the site, they will acquire periodic measurements from the environment (e.g. ambient temperature, humidity) and provide their readings through the network to the monitoring centre.
In the case of fire detection, the system should create an alert message for the firefighting management. Moreover, the system should receive data from official weather information services as well as from local meteorological station installed in the site and should create alerts in case of extreme weather conditions.
Detecting the starting position of a fire is only the first step in firefighting. After detecting a wildfire, the main focus should be the estimation of the propagation direction and speed, in order to help the forest fire management. If the vegetation model and other important parameters like wind speed, slope, and aspect of the ground surface are available, the propagation of the fire can be estimated. Finally, a Geographic Information System (GIS) could visualize the predicted fire propagation in 3D, providing services for decision and operational support in forest fire suppression.
A lot of projects, without specific reference to cultural heritage assets, can be found in the literature concerning fire and wildfire risk assessment. These projects and studies are addressed to map and develop predictive models to asses and prevent fire risks, especially in the Mediterranean Basin countries, where this kind of risk is particularly serious (EC 2007a; Catry et al. 2009).

2.4 Pollution

Degradation of building material may have various causes, including those related with chemical agents. The most frequent reasons of chemically affected damages are consequences of water, acid rain (acidification), carbonation, salinization, sulphate attack and oxidation.
The first of the chemical risks represents water from various sources: rain, fog, floods, surface water, groundwater, capillary action. In relation to this fact, it’s useful to remark that even the impact of ‘normal’ rain is intensified by slight acidity because of carbon dioxide – CO2 dissolving in rain-drops and forming carbonic acid – H2CO3:

$$CO_2 + H_2O – H_2CO_3$$

The influence of water on buildings can cause moisten, destabilization of foundations, leaching of some wall components, damage of roofs, leaking of interior, destruction of external and internal rendering etc.
One of the most aggressive impact on building materials is the acidification mainly caused by acid rain. Its principal cause is the reaction of sulfide and nitrogen compounds (emissions) with air moisture (rain-drops) mainly from human sources, but also from volcanoes. Formation of sulfuric acid is presented by the following set of equations:

$$SO_2 + OH\cdot \rightarrow HOSO_2\cdot$$

$$HOSO_2\cdot + O2 \rightarrow HO_2\cdot + SO_3$$

In case of presence of water, SO_3 is converted to sulfuric acid:

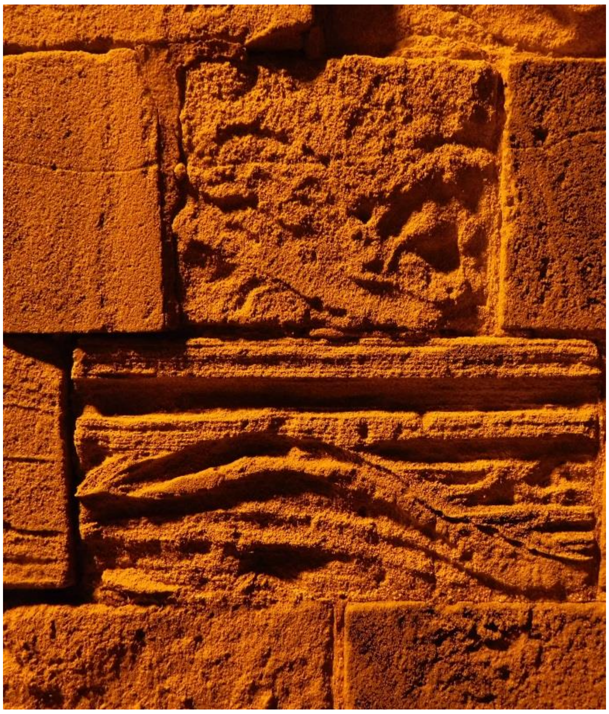
$$SO_3\ (g) + H_2O\ (l) \rightarrow H_2SO_4\ (aq)$$

Acid rain can damage both the rock/other constructional materials and the possible metallic parts of buildings that are exposed to rain or fog. Acids have a dissolving, leaching and corrosive effect on rocks (first of all on limestone/marble), bricks, concrete and lot of other building materials, Dissolved ions – e.g. calcium (Ca2+) or magnesium (Mg2+) – may further precipitate in form of Ca- /Mg-carbonates inside the cracks, or removed out of the building material and transported in solution outside the walls. When sulphurous, sulphuric or nitric acids in air and rain react with the calcite which form part of marble and limestone, the calcite dissolves.
Another source of the acidification may be presence of iron sulphides (mainly of pyrite – FeS_2 and pyrrhotite – FeS) in the rocks in building material (e.g. rocks or concrete) or in rocks underneath buildings. Moisture in connection with the oxygen contained in air may cause decomposition of the sulphides and formation of sulfuric acid.
Due to the acidic nature of soot, also fire and the related soot contamination could cause secondary damage to monuments. In fact, smoke penetrates throughout building material and causes not only discoloration, but also corrosion.
Very dangerous can be for walls also efflorescence. Several kinds of salts, transported by wind and water droplets on the surface of the building materials and are powerful minerals which are able cause great problems. Not only halite but also other saline solutions are formed also as a consequence of the use of road salt during winter time. Even more dangerous is the situation, when soil moisture – which is full of dissolved salts - infiltrate by capillary action the walls. As water evaporates, thus efflorescence crystals can grow, several times increase their size and destroy the mortar, protective plaster, affects porosity of bricks, concrete or rock wall material. Dissolves and grows of various salts can be repeated even several times during the day and this phenomenon depends on the climate. This process is most critical on those parts of buildings where there is a wider difference of temperature during the day. Efflorescence generates enough force to cause breakages or crumbles of building materials.
Industry and power-stations using fossil fuels (coal, oil, natural gas) generate metal particles and particles of soot, asphalt, fly-ash, quartz, calcite, chlorides and also sulphide dioxide gas – SO2. Sulphates in solution can modify their own chemical composition by effect of crystallization (salt attack) and recrystallization changes to the cement/mortar composition, microstructural effects leading to the weakening of the cement binder.
Frequent pattern on the surface of buildings is a black crust composed of gypsum, as a result of the reaction between calcite, water, and sulfuric acid. The sulphide dioxide gas concentrations in polluted air, cause first of all formation of sulfuric acid – H_2SO_4 black crust composed of gypsum – $CaSO_4{\cdot}2H_2O$ on surface of calcareous building material:

