Alpine cultural heritage and natural hazards: where do we stand?

Review and survey for the framework analysis on Alpine cultural identity and natural hazards

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Review and survey – framework analysis on Alpine cultural identity and natural hazards

Document references

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Scope:

A brief description of project part A.T1.1

Representing document includes a capitalization process framing the state in the definition of the concept of Alpine cultural heritage, in relation to specific environment where it developed and selected natural hazards it is exposed to in the Alps. It is a review of previous project results, initiatives, strategic documents from the Alpine area and analogous regions, integrated with inputs from relevant sources at national and transnational level (e.g. expert interviews).

The survey results presented in this document have been developed on the basis of the evidence of the specificities and values of the alpine cultural heritage at risk because of a system of natural hazards they are exposed to.

Two main issues are therefore tackled. The first one is the occurrence of the different typologies of natural hazards in the alpine regions (of the six countries participating in the project). The second one considers the policies and tools for the protection of cultural heritage and properties if a disaster occurs.

Finally, a review of the results of previous projects (at the national and European level), initiatives, strategies and policy documents involving or dedicated to the cultural heritage of Alpine area and analogous regions is provided, integrated with inputs from relevant sources at national and transnational level.

Key words

cultural heritage, Alpine region, natural hazard, protection

Forward

As in the presentation of the EUSALP action group 6, one of the main features of the Alpine Region are its outstanding natural and cultural resources. The morphological and geographical characteristics of this territorial area and the natural environment have shaped the life and the economy of the local communities over the hundred years. Due to a number of quite easy natural passages through the mountains, the alpine region is also peculiar for the transnational relationships and exchanges built up by the alpine populations in different countries. These dynamics produced, in many cases, similar economic activities, architectures, pieces of arts, handicrafts and communities' traditions, among which common languages spoken by communities in different countries, some religious customs and food dishes (object of several European funded projects under different funding programs like the Interreg Alpine Space and the LIFE).

The richness of the resources and the variety that characterizes the alpine area can therefore be observed under the double perspective of a unique, quite homogenous, macroregion and of a system of local specificities.

From the one hand, the Alpine Macroregion is recognized by the European Commission, as in ESPON, EUSALP and Interreg Alpine Space as a system of territories with common characteristics and a history connecting them. It becomes, therefore, object of common policies. On the other hand, it is important to highlight and valorise the different development paths, as well as diversified are the current images of the Alpine areas in terms of quality and characteristics of individual socio-economic systems.
We then speak of places characterized in a strong and substantial way by being Alpine in a "plural" sense and, consequently, characterized in various ways and shapes by that series of elements and dynamics that many studies have now helped to highlight as "specific ". Here the reference is to the increasingly solid and widespread literature on the subject produced as the result of many seasons of European investments in theoretical and applied research projects on

the most diverse themes within, among others, the Interreg AlpineSpace program[1].

Four main categories of factors can be recognized as main development factors[2]:

- Material resources - elements of the natural environment, renewable and non-renewable raw materials, natural and man-made landscapes, built cultural heritage and works of art, traditional architecture;
- Intangible resources - local culture and traditions, socio-economic structure, knowledge, cooperative and social forms (for example applied to agriculture and handicraft activities but also, in many cases around the Alps, to the banking sector), propensity to active participation by the local communities, associative and organizational models for the production of territorial services;
- Activities - specific local productions related to handicrafts, agriculture, breeding and the use of raw materials and energy sources in specific manufacturing sectors (for example textiles), resources that have left evidence of their flowering in buildings and cultural heritage of high historical and artistic value;
- Territory - set of elements linked to the socio-economic model inserted in a specific geographical and natural context and characterized by some specificities in terms of production and consumption activities.

Assuming the UNESCO[3] perspective as a reference for more precisely focusing the cultural heritage as the target of the CHEERS project, common characteristics can be envisaged in alpine territories, both tangible and intangible. Values are related to individual elements as well as to the cultural heritage system as a whole. The alpine traditional way of life, production and consumption models, history, culture and the outstanding natural environment and landscapes can be well perceived in the different typologies of tangible and intangible cultural heritage spread around and, in some cases, in very isolated locations:

[1] See, among others, the projects CulturALP (http://www.alpine-space.org/2000-2006/culturalp.html) and CAPACities (http://www.alpine-space.org/2007-2013/projects/projects/detail/CAPACities/show/index-2.html)

[2] Pesaro G. (2012), "Distretti culturali nelle Alpi tra omogeneità e specificità: le determinanti di esiti diversi in due casi lombardi", Acta XXXIII Italian Conference of Regional Science, Rome, September 13-15 2012

[3] UNESCO (1982), Mexico City Declaration on Cultural Policies World Conference on Cultural Policies, Mexico City, 26 July - 6 August 1982 http://www.culturalrights.net/descargas/drets_culturals401.pdf

- Historical mobility and accessibility infrastructures, like the UNESCO Heritage Bernina line, a rail line which connects Italy and Switzerland through a passage in a glacier and over ancient bridges;
- Monuments and votive chapels along the mountain trails, built in the past to provide a place for a little rest during the transhumance or protecting the people travelling for work or commercial purposes;
- Churches and other religious buildings and sites, telling the story and living conditions of the alpine people and families. For instance, it is quite easy to find frescos on the external wall of churches all along the Alps with the image of Saint Christophe, protector of the pilgrims which used to cross the Alpine passes over the centuries;
- Museums, collections and archives, that bear witness of the history, culture, arts, crafts and knowledge of the alpine people;
- Decorated ancient palaces and villas enriched with furniture, furnishing and pieces of arts and handicrafts, where wealthy families used to exhibit their well-being;
- Fortresses, military buildings and other traces from the wars which took place along the Alps, a cultural heritage which is more and more recognized at the international level, as demonstrates the so called Walk of Peace from the Alps to the Adriatic, which is in the tentative list of UNESCO;
- Production sites, like early hydropower plants or mines, like the UNESCO Heritage of Mercury which includes the mines of Idrija, in Slovenia;
- Prehistoric sites and rock engravings, like the UNESCO Heritage Rock Engravings National Park of Naquane in Italy
- Urban and rural traditional buildings and historical centres.

Because of the same geographical localization, geomorphology and characteristics of the environment that gave birth to the alpine cultural heritage, the heritage resources themselves are often undermined by a wide range of risks and natural hazards, such as floods, earthquakes, fires and avalanches.

It becomes more and more important to identify and implement tools able to increase and ameliorate knowledge

about the hazards themselves and the characteristics they take in this specific environment. Moreover, it is crucial to better understand and share how to slow down the increasing vulnerability of cultural heritage pieces according to their specificities, which have to be protected not only as human capital but also as witnesses of the past of the Alpine people. As in any other territorial area, it is expected that local and overlocal initiatives will be proposed and implemented in such a way as to favour the development and implementation of governance and management tools capable of reconciling the needs of protection with those of activation and enhancement of local heritage in its particular context.

For sure, the prevention to cope with natural hazards would be the best way to protect people, houses and cultural heritage, but effective preparation to face emergencies, lead-time procedures, salvaging and rescue activities are crucial as well, when dealing with a list of assets that risk being lost forever or heavily damaged by disasters. As shown in several regional assessments, even though cultural heritage in the Alps is subject to general local protection, the specific safeguard from natural hazards during the emergency and recovery phases still lacks proper regulatory settings, operational abilities and widely-shared knowledge of the socio-economic value embodied into assets at stake. On the other hand, as it will be underlined in the following chapters, there are natural hazards which are more likely to happen in the Alps than in other areas of the Regions belonging to the Alpine Space.

Giulia Pesaro

Executive Summary

This report aims to cover several topics on a cultural heritage-Alps-natural hazards relation. It is to be a state-of-art update on those issues, which would serve as a starting action for all other project activities. The five sections of the report cover several aspects important for having an overview in the field of natural hazards related to cultural heritage. The first section provides natural hazards statistics in each country within the CHEERS project, which is to give a general overview of importance/occurrence of natural hazards in the Alps. The next section briefly introduces a conceptual framework and assumptions of the project with a focus given on link between work package 1 and other project activities and how review of state-of-art was done methodology wise. The third section of this report presents results of the review of projects, case studies and research in the field of cultural heritage and natural hazards. There is an additional section on legislation and regulation, which follows the same review approach employed in previous section only that is focuses solely on legal acts, policy programs and regulation, all important for cultural heritage management in relation to protection against negative impacts of natural hazards. Finally, report ends with a closing section on policy implication derived from the state-of-art overview and main messages the project team wishes to deliver to policy makers and decision takers. Future measures should be more efficiently directed in providing enough protection of cultural heritage against natural hazards.

Alps, cultural heritage and natural hazards

Alps, cultural heritage and natural hazards

Figure 1 Valley in Slovenian Alpine region

Alps, as defined by Alpine Convention, cover almost two tenths of a million square km and span across eight different countries. They are home to more than 14 million people, but despite being an example of human-shaped environment, the Alps are also habitat to approximately 13.000 plant and 30.000 animal species, making it biodiversity-wise rich and regionally important. This is obvious by a more than 20% of the Alps being National Parks, bountiful number of Natura 2000 sites and relatively low levels of intensive agriculture – less than 4% of people (a 40% drop in 25 years) still practicing farming and more than 80% of farm land is managed as pastures.

Overall population trend was not as negative as one of farmers and in fact varies much according to location. Some parts of the Alps experienced a substantial growth (e.g. parts of France and Italy), whereas some were subjected to significant drain of population (e.g. some parts in Austria). People have mainly left to larger cities because of more plentiful jobs, but the trend is not as negative as in the past due to seasonal residents. New opportunities for work are emerging, especially in tourism and ecological farming. A clear pattern can be observed as population near tourist centres is predominantly increasing, which depicts the growing importance of income from tourism.

One more feature is important for the Alps – climate change and its effects. The alpine space is facing exceptionally high rise in average temperatures, more twice as much as the rest of northern hemisphere. On the other hand, the trend in precipitation is not so unambiguous. As the northern part of the Alps is to receive more precipitation in future, Southern Alps could become drier (EEA,

2009). Increase in frequency and intensity of natural disaster events is one of the aftereffects of climate change and since Alps are extremely vulnerable to shifting climate (EC, 2009), natural hazards play a crucial role as well. In addition to losses in winter tourism due to decrease in snow cover, OECD has identified increasing exposure of settlements and infrastructure as a leading cause of vulnerability (OECD, 2007). This was showcased by extreme flooding across the Alps in 1999, 2002, 2005, 2007 and 2010 and an exceptional avalanche episode in winter of 1999. It is therefore decisive to establish an effective safeguarding of Alpine population so that people will be able to enjoy minimal risk. In this way local population will feel safer and will not seek home or work elsewhere.

For more centuries Alps have been interchangeably a place of both rapid development and quick abandonment, which meant that people and their culture had changed several times. Farming, mining, forestry, and lately also tourism have brought changes in the landscape and caused the development of cultural landscape. Not only built elements like churches, castles, bridges, mine shafts, built waterways etc. but also other artefacts, which are commonly associated with those consist cultural heritage making Alps unique and worthy of preserving. Visiting museums, monasteries, and old village centres are a key part of touristic arrangements making cultural heritage crucial for sustaining a part of locals' wellbeing. Thus, it makes sense to safeguard cultural heritage in order to preserve a part of the Alpine economy making the Alps more attractive to live in and sustain local society.