$$CaCO_3(s) + SO_2(g) \rightarrow CaSO_3(s) + CO_2$$

$$CaSO_3(aq) + 2H_2O(l) + \tfrac{1}{2}O_2(g) \rightarrow CaSO_4 \cdot 2H_2O(s)$$

On the other hand, gypsum is soluble in water, so it is usually washed away by rain.




Images 3, 4: Patterns of acid rain on sandstone and of efflorescence both on rocks and on mortar

Chlorides, particularly calcium chloride or lesser also sodium chloride, which are used to shorten the setting time of some cement containing components, are able leach calcium hydroxide and cause chemical (and consequently physical) changes in cement.
Also carbonation may influence the quality of the building material (mainly of concrete or cement). Carbon dioxide from air can react with the calcium hydroxide in walls to form calcium carbonate. The main problem of this slow and continuous process is the decrease of alkalinity, which is really important for corrosion prevention of the metal (steel) parts of buildings.
Free calcium hydroxide – $Ca(OH)_2$ – present in building structure can dissociate to form Ca2+ and hydroxide (OH−) ions. Water (moisture) may carry the calcium hydroxide and Ca2+ ions to the surface, where leachate solution contacts the air oxygen. In such a case, carbon dioxide (CO_2) from the atmosphere diffuses into the leachate and causes a chemical reaction, which precipitates $CaCO_3$ on the outside of the walls (so called 'calthemite'), causing decalcification of the structure.

2.5 Landslides and soil erosion

Landslides and similar phenomena cause major losses of historic objects and damage to the architectural heritage. They affect large areas and the damage is mostly irreparable (Canuti et al. 2009). A landslide event is usually caused by a combination of factors, the most important of which are:
1. the material properties of the soil/rock massif;
2. geological composition;
3. precipitation and water saturation;
4. slope inclination.

The Italian territory is also particularly prone to natural hazards, in particular many of architectural, monumental and archaeological heritage are exposed to landslide at national scale.
The data on this problem are provided by the Italian Cultural Heritage database (Risk Map, Carta del Rischio, realized by Central Institute for the Conservation and Restoration); the Italian Landslide Inventory (IFFI project) developed by ISPRA (Italian National Institute for Environmental Protection and Research) and the Regions and Self-Governing Provinces of Italy and the flood hazard zones defined by the Italian River Basin Authorities. Italian landslide inventory contains more than 486,000 landslides affecting an area of about 20,800 km2, equal to 6.9% of Italian territory. In order to estimate the number and type of cultural heritage at risk some GIS processing have been carried out, overlapping information from the above-mentioned databases. The analysis provided the following results: Cultural Heritage exposed to landslide risk were estimated to 5.511 (6.6%) while the ones exposed to flood risk results 9.859 (11.7%) (Iadanza et al. 2011).

Since early 90's the capability of Synthetic Aperture Radar (SAR) Interferometry technique (Massonet and Feigl 1998) have been exploited to study surface displacement and deformation due to different geo-hazard. In particular, the multi-image Permanent Scatterers SAR Interferometry (PSInSARTM) technique (Ferretti, Prati and Rocca 2000, 2001), developed by Politecnico di Milano and licensed exclusively to *Tele Rilevamento Europa* (TRE), showed its capability to provide information about ground deformations over wide area with millimetric precision, making this technique suitable for both wide and site scale investigations.
The IFFI project and *Carta del Rischio* (Italian Risk Map) represent two excellences in the field of thematic databases (at national and international level) for the methodology used, the details and completeness of data, and for online mapping services.

Landslides are one of the soil threats considered in the EU Thematic Strategy for Soil Protection and the related Proposal for a Soil Framework Directive. The Strategy calls for actions and means for the protection and sustainable use of soils as a physical platform on which human activities are developed. The proposed Directive requires to identify landslide and other soil threat risk areas in the European Union, set risk reduction targets for those areas and establish measure programs by Member States.
On 13 February 2012 the European Commission published the report "The implementation of the Soil Thematic Strategy and ongoing activities" (COM 2012, 46). The report provides an overview of the actions undertaken by the Commission to implement the four pillars of the Strategy, namely awareness raising, research, integration, and legislation. It also presents current and future challenges to ensure soil protection.