The next section follows the main message of natural hazard events in the Alps by trying to give key characteristics of such events in each of the six partnering countries. Individual subchapters cover basic statistics of occurrence of natural hazards relevant for the country and case studies of events, specific because of either the magnitude or organizational/emergency characteristics. This gives a reader an insight into importance of protection of cultural heritage in the Alps against floods, wild fires, rockfalls, landslides, storms etc. Some countries even provide a brief description of institutional framework relevant in case of urgency with definitions of roles of individual organisations within the chain of command. This could facilitate further discussion on optimization of emergency planning, securing actions, and recover procedures for Alpine countries, which is to be dealt with in work packages two, three and four altogether logically completing the project loop.

Given the rationale of the following subchapters being provided above introductory text is omitted from all six sections.

Occurrence of natural disasters in case of Slovenia

Frequency of natural disasters in municipalities within the Slovenia'a part of Alpine Convention area in the period of 2009 to 2018 are compared those from municipalities outside this area. Event data was obtained from the SPIN web portal (https://spin.sos112.si/spin2/javno/) managed by the Administration of the Republic of Slovenia for Civil Protection and Disaster Relief aimed at keeping records on all events of natural hazards.

Figure 2 Forest after ice-storm event in 2014

We wanted to find out if the occurrence of natural disasters is higher in municipalities located in the area of the Alpine Convention than in other municipalities in Slovenia. By doing so we wished to establish whether this area is more exposed to natural disasters, which would indicate more need to address risk on cultural heritage in the Alps.

The area of Slovenian municipalities located in the area of the Alpine Convention is 7.679 km^2. This represents 38 % of the total area of Slovenia.

We analysed occurrence of 10 different events (also lightning, strong wind, hail, high snow, storm and ice storm) in municipalities located in the area of Alpine Convention and compared with occurrence in other Slovenian municipalities.

We choose only 4 major natural hazards to show in images – occurrence of landslides, floods, earthquakes and fires in time frame from 2009-2018.

We compared number of events per square kilometre. In all municipalities located in the area of the Alpine Convention during 2009-2018, there were:

- 20 % more landslides,
- 17 % more events with hail and strong wind,
- 46 % more ice storms, then in other Slovenian municipalities.

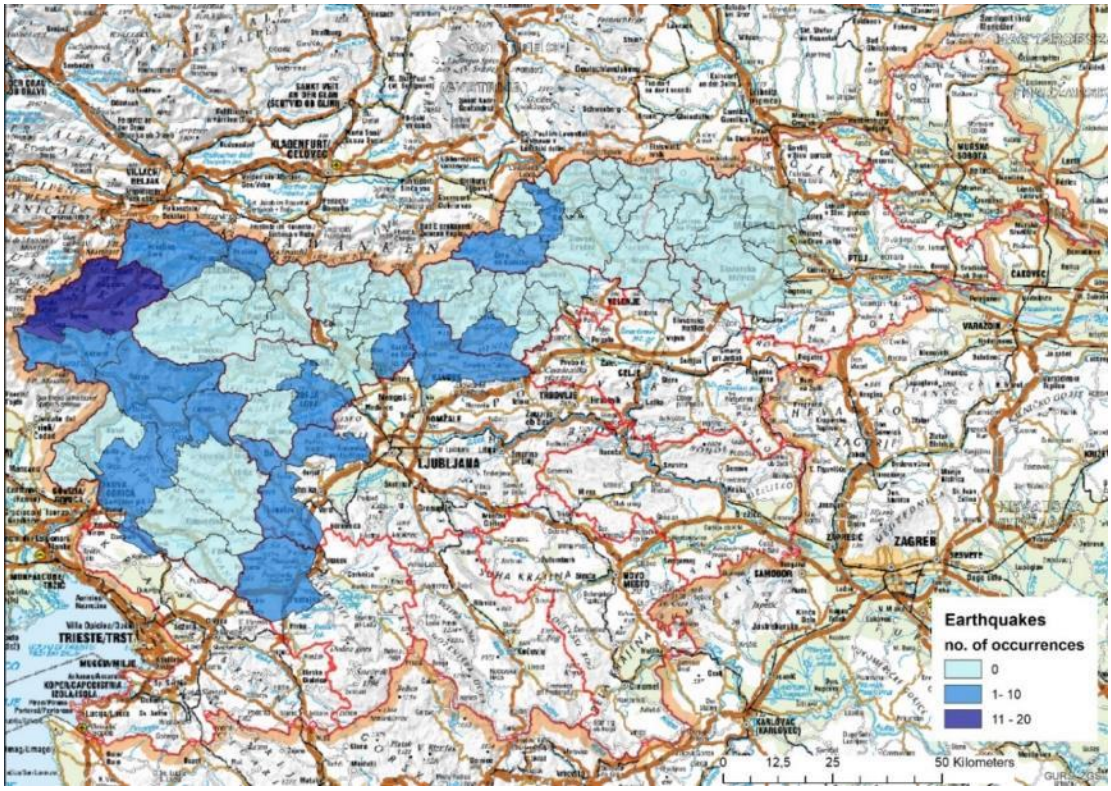

Figure 3 Earthquakes in Slovenian municipalities from 2009 to 2018

With regard to the number and intensity of earthquakes, the territory of Slovenia is quite an active area. This is because the country lies on the seismically active southern boundary of the Eurasian tectonic plate on the north-western boundary of the Mediterranean-Himalayan seismic belt, which is one of the most seismically active zones on Earth. The small Slovenian territory is the juncture of three geotectonic units: the Alps in the north and west, the Dinarides in the southern, south-western and central part, and the Pannonian Basin in the northeast.

By examining historical sources and by recording and monitoring seismic phenomena in the recent period, we can see that more than 60 devastating earthquakes have occurred on Slovenian territory in the past.

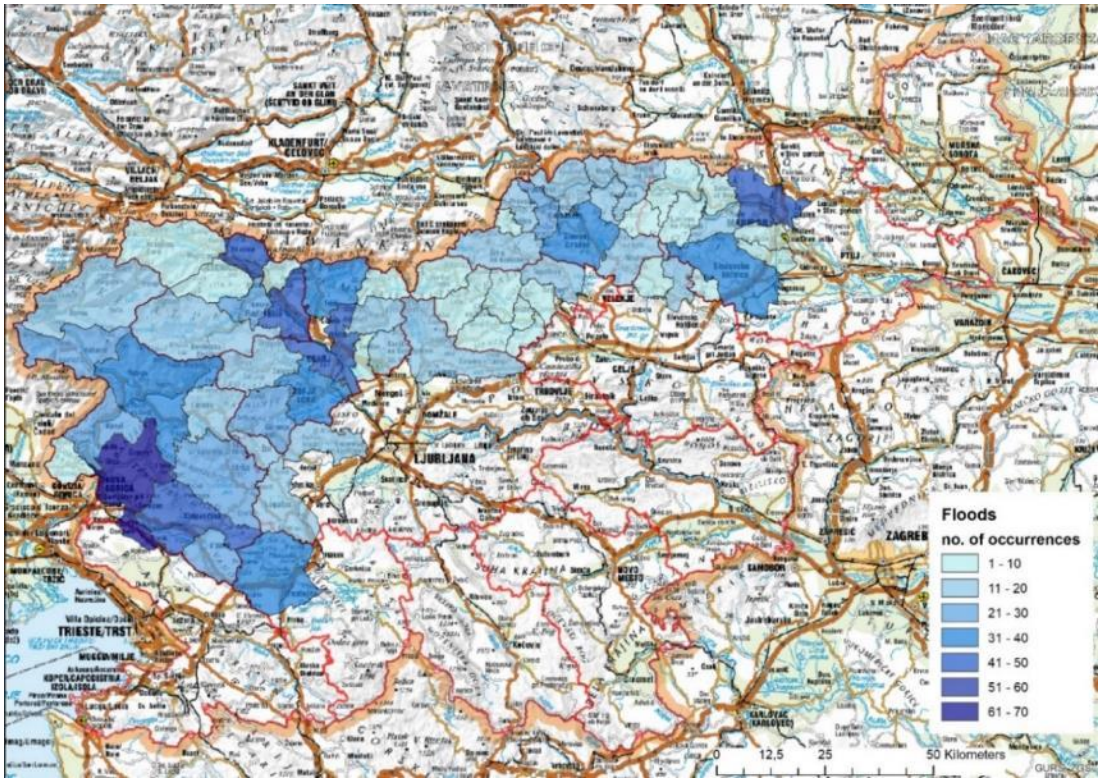

Figure 4 Floods in Slovenian municipalities from 2009 to 2018

The interaction of three major climate systems (Continental, Alpine and sub-Mediterranean) influences the precipitation regime in the territory of the Slovenian Alps. The spatial variability of precipitation is high – annual precipitation varies from 1100 mm in the coastal parts of river basins to more than 3500 mm in the Julian Alps, where maximum Alpine precipitation has been recorded.

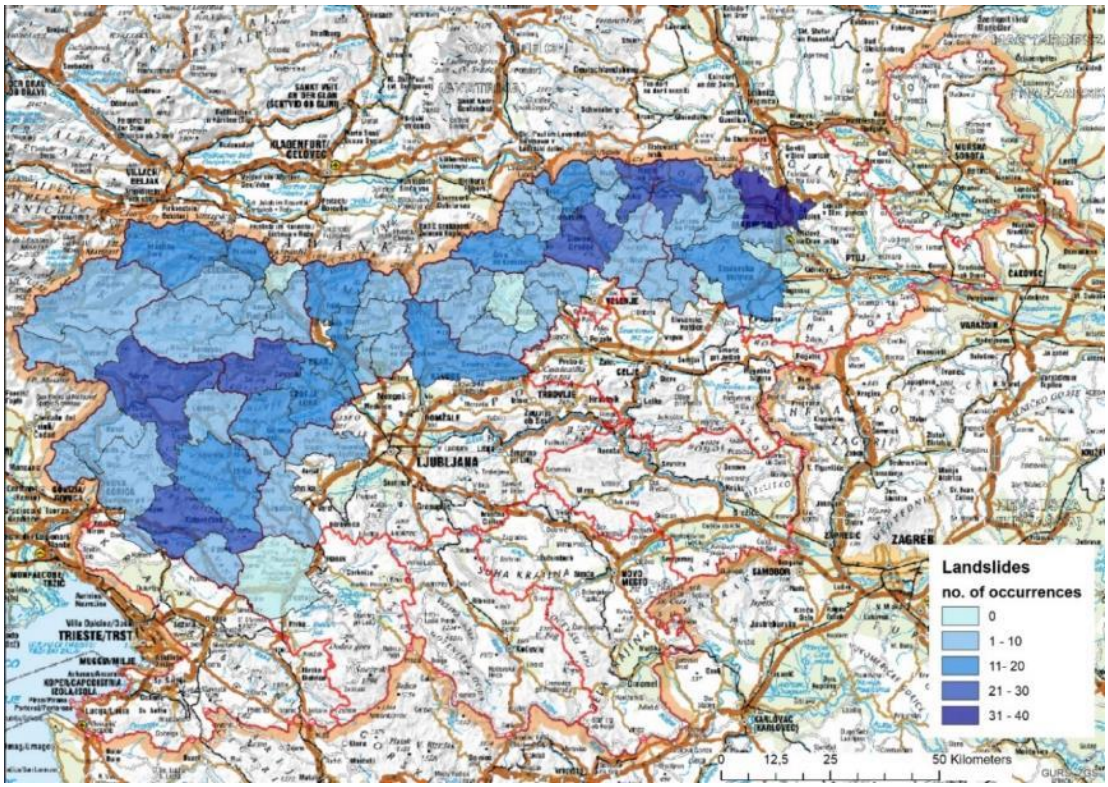

Figure 5 Landslides in Slovenian municipalities from 2009 to 2018

In the Alpine region the most pronounced precipitation maximum occurs in autumn. Also landslides are tightly connected to quantity of water on and in the soils.