The report includes a preliminary version of the published landslide susceptibility map of the EU and neighbouring countries produced by the European Landslide Expert Group coordinated by JRC (Joint Research Centre).
The JRC provides scientific and technical support to the European Commission Services for the implementation of the EU Thematic Strategy for Soil Protection, both through its own work activities and in collaboration with national research organizations, mapping agencies and academia. The main activities and expertise of JRC include harmonization of methods for landslide mapping and zoning in Europe (inventory, susceptibility, hazard and risk) at various scales, development of satellite, airborne and ground-based remote sensing techniques for landslide mapping and long-term monitoring, analysis of lessons learnt from management of past landslide disasters, and geospatial database creation and management.
JRC started a series of collaborative activities with external partners within various frameworks linked to landslide management. For example, the European Landslide Expert Group was created and coordinated by JRC in order to develop landslide inventories and models for landslide susceptibility assessment and mapping at European and national scales.
JRC is also a member of the International Consortium on Landslides (ICL), an international non-governmental scientific organization supported by UNESCO, UNISDR, and other international organizations,

which aims at promoting and coordinating collaborative research and expertise, as well as capacity building on landslide disaster risk reduction.
JRC collaborates with EU Framework Program research projects devoted to landslide risk (e.g. the recent project SAFELAND - Living with landslide risk in Europe: Assessment, effects of global change, and risk management strategies).
Lastly, JRC is involved in the activities of the European Centre on Geomorphological Hazards (CERG), a specialized research network of EUR-OPA Major Hazards Agreement of the Council of Europe. CERG promotes international scientific cooperation and training on prevention of geomorphological and hydro-geological hazards and risks, especially landslides, gravitational flows and floods.
ELSUS1000 (European Landslide Susceptibility Map version 1) shows levels of spatial probability of generic landslide occurrence at continental scale. It covers most of the European Union and several neighbouring countries. The map was created by regionalizing the investigated area based on elevation and climatic conditions, followed by spatial multi-criteria evaluation. The location of over 100,000 landslides across Europe, provided by various national organizations or collected by the authors, has been used for model calibration and validation (Günther et al. 2014).
The map has been produced jointly by the Federal Institute for Geosciences and Natural Resources (BGR, Hannover, Germany), the Joint Research Centre (JRC, Ispra, Italy), the Institute of Physics of the Globe (CNRS-EOST, Strasbourg, France), and the Research Institute for Hydrogeological Protection (CNR-IRPI, Perugia, Italy).
An important initiative is the World Landslide Forum (WLF), a triennial mainstream conference aimed at involving scientists, stakeholders, policy makers, and industry to deal with the management of landslide risk. The first WLF was organized in 2008 by ICL, United Nations Educational, UNESCO, World Meteorological Organization (WMO), Food and Agriculture Organization (FAO), United Nations International Strategy for Disaster Reduction (UNISDR), and many other international organizations17.
The Third World Landslide Forum (WLF3) aimed at further developing the outcomes from the previous editions of the forum editions by providing a global cooperation platform for all types of organizations that could contribute to landslide research, practice, education, and decision making to strengthen strategies for landslide risk reduction. The emphasis of this forum is "*Toward a safer geo-environment*"18.
Other important project is DORIS19: an advanced downstream service for the detection, mapping, monitoring and forecasting of ground deformations, at different temporal and spatial scales and in various physiographic and climatic and environments. DORIS integrates traditional and innovative Earth Observation (EO) and ground based (non-EO) data and technologies to improve the understanding of the complex phenomena that result in ground deformations, including landslides and land subsidence, and to foster the ability of Civil Protection Authorities to manage the risks posed by ground deformations.
DORIS has improved the state-of-the-art in the science and technology currently used to detect, map, monitor, and forecast ground deformations. Improvements consist in the innovative exploitation of EO data and technologies. DORIS exploits the unique ESA ERS-1/2 and ENVISAT C-band Synthetic Aperture Radar (SAR) archives to provide unprecedented, very long time-series of ground deformations. DORIS will evaluate new sensors, including ALOS, COSMO-SkyMed and TerraSAR-X. DORIS projects operates in different areas selected in Hungary, Italy, Poland, Spain, and Switzerland.
A wide panorama of projects, devoted to landslide studied, has been reported above. However, prevention activities for landslides are usually performed at a local scale with the aid of different kind of instruments, which will be shortly described in the subsequent pages. These instruments are commonly used in European countries for monitoring landslides and soil erosion processes.
The deformation monitoring with GNSS (Global Navigation Satellite System) measurements is a well-known method which can be employed both for continental scale and local phenomena such as landslides.
A geodetic GNSS receiver is traditionally used in these applications because a high level of accuracy is needed even if but this system is quite expensive.
Nowadays, new technologies make it possible to use small and efficient low-cost single-frequency GNSS receivers, which are able to achieve a centimetric or higher level of accuracy, in static positioning. Under this point of view, the single-frequency receiver can be less efficient in estimating the ambiguity values of