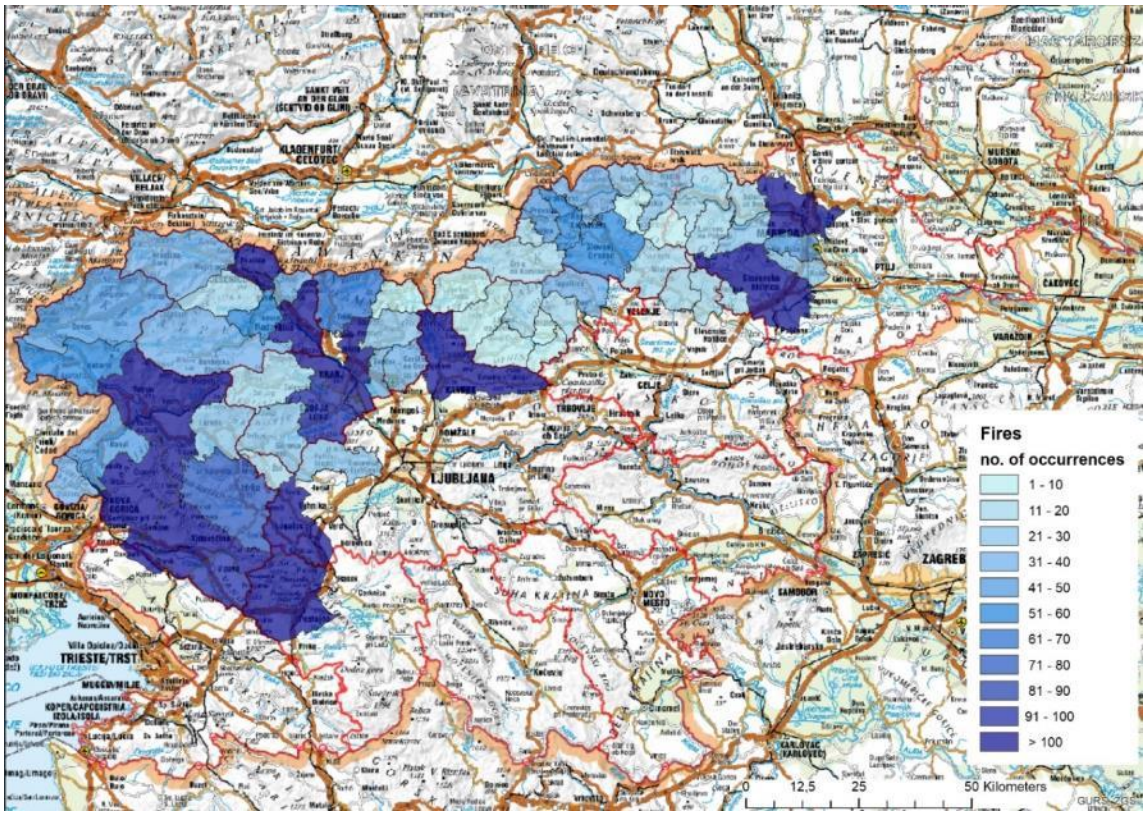

Figure 6 Fires in nature in Slovenian municipalities from 2009 to 2018

So far, forest fires do not constitute a significant hazard in the central and northern parts of the Alps, while on the southern side of Alps they are more common even if the fire number and the burned area are low compared to the neighbouring Mediterranean area, where the climate is more in favour of the development of frequent and large wildfires.

Ice storms seem to be much more frequent in Alpine convention area. More frequent are also landslides and events with hail and strong wind.

Some types of natural hazards are occurring more often in area of Alpine convention as in the remaining part of Slovenia, which indicates where to put research and development focus in terms of either prevention or mitigation of damage on cultural heritage.

Occurrence of natural disasters in case of Austria

From the maps, it is evident that the municipalities belonging to the Alpine Convention, that make up more than 65% (54.702 km^2) of Austria's entire area, are under a much bigger threat of natural disasters compared to the rest of the country. The data are taken from the interactive map at the "Leben mit Naturgefahren" (Living with natural hazards) platform web site[4] of the Austrian Federal Ministry for Sustainability and Tourism (BMNT).

This interactive web site offers the option of exploring historical events by clicking on the event "dot". The maps show a clear correlation between the mountainous regions and natural hazards. The westernmost regions of Vorarlberg and Tyrol are largely prone to avalanches, especially in the highest regions of over 2000 m above sea level; while in the central and eastern region, especially along river valleys, flooding is a prevalent hazard. Two other major threats to both the west and east are landslides and rockfall. The top easternmost parts of Lower Austria haven't had any documented history of natural disasters. The same is true for Southern Styria.

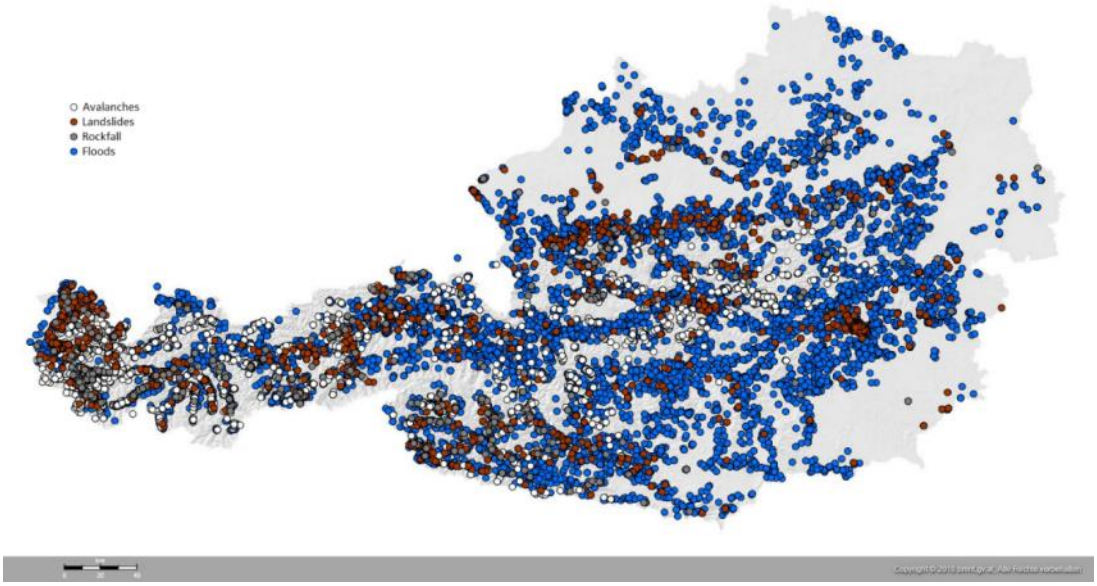

Figure 7 Historical Events of Natural disasters in Austria, accessed 25.3.2019

The event documentation started in the late 19th century but intensified at the beginning of the 20th with a decree from the Ministry of Agriculture. Even though the current natural hazard potential maps depict similar data to the historical disaster maps, it is difficult to predict what impact would climate change have on future occurrences. Therefore, it is important to learn from the historical documented events but make society aware of the changing conditions not only in the Alpine region, but more broadly in Europe.

Possible hazards for sites in Austria can be retrieved from the platform eHORA [5]. eHORA web site is a cooperation between BMNT and the National Weather Agency (Zentralanstalt für Meteorologie und Geodynamik - ZAMG). This application shows potential hazards due to floods, earthquakes, storm, hail and snow based on the occurrence of historical documents and a variety

[4] https://www.naturgefahren.at/karten/detailkarten.html, accessed 25.3.2019

[5] www.hora.gv.at, accessed 25.3.2019

of prediction models. By clicking on a special site on the map (or entering a mailing address) and defining a radius, information about specific hazards on this place can be obtained, the results of the query is documented in the very visual and explicit “HORA-Pass”. An example for one of the Austrian demonstration site Dürnstein is shown in Fig. 8.

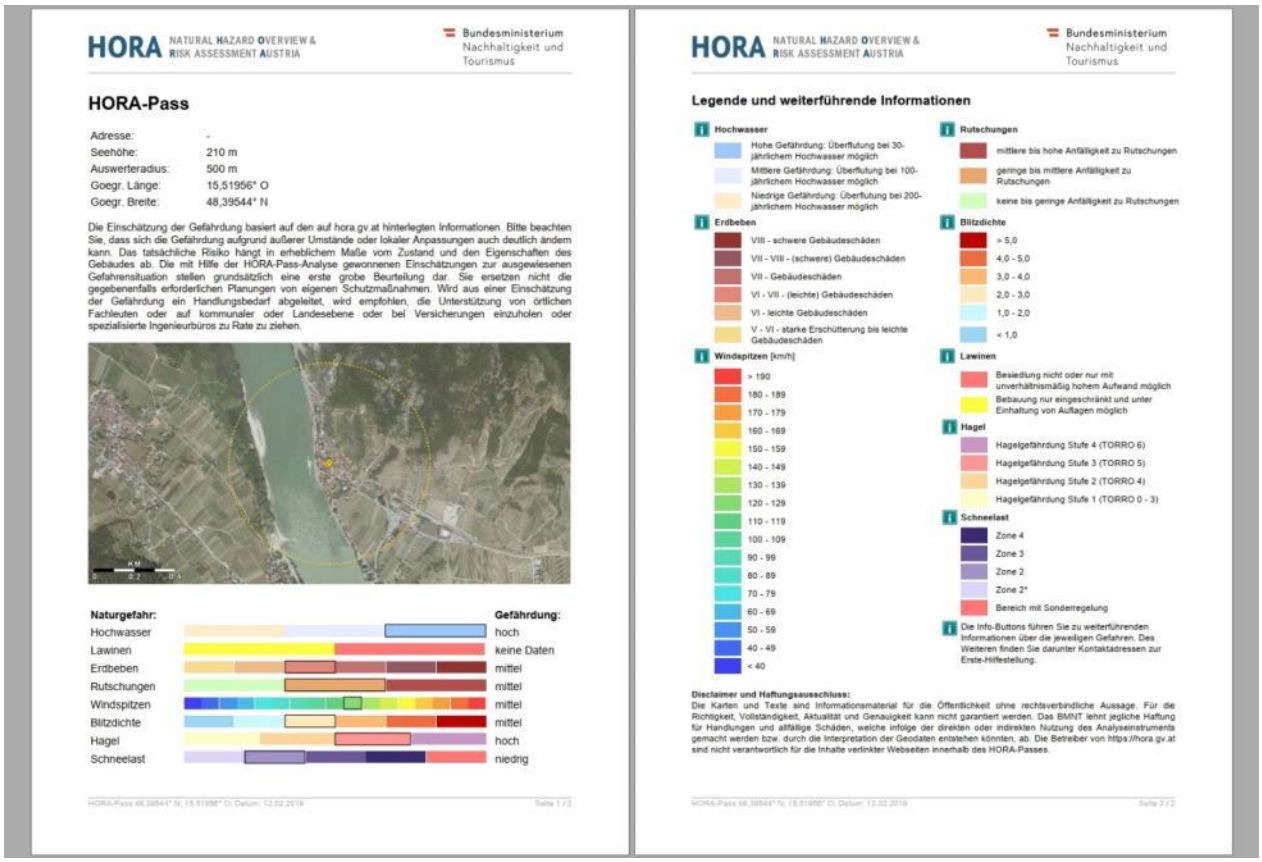

Figure 8 “Hora Pass” for Dürnstein: the natural hazards to which the place is exposed are characterized in different hazard exposure levels and plotted in bar charts

The different hazards can also be plotted in maps. In the following figures the exposition of cultural sites in Austria to natural hazards is depicted, with a pie chart showing the proportional distribution of exposure to the specific natural hazard. The mentioned 135 Cultural Heritage Sites are listed in The Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict.