the carrier phase, with respect to geodetic one. This characteristic is not negligible because, in order to have a positioning with a high level of accuracy, it is necessary to correctly estimate the ambiguity phase.
A ground network of GNSS CORSs (Continuous Operating Reference Stations) dedicated to offer a service for RTK (Real-Time Kinematic) positioning could permit us to bypass some of these limitations.
There is a large number of commercial mass-market GNSS receivers, which are very cheap (<300 US dollars) and light (<50 grams). These sensors are totally different from the first GNSS receivers, which were bulky and expensive. Actually, the new generation of receivers is usually offered as a small card or customized with a dedicated interface.
Low cost and small size are key elements in choosing these single-frequency receivers in order to describe a phenomenon of deformation with a large number of monitoring points and a high number of sensors involved in the field.
Moreover, the better performance derived from the new generation of GPS satellite and the increased number of available GLONASS satellites, led the users to employ the single-frequency receiver in different types of monitoring such as landslides, other natural phenomena and buildings, often combining additional measurements.
The instrumentation usually used for GNSS monitoring usually consist of: single-frequency GNSS receivers kit and default antennas, RTK permanent network connection, Geodetic RTK rover receiver, and a software for single-frequency GNSS receiver control. This software can provide a powerful platform for data evaluation, configuration, testing and real time performance visualization of GNSS receiver data. The software provides a convenient means to configure the GNSS receiver, to save customized configuration settings in the GNSS receiver flash memory and to restore factory settings if needed.
These kinds of receivers, if damaged or un-recoverable (due for example to rock fall, atmospheric event, etc.), can be considered mass-market receivers, or “throwaway instrumentation”, with less economic damage than the use of geodetic receivers.
It is possible to apply other low impact techniques for risk prevention in landslide areas. In order to identify landslide surface and estimate the involved volumes, 3D laser scanner acquisition can be used at different times:

- in the pre-disaster phase, to monitor deviations (also sub centimetre) of landslide risk areas. The control can be done periodically comparing the point clouds acquired at different times with the 3D laser scanner;
- in post disaster phase laser scanning surveying is performed to accurately map of the landslide geometry and estimate the involved volumes.

The collected data allow to extract a Digital Terrain Model (TIN) of the landslide body (after having removed artefacts and sparse vegetation form 3D laser point clouds). It is possible to obtain a model at the beginning of investigations for a detailed description of the area aimed at assessing the landslide area and volume, as well at precisely locating of the potential surrounding area subjected to risk. Reference cross sections for the implementation of slope stability analysis are extrapolated from the two 3D model.
Total Stations are perfectly suited for continuous measurements in monitoring of historic buildings, archaeological sites, geological contexts, landslides, etc.
The Total Station is a surveying instrument that integrates an electronic theodolite with an electronic distance meter (EDM Electronic Distance Measuring or EDME Electronic Distance Measuring Equipment). It is also integrated with microprocessor, electronic data collector and storage system. With the aid of trigonometry, the angles and distances may be used to calculate the actual positions (x, y, and z or north, east and elevation).
Motorized Total Station with automatic collimation precision functions are available on the market. This facility makes them more practical and efficient for repeating the monitoring operations during the time, on a local scale.
The advantages of this system are considerable:

- it always guarantees high accuracy, independent from collimation errors by operator;
- it allows faster measurement times;

- it makes research, engagement and tracking of the reflector in automatic way after the first measure.

The Total Station is recommended for the supervision of landslides and mudslides in areas of cultural interest: the TS must be settled on a stable base (in an area which is not affected by the phenomenon to be monitored), not far from the GCP (Ground Control Point) to be monitored, in order to assess the landslides movements in the three directions.
The study of a landslide usually occurs according to well codified phases that include:

- identification, delimitation and classification of the instability;
- checking its evolution by measuring the superficial and deep movements;
- analysis and evaluation of possible evolutionary scenarios;

The precision required for the measurement of surface displacements related to a disruption is, in most cases, centimetre and, in some cases, also sub centimetric.
The monitoring requires, almost always, the creation of pillars, reliable and durable in time, in correspondence of control points representative of the investigated phenomenon as well as in external points of the investigated area, for the creation of the reference with “datum”.
Similarly, the TS can be used for structural assessment and monitoring of monuments and historic buildings interested in geological and landslide events.
TS can be used for in continuous monitoring, through:

- a motorized Total Station S with automatic precision collimation functions (self-centring system with CCD digital video camera, which allows an accuracy below 1 mm for distances up to 200 m, and an accuracy in the angular extent of not more than 2");
- a management system consisting of a computer for the control of the station, processing and displaying data and a system for the data transmission;
- reflective targets installed in the monitoring area or placed on the infrastructure to monitor a landslide on fixed GCP. Moreover, additional target should be installed on buildings not involved in the phenomenon aimed at constituting the reference datum for controlling the stability of the TS and for the geo-referencing of the system with respect to points the WGS84 absolute coordinates.

The continuous monitoring system allows to perform measurements with hourly basis, or daily, in order to follow, in near real time, the deformation evolution patterns and save them in a database.
The measuring system on a weekly or monthly basis is usually accomplished using motorized or traditional TS; the procedures are the same as those described above with the only difference in the ability to automatically fit storage and remote transmission.
In these cases, the monitoring is repeated at regular intervals by an operator who provides to reposition the TS on its fixed base and to measure the target and of the GPC.

3. Other RUINS Countries

3.1 Poland

The Monuments Protection and Preservation Act is the basic and most important legislative act on the protection of cultural heritage, which governs the rules of protection and preservation of monuments, defines the notion of monument, defines the object, scope and forms of monument protection, organization and competence of monuments conservation authorities (including government and self-government administration), the rules of financing conservation, restoration and construction works on monuments.

The law defines the concept of protection of monuments and preservation of monuments: Protection of monuments consists, in particular, in the actions taken by public administration bodies to:

1) providing legal, organizational and financial conditions for the permanent preservation of the monuments and their development and maintenance;
2) prevention of threats that may damage the value of monuments
3) thwarting the destruction and misuse of monuments;
4) preventing theft, disappearance or illegal export of monuments abroad;
5) control of the state of preservation and destination of monuments;
6) include protective tasks in planning and spatial planning and in shaping the environment.

The preservation of the monument is exercised by its owner and consists, in particular, in ensuring the following conditions:

1) scientific study and documentation of the monument;
2) conducting conservation, restoration and construction works at the monument;
3) secure and maintain the monument and its surroundings in the best possible condition;
4) use the monument in a manner that ensures its permanent preservation;
5) popularizing and disseminating knowledge about the monument and its importance to history and culture.

In addition, the law defines forms of protection of monuments:

- entry into the register of monuments, which for the monuments located in the voivodship is maintained by the Voivodeship Conservator of Monuments
- recognition as a Monument of History by the President of the Republic of Poland
- creation of a cultural park (created on the basis of a resolution of the municipality council)
- protection arrangements in the local spatial development plan

Protection of monuments entered in the register of monuments is held by the state conservation administration (Voivodship Offices of Monuments Protection in each of 16 voivodships)

The law also defines the duties and powers of local self-government in respect of the protection of monuments and the preservation of monuments. The duties of the municipality include in particular:

- keeping Communal Inventory of Monuments
- preparation of the Communal program for the preservation of monuments
- Include the protection of monuments in spatial planning.

Estimation of dangers and monitoring

In Polish system of monument protection, the problem of dangers threatening the monuments - their identification, prevention and elimination may be solved mainly by the accomplishment of the statements of The Law of Monument Protection and Preservation, which was intended by the legislator to provide suitable tools in order to prevent the unfavorable activities threatening legally protected monumental objects. The issues of preventing various threats that endanger the protected objects and monumental areas are legally defined, among others by determining the forbidden activities and specification of the activities that require permission of the voivodship monument conservator. The protection of monuments carried out by the public administration unit consists, among others in preventing threats that could affect the value of a monument in a negative way, and in counteracting the damage and the and the improper exploitation of the monument. Besides, the conservatory services are endowed with the prerogatives to control the monument and its threats. The threats should also be identified by the monument owner who is obliged to inform the conservatory services immediately about any danger. Practically, however, (and for many reasons) those activities are not often accomplished or executed. There is also a need for systemic activities within this realm, both with regard to the identification and counteracting threats (monitoring threats) as well as carrying the monitoring of the management activities.
The form of an overall, systemic enterprise carried out on the basis of unified methodological assumptions (for the whole resource of registered immovable property monuments) and concerning, among others, the threats, was a verification of the monumental resources carried out by the National Heritage Institute during the years 2009-2015[2]. All the monuments were submitted to an area view and the basic objective of the verification was to establish the actual resource of the legally protected immovable property monuments. That is why the verification was focused upon pointing out several verification groups: the no-longer existing objects, objects taken to museums and skansen museums and the objects that have lost their monumental values – in order to cancel them from the monument register. The verification also helped to point out the monuments directly endangered with the loss of their monumental value, in order to make the conservatory services take up the immediate restoration activities. The verification and estimation of the state of the monuments carried out in 2016 at the representatively pointed out statistical specimen has become the basis for the elaboration of the Complex report concerning the state of preservation of the registered immovable property monuments (*Register Books A and C*)[3]. However, the report cannot be the basis for presenting the overall estimation of the state of preservation and threats of the mediaeval castle ruins submitted to protection by the act of registering them. It results mainly from to facts – the lack of a precise determination of the object of protection (and the onomatology) with respect

[2] The verification comprised the monuments registered before September 2008, i.e. 62291 objects.

[3] The items of information have been quoted on basis of not-yet-published working materials from the Complex report of the preservations state of the immovable property registered monuments (Register Books A, and C) – in the collection f NID. The report will be published on December 2017. The completion of the report required the statistical research of the state of preservation of immovable registered monuments, specimen representative for the resource of monument register comprising 1303 immovable objects located across the area of the whole country.

to the castle ruins in the decisions concerning registration, as well as the fact, that the statistically pointed out specimen of monuments submitted to a detailed estimation of the state of preservation (in the technical sense as well as the monumental substance) was not representative for the particular categories of monuments (also the castle ruins). However, some data from the report are worth quoting that point out the scale of disadvantageous phenomena and threats with respect to the registered castles[4]. The verification group determined as: specially endangered objects that did not lose their monumental values comprised 15%[5] of the overall number of 405 registered castles. The proportion of castles endangered with the loss of their value is 30% of the endangered objects coming from the mediaeval period[6], while 15 castles regarded as endangered objects are privately owned.
In case of historical ruins of castles, the identification of threats and monitoring those objects is an especially significant issue. The specific character of these monuments (first of all the exposition of the walls to the operation of atmospheric factors), the climatic conditions typical for Poland and a relatively non-durable material of a great number of the ruins (sandstone, limestone, bricks) are the reasons of the rapidly progressing negative changes of their technical state. With respect to the unexploited and unsecured ruins the process is really fast. The fact that no periodical, repeated estimations of the state of the monument resource is the reason why our knowledge of the resource and its state is incomplete. Another crucial problem and a threat for the value of the resource is the development of the ruins for their new functions which is usually concerned with the intentions (and accomplishments of the manager to reconstruct some parts of the object.