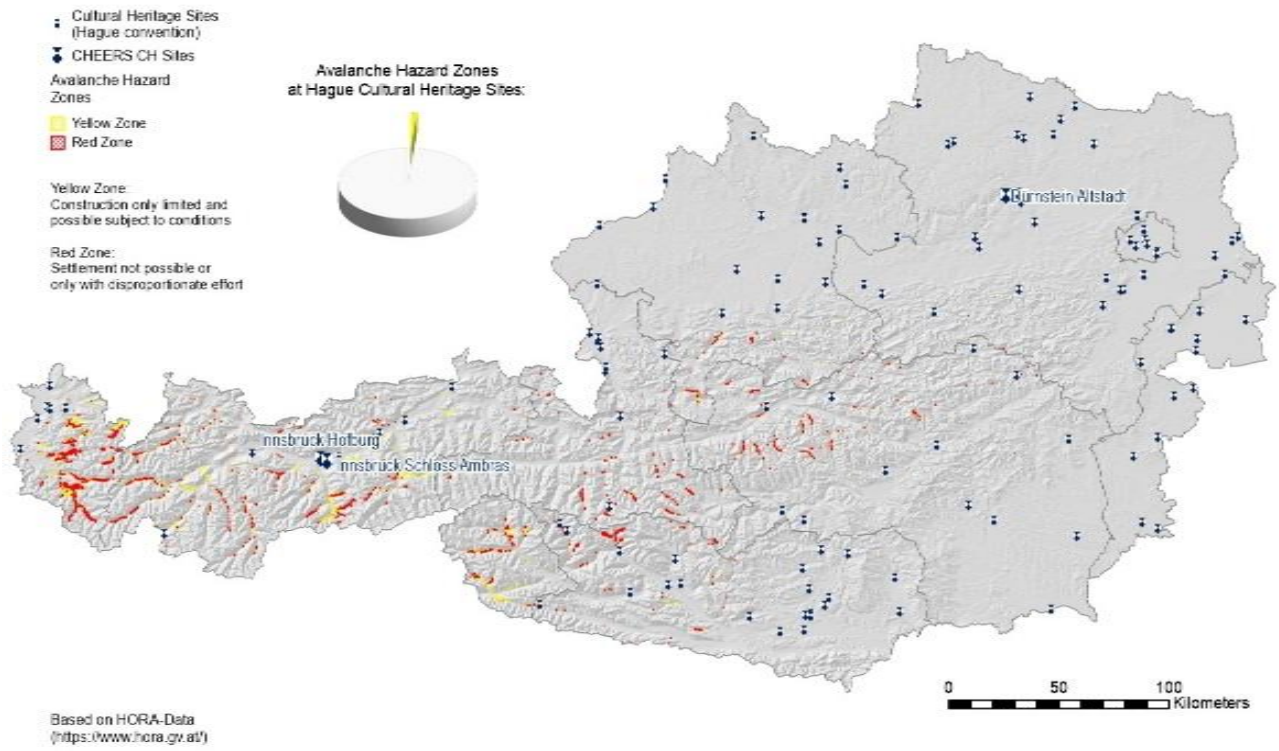

Figure 9 Exposition of cultural sites to Red and Yellow zones of avalanche hazard.

The avalanche hazard map in eHORA is based on the "Gefahrenzonenplan" (GZP; Hazard Zone Plan) of the "Die Wildbach- und Lawinenverbauung", a section of BMNT, with local offices in 7 Austrian provinces. The GZP is a comprehensive report on torrents, avalanches and erosion. It is the basis for planning the protective measures and for assessing their priority, and it supports the building authority, local and regional spatial planning and serves the public safety. The GZP shows two different zones: red hazard zone and a yellow hazard zone. In the Red Hazard Zone, the risk of torrents and avalanches is so great that permanent settlement is impossible or only possible with disproportionate effort. In the Yellow Hazard Zone, the constant use for settlement and transport purposes is impaired. A development here is limited and possible in compliance with conditions. In addition, the original GZP defines also blue reserved areas for future protection measures, and brown reference areas with other natural hazards (e.g. geogenic or floods) and protected violet zones (e.g. barrier woodland or protective forest). These are not included in Fig. 9. From the analyzed 135 cultural sites only 2 are situated in a yellow zone and none in red zones.

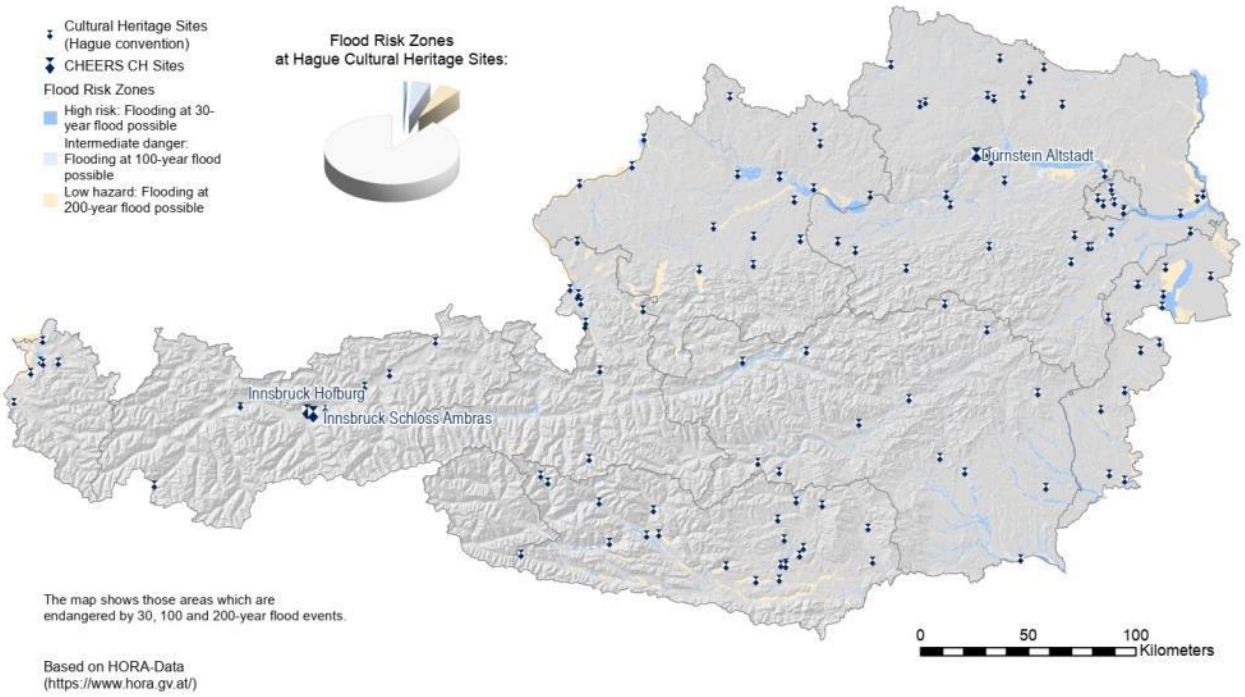

Figure 10 Exposition of cultural sites to flood risk zones

The Flood risk zone map shown in Fig. 10 is the outcome of extensive compilation of relevant hydrologic and hydraulic data and shows areas endangered by 30-, 100-, and 200-year flood events. Only 10 percent of the investigated cultural sites lie in zones with a designated flood risk.

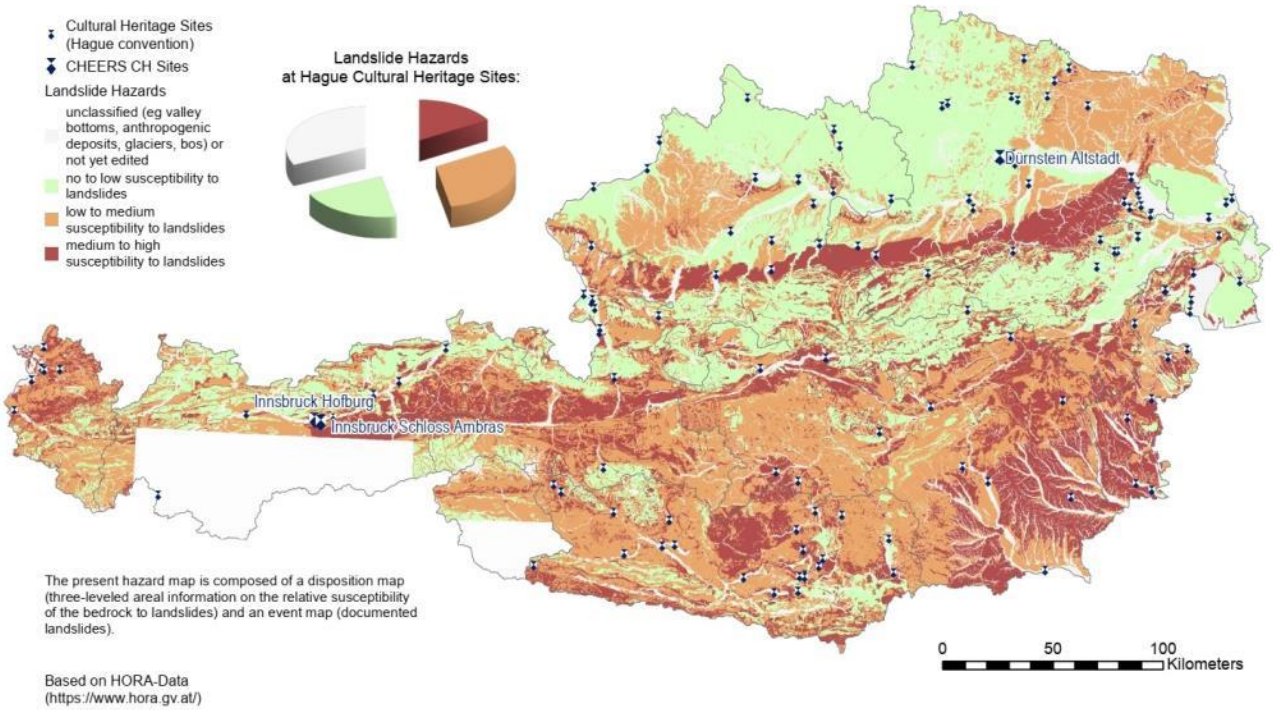

Figure 11 Exposition of cultural sites to landslide hazard zones

The landslide hazard map shown in Fig. 11 is a harmonized compilation of different hazard maps of the 9 Austrian provinces. The work is in progress, so parts of Tyrol are still missing due to the lack of proper geological base maps. A first evaluation shows that cultural heritage sites are quite endangered by landslides.