3.2 Slovenia

Modern heritage protection encompasses more than simply the protection of buildings and objects. By considering the spatial totalities and values of the cultural environment, it brings together the expertise of the fundamental disciplines of archaeology, architecture, ethnology, landscape architecture, history, technical history, art history and urban history, and the specialist knowledge and theoretical approaches of conservation, restoration and preventive archaeology.

Conservation

Conservation as an interdisciplinary discipline combines all types of policies, strategies, legal, administrative and technical measures as well as tasks and assignments in connection with cultural heritage and its preservation. Conservation also includes the development of an awareness about heritage, its meaning and the conservation tasks owners and the general public should be aware of.

Restoration

Restoration comprises a variety of activities that are directly carried out on the heritage building or object with the purpose of facilitating its enjoyment, understanding and use. Activities are carried out in the event

[4] Most of the historical castle ruins were taken into account within the group of castles.

[5] In the assumptions for verification the following threats were mentioned: the lack of an owner, lack of protection, improper exploitation, non-regulated legal state, landslips, ground-water, mining – damages, investment threats of the object, investment threats of the premises wearing out of the construction and material.

[6] *Kompleksowy raport o stanie zachowania zabytków nieruchomych wpisanych do rejestru zabytków (Księgi Rejestru A I C, mps w zbiorach NID, s. 88.*

of a loss to the value or functionality of cultural heritage due to prior alterations or deterioration. Restoration activities are based on a respect for the original material and the historical context.

Institute for the Protection of Cultural Heritage (IPCHS/ZVKDS)

Slovenia established the Institute for the Protection of Cultural Heritage to protect immovable cultural heritage as a public service. The first such institute dates back to the second half of the 19th century; since then it has gone through a series of statutory and organisational changes, mainly due to the changes to state frameworks and territorial jurisdiction that occurred in the 20th century. Today, the ZVKDS has the status of expert organisation at the Ministry of Culture and is not directly subordinate to the minister. The ministry itself has a Directorate for Cultural Heritage, a purely administrative body responsible for dealing with legislative and administrative heritage protection issues, while all expert work is the domain of the ZVKDS.

The principal tasks of the IPCHS/ZVKDS include:

- Identifying, evaluating and recording cultural heritage ;
- Drawing up proposals for new structures and areas for the Registry of Immovable Heritage;
- Compiling conservation plans and restoration projects;
- Monitoring and/or implementing construction, research and protection work on heritage structures and areas;
- Monitoring all archaeological research;
- Advising owners/proprietors of cultural heritage structures, and conducting education and promotion work.

The IPCHS/ZVKDS has two major offices:

- the Office for Cultural Heritage, responsible for developing and implementing protection strategies, and for issuing protection recommendations and protection conditions (KVP);
- the Centre for Conservation,responsible for undertaking research and restoration work on heritage structures and areas. The centre itself consists of two units, the Centre for Preventive Archaeology (CPA) and the Centre for Restoration, both acting as expert services with no executive or administrative powers. The CPA's primary task is to carry out preventive research in cases where such research is funded by the state budget and preventive research (estimation of archaeological potential) within spatial planning procedures, most frequently in cases of large (mostly publicly funded) infrastructural projects, e.g. motorways, pipelines, power plants, etc.

Cultural Heritage Protection Act /Zakon o varstvu kulturne dediščine

In 2008 Slovenia introduced major reforms to cultural heritage protection that included changes to the legal status of the various components of cultural heritage, along with major organisational changes to the public service responsible for heritage protection. Archaeology had been the particular focus of these changes since the early 1990s, when large-scale rescue projects were launched in response to motorway construction. It was at this time that the La Valletta Convention was ratified (1999) and implemented. The implementation itself required further changes to the archaeological heritage protection system, which in 2010 or so evolved into what can now be termed 'preventive archaeology.

The most recent Cultural Heritage Protection Act (Zakon o varstvu kulturne dediščine , *Uradni list RS, št. 7/99, 110/02 – ZGO-1, 126/03 – ZVPOPKD in 16/08 – ZVKD-1)* recognizes three legal protection statuses: a) cultural heritage (registered), b) cultural monuments of local importance (statutorily protected) and c) cultural monuments of national importance (statutorily protected).

One of the most important achievements of the 2008 act was to insert heritage protection within the spatial planning process; this means, in general, that no spatial plans or subsequent development can occur or be adopted without proper consideration of the impact on cultural heritage. If it is deemed necessary in a particular case, preventive archaeological research is conducted in order to properly evaluate heritage content and any area of land containing heritage, at all three major levels of spatial planning: the National Spatial Plan (DPN), Municipal Spatial Plans (OPN) and Detailed Municipal Spatial Plans (OPPN).

This process includes a consideration of all existing documents on monument declarations and on registered archaeological sites and heritage, cultural heritage impact studies, and expert opinions and recommendations by the relevant bodies responsible for cultural heritage protection. It is here that preliminary or preventive archaeological research is normally planned and implemented in order to:

- Obtain the information required to evaluate heritage prior to development or to any other physical interventions on the land;
- Prescribe more detailed protection measures;
- Monitor the removal of heritage (e.g. excavations) prior to development.

3.3 Croatia

Protecting and Preserving Cultural Heritage in Croatia

The Croatian Ministry of Culture ensures the preservation of cultural heritage and values. The Ministry performs administrative and other tasks related to: research, study, monitoring, recording, documenting and promoting cultural heritage; central information and documentation service; determining the properties of protected cultural goods; prescribing benchmarks for determining the program of public needs in the culture of the Republic of Croatia; care, harmonization and supervision of funding for the program of cultural heritage protection; establishment and supervision of institutions for carrying out cultural heritage activities; assessing the conditions for the work of legal persons in restoration, conservation and other cultural heritage conservation activities; providing conditions for the education and training of skilled workers in cultural heritage affairs; implementation of traffic control, import and export of protected cultural goods; determining conditions for use and reuse of cultural goods, and managing cultural assets in accordance with regulations; determining special construction conditions for the protection of cultural heritage sites; carrying out inspection activities for the protection of cultural heritage.

In June 2016 the ODA special platform was established (http://data.gov.hr/), accessible to users of the Ministry of Culture, by means of which through the Open Data Portal one can access public information on protected sites in an easily searchable and machine-readable form.

Laws and Regulations

• Low for protection and conservation of cultural goods (NN 69/99, NN 151/03; NN 157/03 Ispravak, NN 87/09, NN 88/10, NN 61/11 , NN 25/12, NN 136/12 , NN 157/13,NN 152/14)

The present law contains the rules and regulations for conservation and protection of all cultural goods in Croatia. This document serves as basis for all activities regarding the cultural goods. It defines the rules and regulations for the form and criteria of object; the content, activities and management of cultural good.
The first Article of the present Law defines:

> the type of cultural goods, the procedures for determination of needed protection; the obligations and rights of the owners of the cultural good enlisted; the measures of protection and preservation of cultural good; the activities and actions that can or cannot be carried out on the protected object; the measures for the administrative obligations and regular inspections; the competences and obligations of the Croatian Council for cultural goods; the rules and regulations for the financing of protection and preservation measures on cultural goods; and other issues regarding protection and preservation of cultural goods.

The first Article defines as well the criteria and categories for defining the status of immovable cultural heritage as established cultural heritage of Croatia.
The Ministry of Culture protects the architectural and other heritage through the Department for the Protection of Cultural Heritage with the Network of Conservation Departments in all major cities. Established by the Ministry of Culture, in Croatia there are 21 Conservation effective offices.

- Based on the Act on the Protection of the Cultural Heritage (Official Gazette No. 69/1999), the Croatian Council for Cultural Property is set up to monitor and improve the status of cultural goods. Council discusses on general issues of protection and conservation of cultural goods and makes recommendations for enhancing the activities of protection and preservation of cultural goods, introduces cultural heritage protection programs and their implementation, proposes to the Minister of Culture the cultural domains that are threatened and need to be protected, discusses transgressional issues in the field of protection and preservation of cultural goods and proposes solutions.

The council has a president and eight members. The president and three members of the Council are appointed by the Minister of Culture from the line of prominent experts for the protection and preservation of cultural goods. The members of the Council are: Director of the Croatian Restoration Institute, Director of the Croatian State Archives, Chief Director of the National and University Library; representative of the Croatian Museum Council and a representative of the state administration bodies responsible for the protection of nature and the environment.

The Council works in sessions where the majority of the members is present, concludes by majority of the votes of the present members, and the decision is made by a majority of the total number of members. If necessary, the Council may establish expert committees for the purpose of discussing expert issues on the preservation and protection of cultural goods.
Administrative Affairs of the Council are performed by the Ministry of Culture, and funds for its work are provided in the state budget.

- The Strategy for the Conservation, Protection and Sustainable Economic Use of Cultural Heritage of the Republic of Croatia for the period 2011-2015. has been launched.

The purpose was to consider and analyze the existing system of protection and preservation of cultural heritage as well as to develop the attitude towards the present, especially viable, use of heritage, and to identify goals, measures and activities in order to use the cultural heritage and its potentials more successfully and efficiently on the principles of sustainable development.
The Draft Strategy was developed in the Working Group composed of experts for protection and conservation of cultural heritage from the Ministry of Culture and Professional Organizations and other experts for sustainable use of cultural heritage. Starting from a critical review of efficiency today, suggestions were made as to what should be done to improve sustainable use of cultural heritage.
It contains guidelines and measures as a framework for concrete development of the projects for the sustainable use of cultural heritage. Considering that the conservation and the re-use of cultural heritage

needs to be sustainable it is essential to establish and develop a strong cross - sectoral link in its implementation.

Conservation

- History

The foundation of the Institute for Restoration of Art at the Yugoslav Academy of Science and Arts in Zagreb in 1948 is considered as the beginning of restauration and conservation offices on the territory of Croatia. The institute itself was created from the restoration workshop of the Zagreb Museum of Arts and Crafts, which operated from 1942 until the end of 1946 and employed 2 restaurateurs. Later on, there were also conservation workshops in Split (1954) and Zadar (1958), and in 1966 the Restoration Institute of Croatia was founded. After the independence of the Republic of Croatia, all these institutions were merged into one in 1997, the today's Croatian Restoration Institute.
As far as archaeological finds are concerned, it has to be emphasized that the conservation of these has begun in the 19th century. Unfortunately, unlike some other highly developed European Union countries, in Croatian museums, no chemist has ever been involved in the elaboration of conservation procedures and the scientific analysis of the subject – even today in Croatia there is no separate institute for archeology.