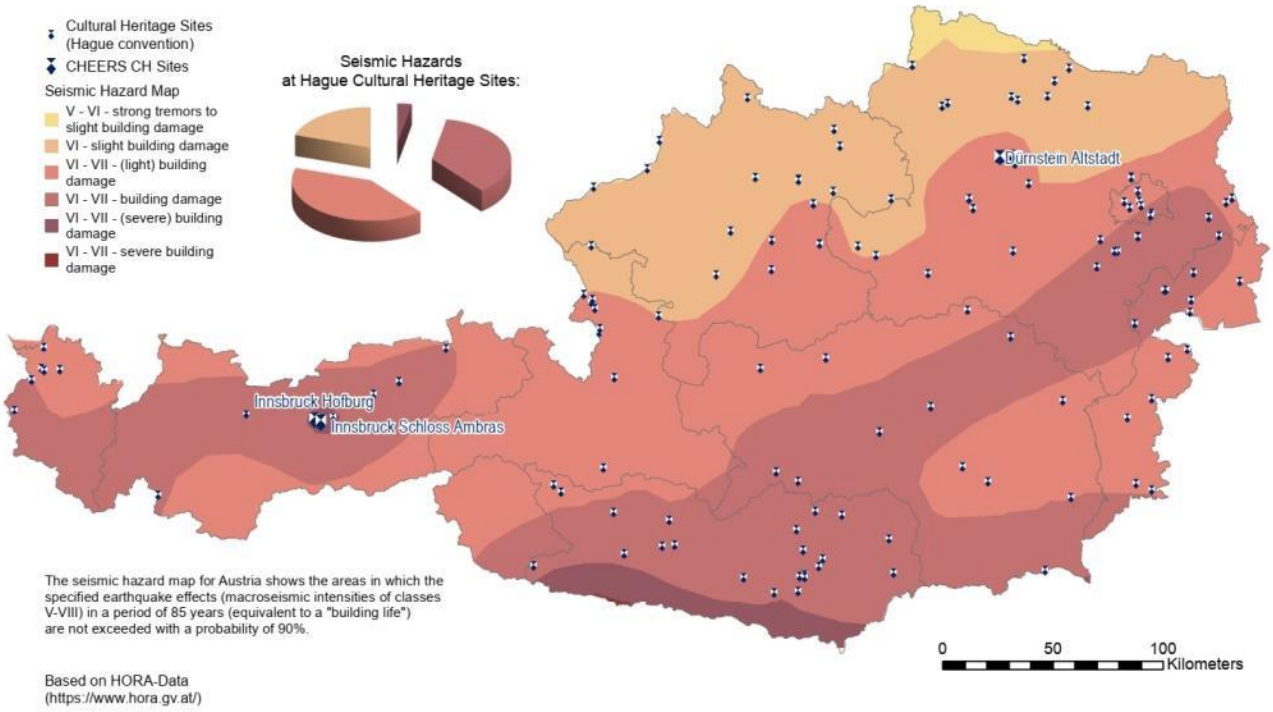

Figure 12 Exposition of cultural sites to seismic hazard zones

Notable seismic hazard zones in Austria are bound to the two major tectonic faults in Austria, the Inn river valley in Tyrol as part of the ISAM (Innsbruck–Salzburg–Amstetten) faultline, and the fault system along the rivers Mur and Mürz and the Vienna Basin in eastern Austria. The most southern part is also strongly influenced by earthquake zones of the southeastern Alps (Friuli and Slovenia). The nearby cities of Innsbruck and Hall with its cultural heritage sites are the most endangered spots in Austria, with severe damages and losses in historic times, e.g. the events in the 1570s and 1670s. Recent geological research results indicate that seismic hazard in the Vienna region could be underestimated[6]. After all, some of the most severe historical events are reported from e.g. Schwadorf (20 km southeast of Vienna; Decker et al., 2006).

[6] Decker, K.; Gangl, G. & Kandler, M. (2006): The earthquake of Carnuntum in the fourth century a.d. – archaeological results, seismologic scenario and seismotectonic implications for the Vienna Basin fault, Austria.- J. Seism.,10/4,479-495.

One of the most frequently predicted effects of climatic change is a rising instability of atmospheric disturbances[7]. However studies for Austrian territories these prognoses of increasing storm threats could not be verified yet (see [in German][8]).

Nevertheless, recent years showed significant damages of cyclones and gusts as well in nature as on cultural sites, as shown below in the Hohensalzburg storm event in 2018[9].

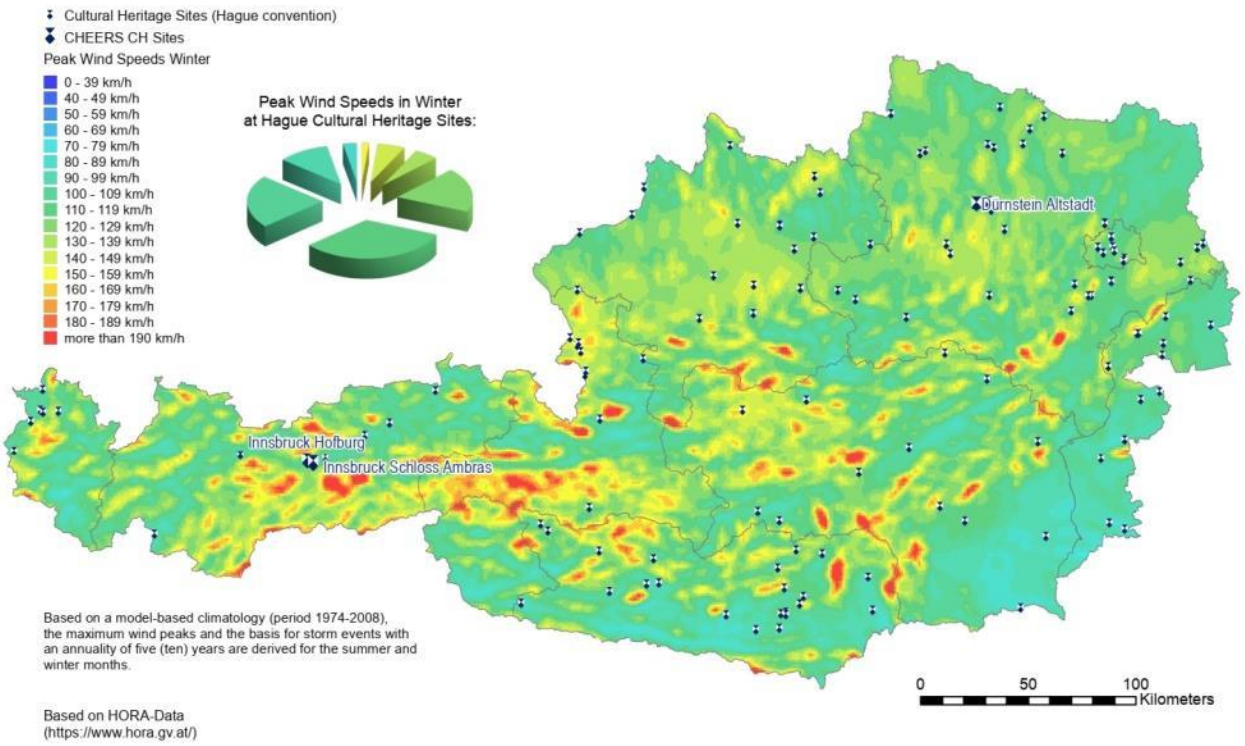

Figure 13 Exposition of cultural sites to wind Speeds in Winter

[7] IPCC, 2012: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA, 582 pp

[8] https://www.zamg.ac.at/cms/de/klima/informationsportalklimawandel/standpunkt/klimavergangenheit/neoklima/stuerme Accessed 25.3.2109.

[9] https://www.sn.at/wiki/Sturmschaden_2018_auf_der_Festung_Hohensalzburg; accessed 25.3.2018

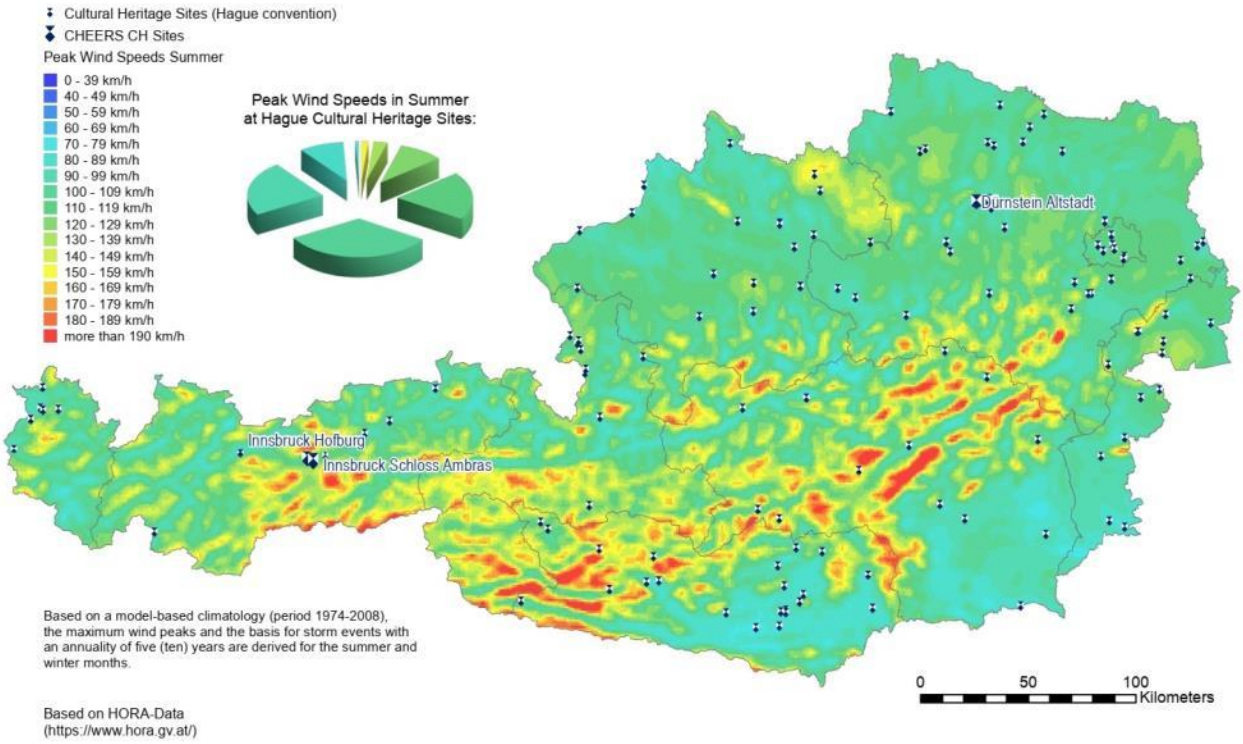

Figure 14 Exposition of cultural sites to wind Speeds in Summer

Maximum peak wind speeds, both in winter and summer are restricted to the top regions of mountain ridges, due to the alpine relief of most parts of the country. Following the hazard maps shown in Figs 13 and 14, cultural heritage sites seem to be weakly endangered on the whole. But it has to be considered that this map is highly generalized in a 1x1 km raster, and especially severe gusts can emerge in built up areas or other certain exposed locations. So, a reliable windstorm hazard for a cultural heritage site can only be estimated in local studies.

Occurrence of natural disasters in case of Germany

Finding suitable pilot sites in the German Alpine region meant focusing on a relatively small part of the country. Germany's Alpine area corresponds to less than 5 percent (or 11.075 km²) of the country's landmass. The data we used for the mapping and data analysis is a combination of several datasets, developed by the Bayerisches Landesamt für Umwelt (LfU), the Bavarian government's environmental department, and the Bayerisches Landesamt für Denkmalpflege (government department for preservation of historic monuments).

In other words, the test sites cover an area amounting to 3 percent of Bavaria, in which 3 % of all CHs are located – but also in which more than 10 % of all NHs took place in the past. cultural heritage in Bavaria is combined of 74% of monuments, 25% of ground monuments and 1% of ensembles (194.849 in total).

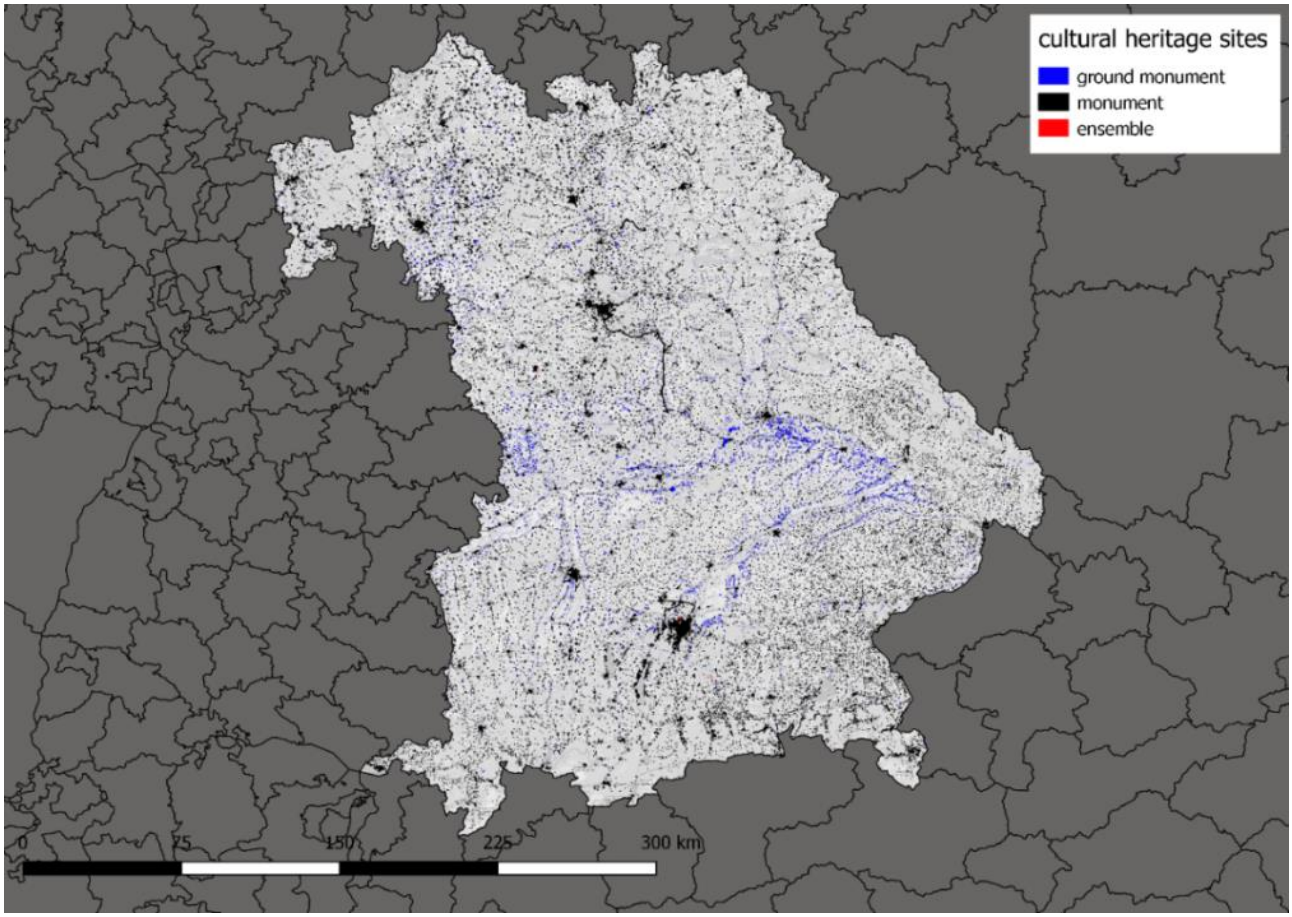

Figure 15 CHs in Bavaria (in total 194.849)

The analysis shows that the test site is located within a very highly hazard-prone area because 38 % of the CHs are in potential danger and more than 400 CHs are threatened by more than one NH.

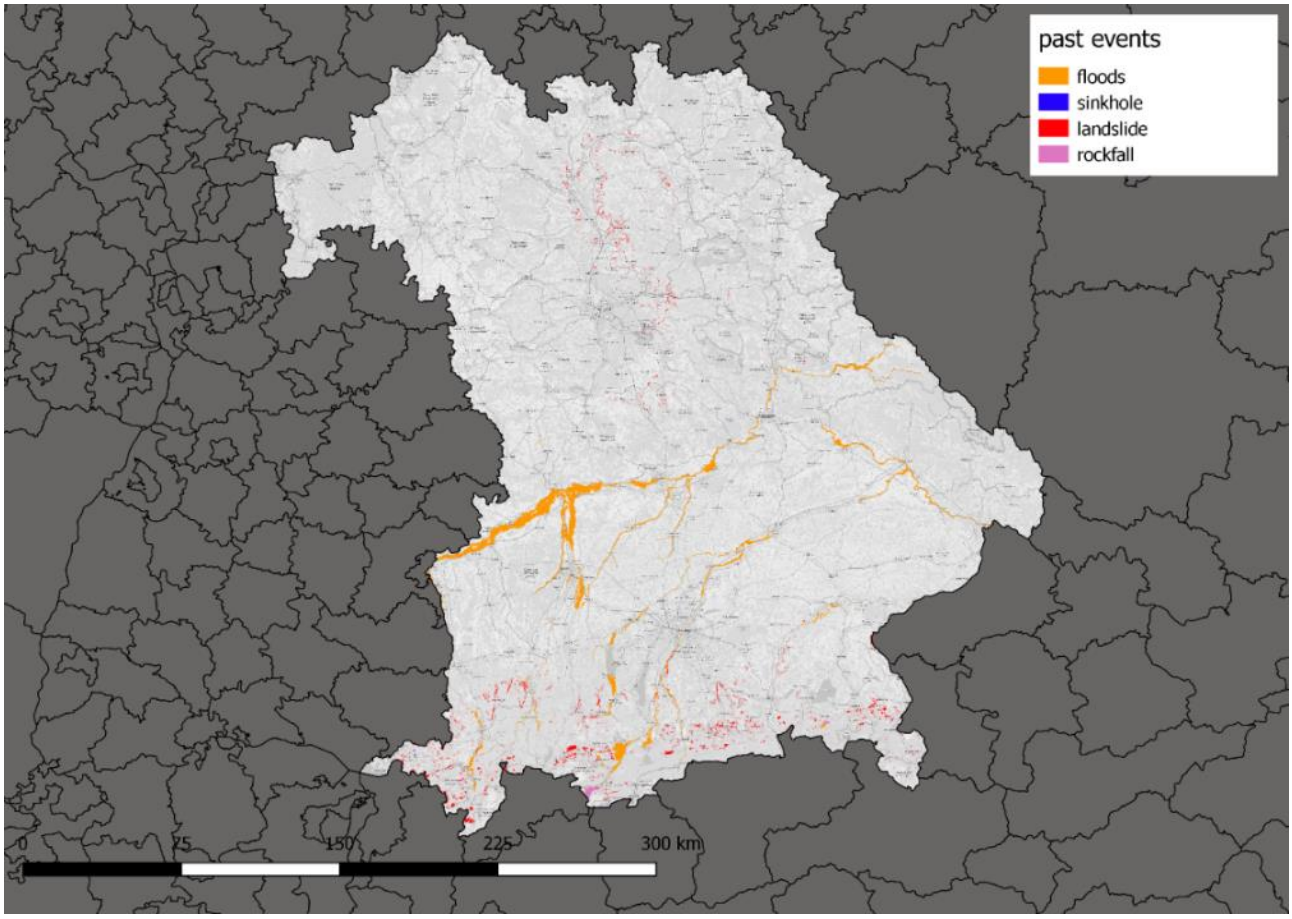

Figure 16 Past NHs in Bavaria (in total 1704)

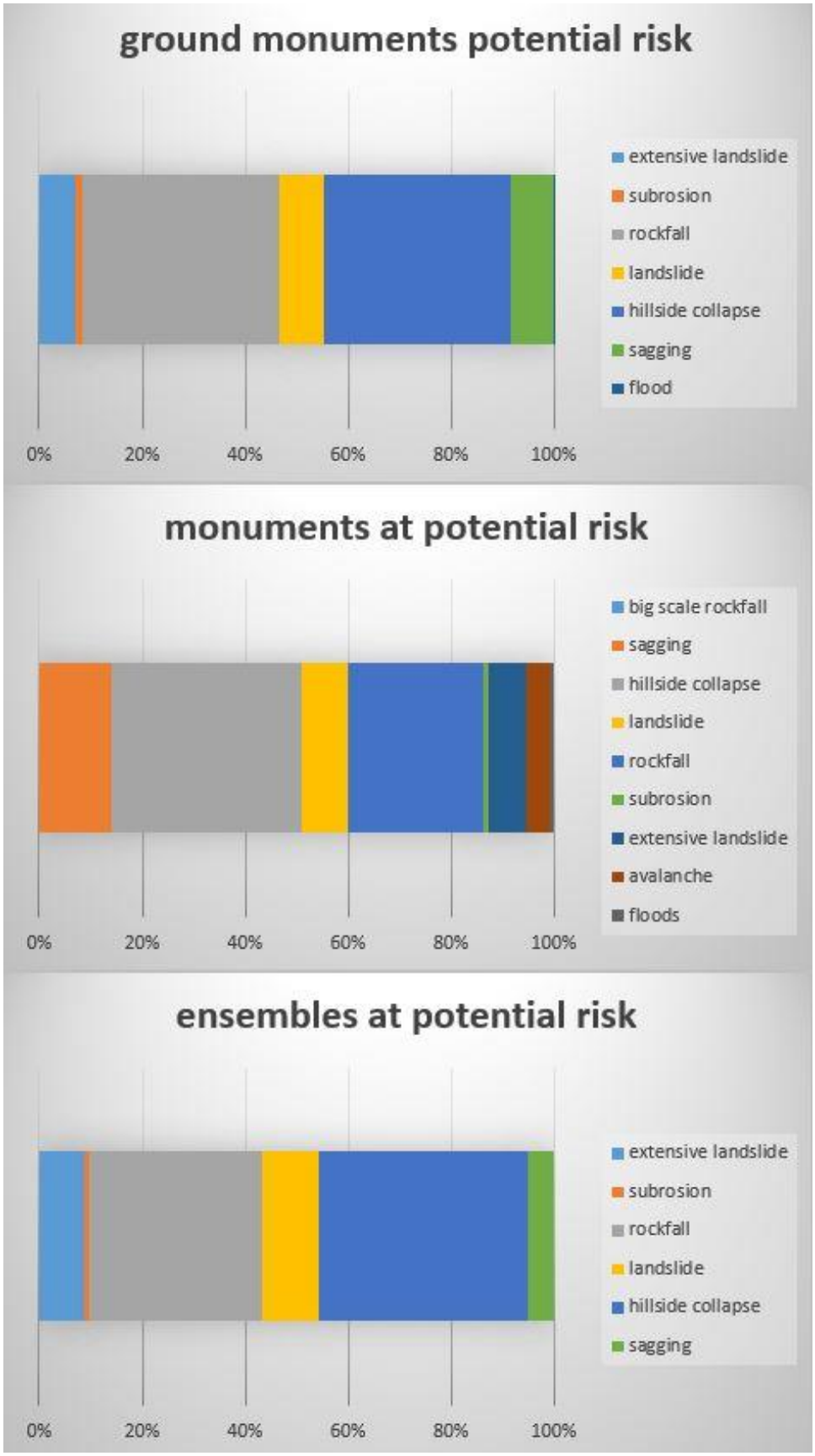

Figure 17 Effected CHs and their potential NH risk in the pilot area (in total 2875)