Laws and Regulations for the restauration and conservation

Except for the general acts of law, the work of conservation and restoration services in Croatia today are primarily determined by the following regulations:

- Museum Act / 21.10.2015. /
- Regulations on conditions and methods for acquiring professional skills in museum sector / 22.07.2010.
- Regulations on Professional Qualifications in Conservation Restoration Activity, Conditions and Methods of Acquisition /11.05.2009./,
- Regulations on Conditions for Natural and Legal Persons to Obtain Licenses for Performing Activities on the Protection and Conservation of Cultural Property /24.04.2003./.

Regarding the rights of the restorers in Croatia, the situation is unsatisfactory. The rights of the restoration employees in museums have been particularly jeopardized. Ministry of culture still didn't find the way to equalize the rights of restorers employed in museums with the rights of restorers working in the Conservation Department office or as free lancers.

The status of a restorer in the museums is clearly explained by the fact that only one (1) restorer (in more than 197 years of public museum activity in Croatia) stands out in the archives of the Museum Documentation Center as a meritory employee.

In the end, we add another feature of conservation/restoration in Croatia - despite all the above mentioned in Croatia we still have no general knowledge about all the obligatory principles of preservation of restoration.

Professional Associations in Croatia:

Section for Restoration at the Association of Fine Art and Artists of Croatia,
Croatian Restoration Society,
Section of the restorer and preparation experts at the Croatian Museum Society,
Croatian section at The International Institute for the Conservation of Historic and Artistic Works.

3.4 Czech Republic

The basic legal in field of culture heritage regulation is the **Act on State Monument Preservation** (Zákon o státní památkové péči) **No. 20/1987 Coll.**, as amended, including decree of the Ministry of Culture (vyhláška ministerstva kultury) No. 66/1988 Coll., implementing the act of the Czech National Council No. 20/1987 Coll., on State Monument Preservation. The monument preservation act has been subject to many amendments.

The requirements and content of the plan for the protection of heritage reservations and heritage zones are regulated by decree of the Ministry of Culture of the Czech Republic (vyhláška ministerstva kultury) No. 420/2008 Coll.

Degrees of protection:

- National Cultural Monuments – the most important cultural items (e.g. ruins of the Hussite's Castle Kozí Hrádek, ruins of the medieval castles Bezděz, Kunětická Hora, Lipnice nad Sázavou, Přimda, Rabí, Trosky, Velhartice)
- Cultural Monuments – listed monuments listed in the Central Register of Cultural Monuments (the vast majority of ruined castles and churches)
- The location on the territory of specific heritage protection:
    - Heritage Reservation (MPR, VPR)
    - Heritage Zone (MPZ, VPZ, KPZ) or in the buffer zone of Cultural Monument or some of the MPR, VPR, MPZ, VPZ[7]

The national monument preservation system is based on consistent decentralisation and delegation of executive powers in state monument preservation to approx. 205 municipalities with extended competences. The state administration of a selected group of "national cultural monuments" (a total of 304 objects) is performed by Regional Authorities. The Ministry of Culture develops concepts for the development of monument preservation. It decides on the declaration of properties as cultural monuments and ensures financial assistance programmes for monument owners. Also, expert advisory service is mandatorily provided both to municipalities and to regions with delegated functions of state administration and is also free of charge for the owners of monuments and centralised in the interest of unified expertise and methodological principles. It is provided by the National Heritage Institute (´NHI´), founded by the Ministry of Culture.

Divisions of National Heritage Institute (Národní památkový ústav):

- a central methodological unit coordinating activities at the national and international level (NPÚ GŘ)
- specialist guidance and supervision to protected buildings and objects, heritage protection areas, and related research and development (NPÚ ÚOP regional units)
- care of the cultural monuments open to the public, above all castles and mansions, that are directly managed by the National Heritage Institute (NPÚ ÚPS regional units)

There are also the **Act on the return of cultural assets unlawfully removed from the territory** (Zákon o navrácení nezákonně vyvezených kulturních statků), as amended by act No. 180/2003 Coll. No. 101/2001 Coll. And the **Act on**

[7] M – urban, V – vernacular, K - landscape

the export of some cultural assets from the customs territory of the European Communities (Zákon o vývozu některých kulturních statků z celního území Evropských společenství) No. 2 14/2002 Coll.

The main international conventions on CH ratified by the Czech Republic

- The European Cultural Convention (Council of Europe), ratified in 1993
- The Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property (UNESCO), ratified in 1993
- The Convention for the Protection of the Architectural Heritage of Europe (Council of Europe), ratified in 2000
- The European Convention on the Protection of the Archaelogical Heritage (Revised - Council of Europe), ratified in 2000
- The European Landscape Convention (Council of Europe), ratified in 2004
- The Convention concerning the Protection of the World Cultural and Natural Heritage 1972 (UNESCO), ratified in 1993
- The Second Protocol to the Hague Convention of 1954 for the Protection of Cultural Property in the Event of Armed Conflict 1999 (UNESCO), ratified in 2007
- The Convention for Safeguarding of the Intangible Cultural Heritage (UNESCO), ratified in 2009
- The Convention on the Protection and Promotion of the Diversity of Cultural Expressions (UNESCO), ratified in 2010

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