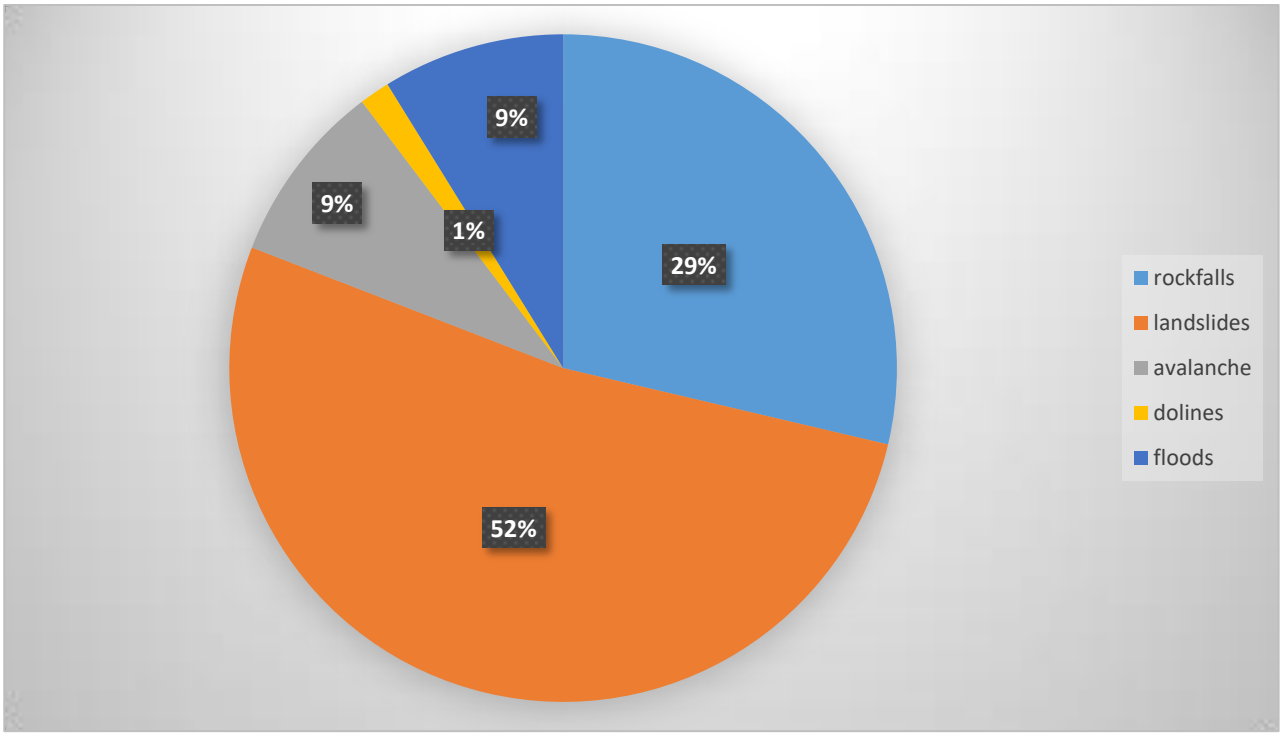

Figure 18 Monuments hit by NHs in the past (in total 136 registered)

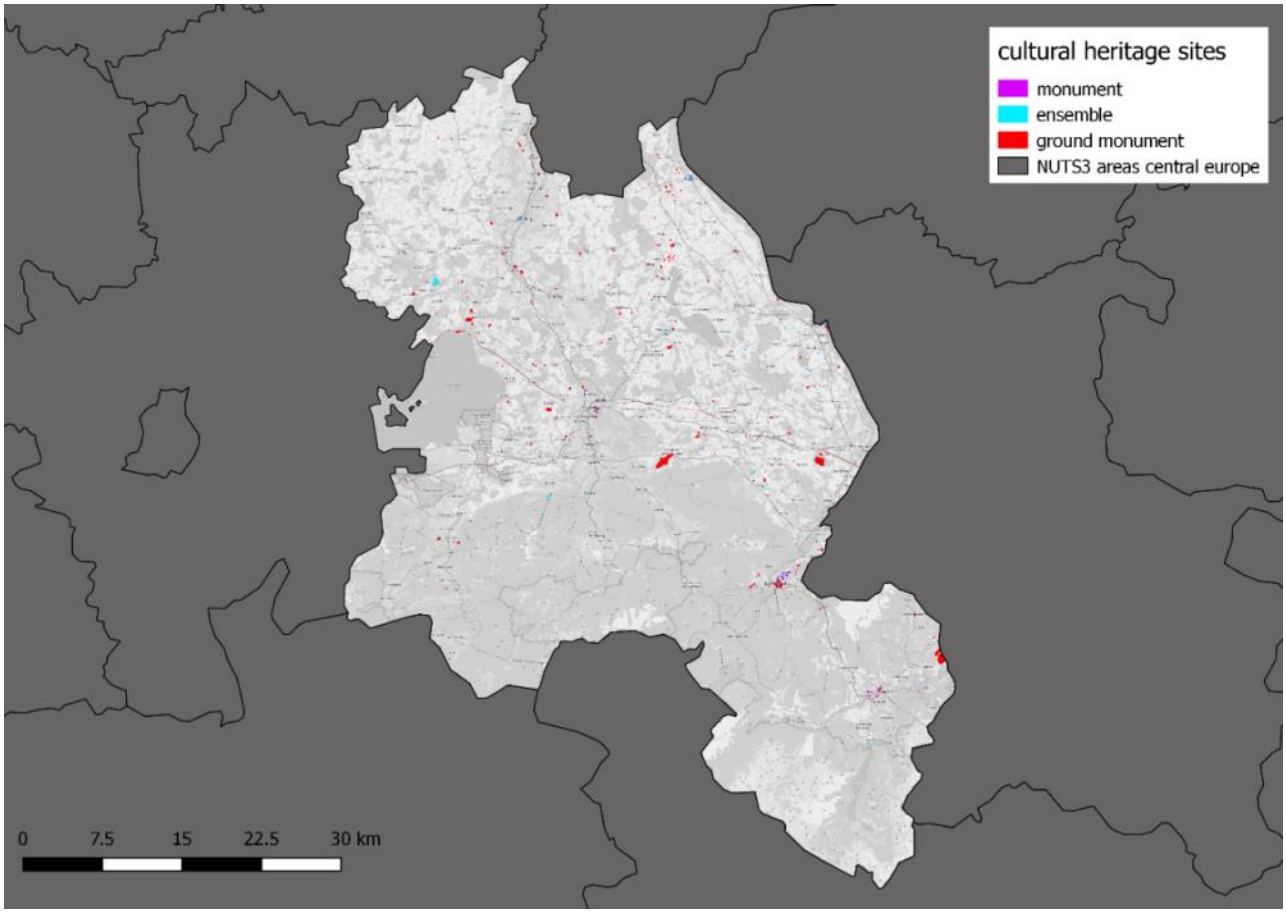

Figure 19 Different CHs in the pilot area (in total 5405)

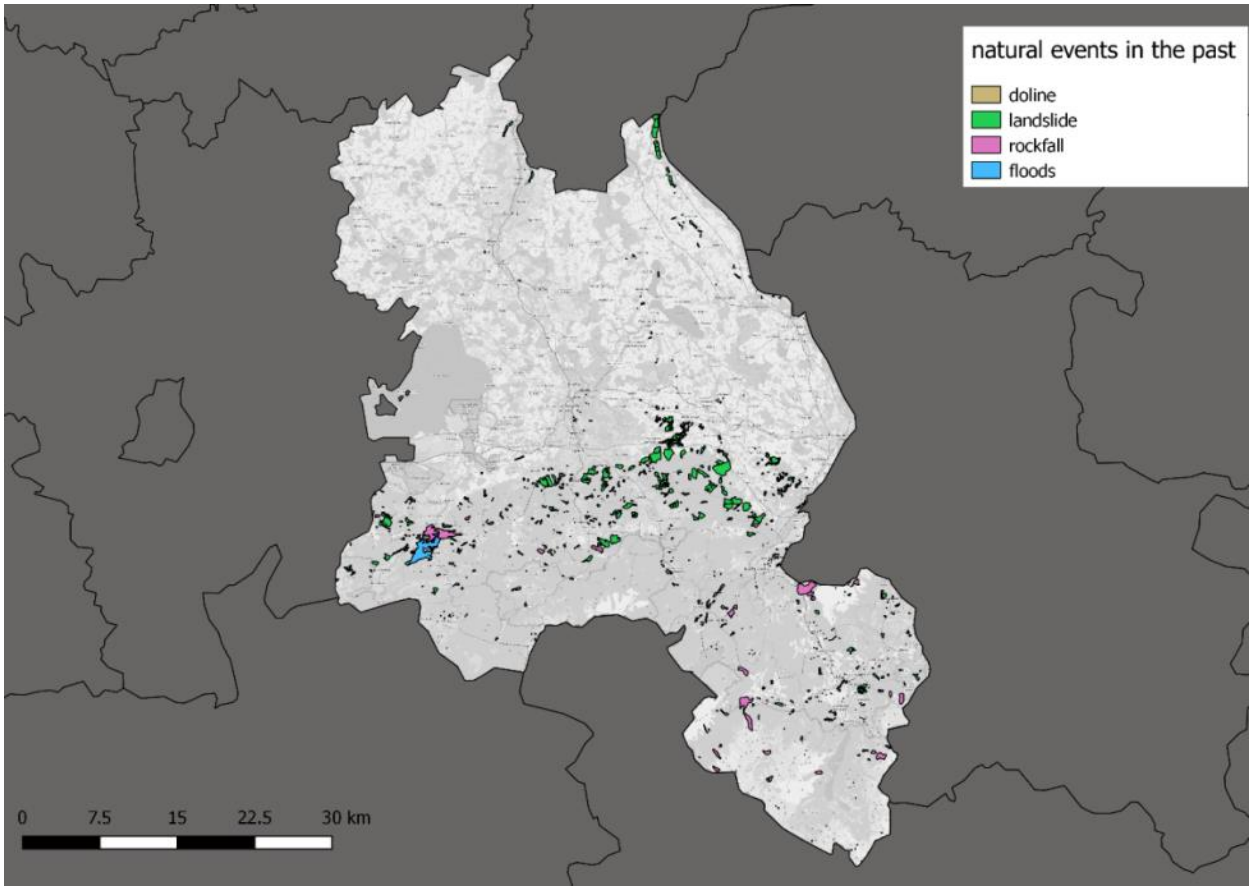

Figure 20 Registered NHs in the past

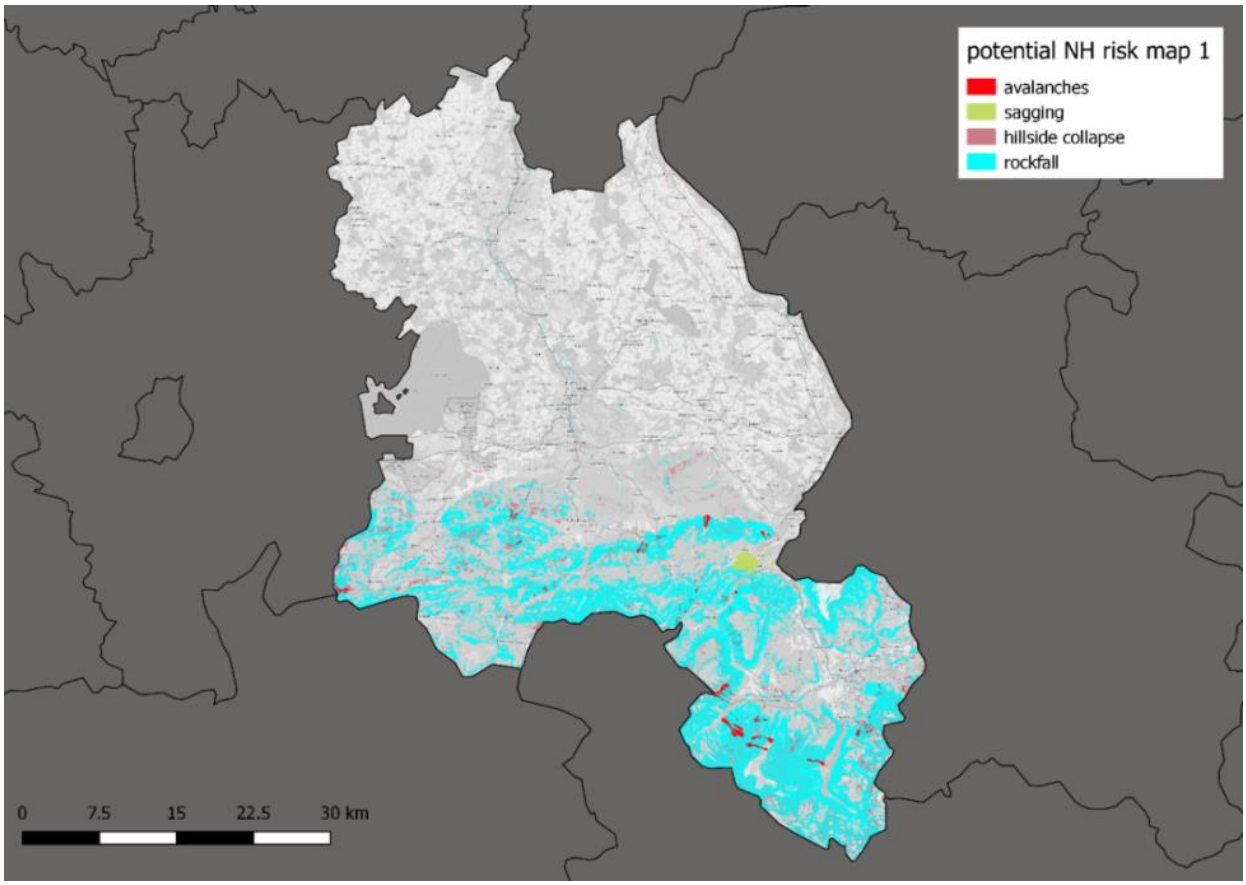

Figure 21 Potential risk areas I. in the pilot site area

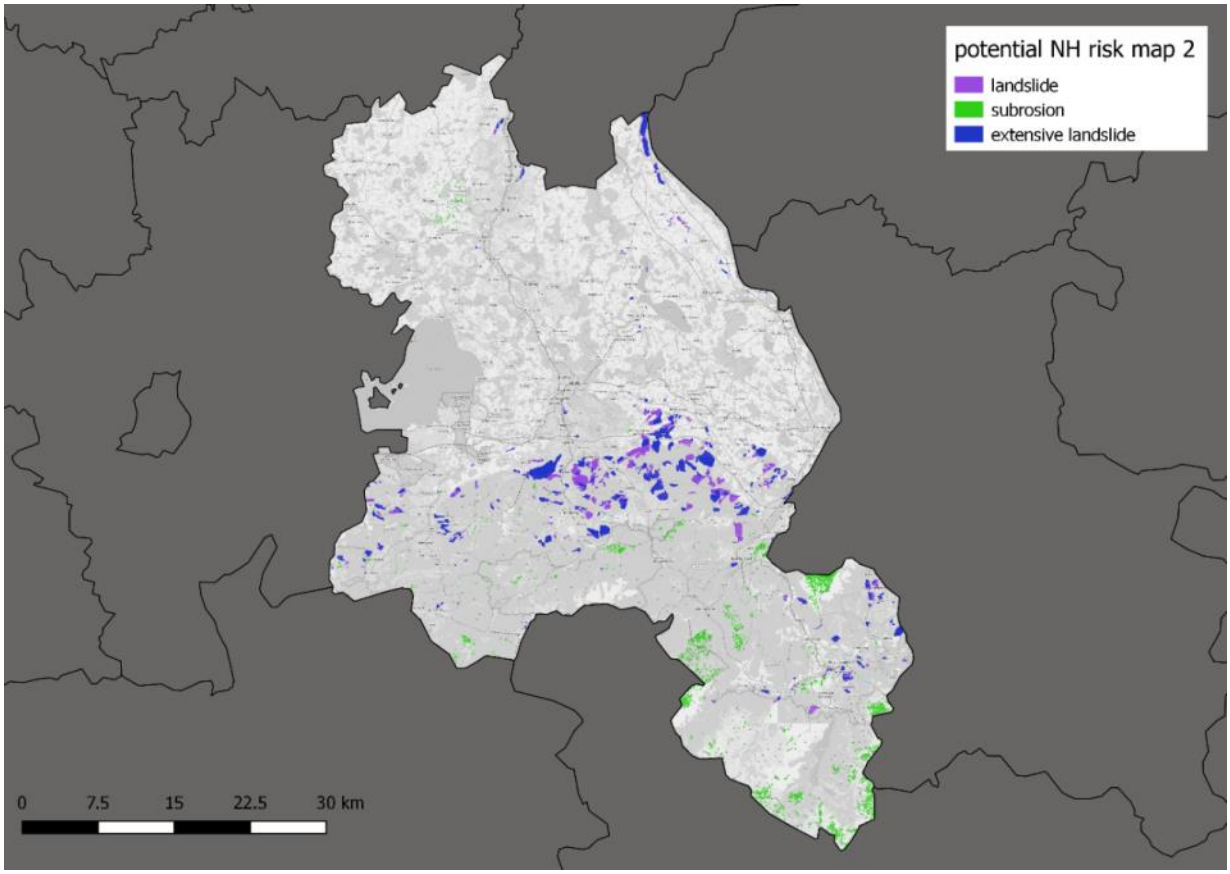

Figure 22 Potential risk areas II. in the pilot site area

Occurrence of natural disasters in case of Italy

Types of natural hazards in the Italy's part of the Alpine convention area considered here are seismic, hydrogeological, hydraulic hazards and forest fires. First estimates on the exposure of cultural heritage to natural hazards are referred to hydrogeological and hydraulic events.

Seismic Risk

In order to reduce the effects of an earthquake, Italy has concentrated its action on territorial classification, based on past earthquakes' intensity and frequency, and on the application of special regulations of buildings in areas classified as seismic.

Italy's anti-seismic regulations, aligned with the most modern ones at international level, establishes technical rules according to which a building should bear minor earthquakes without serious damages, and major ones without collapsing, first of all safeguarding human lives. Up to 2003 the national territory was classified in three seismic categories with different forces. Ministerial Decrees issued by the Ministry of Public Works between 1981 and 1984 had classified totally 2,965 Italian municipalities on 8,102, that correspond to the 45% of the national territory, in which the 40% of the population lives.

New criteria for seismic classification were published in 2003. They are based on recent studies and processing regarding seismic dangerousness of the territory, i.e. the analysis of the likelihood that a territory may be affected, during a given time interval - generally 50 years - by an event that exceeds a given intensity or magnitude threshold.

According to these criteria, the entire national territory has been classified according to the following classes:

Seismic Zone	*Description*
1	It is the most dangerous area, where major earthquakes may occur
2	Municipalities in this area may be affected by quite strong earthquakes
3	Municipalities in this area may be subject to modest shocks
4	It is the least dangerous. Municipalities of this area have a low probability of seismic damages

De facto, there is no such thing as an "*unclassified*" area, that becomes Zone 4 here, within which the Regions have the power of making the ant seismic planning mandatory.

Each Zone has an associated value of the acceleration of peak on rigid ground:

Seismic Zone	*Acceleration with probability of exceeding equal to 10% in 50 years (ag)*
1	ag > 0,25
2	0,15 < ag ≤ 0,25
3	0,05 < ag ≤ 0,15
4	ag ≤ 0,05

Based on addresses and criteria established at national level, some Regions have classified the territory in four zones, as described in the table, and some other have classified it by adopting three zones, and introducing, in some cases, subzones to better adapt regulations to seismicity features.

Regardless of the regional choice, each zone or subzone has a core dangerousness value, expressed in terms of maximum acceleration on rigid ground (ag).

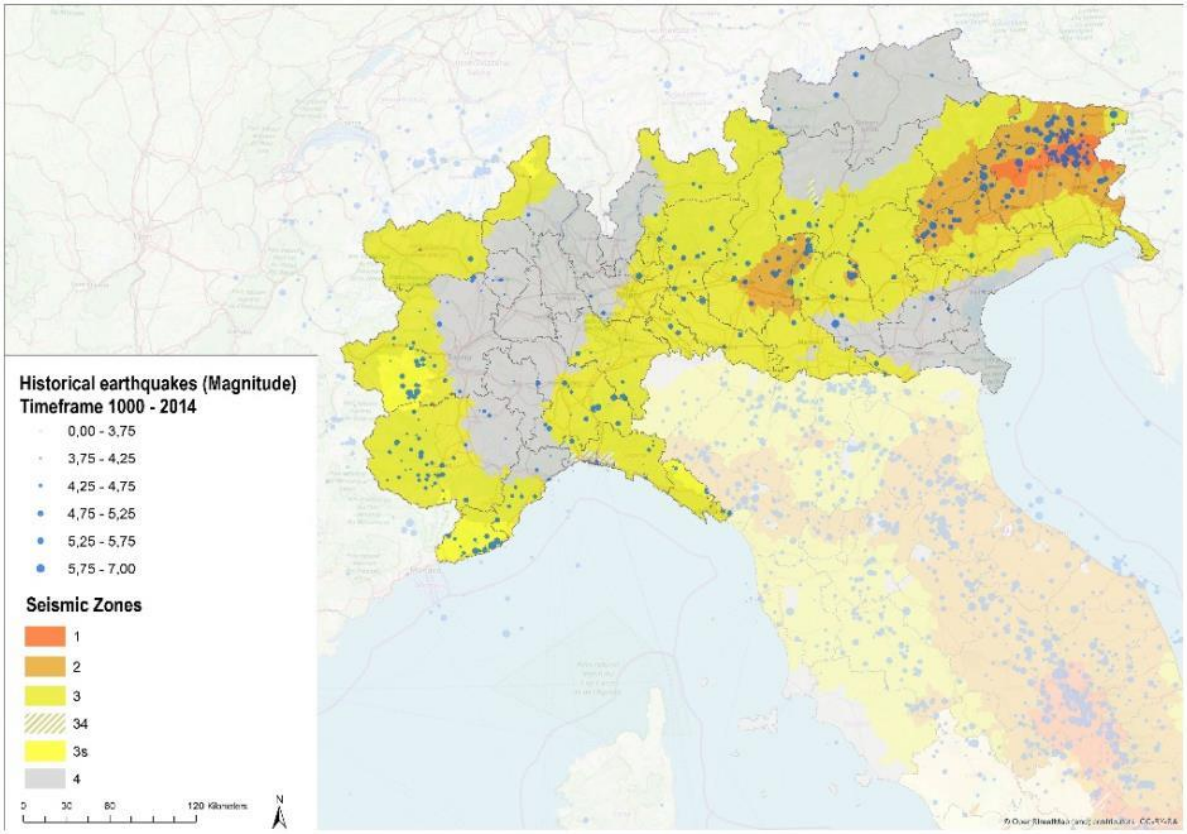

Figure 23 Seismic zones and events of earthquakes from 1000 to 2014

With a focus on the Italian side of the Alpine Space area, the upper map shows:

- **the seismic classification of Municipalities,**
- **the distribution of earthquakes (Magnitude > 2) with epicentre in the Alpine area in the timeframe 1000 – 2014 (data were derived by the Italian Macroseismic Database, DBMI15, produced by the National Institute of Geophysics and Volcanology).**

Year	Magnitude	Location of the epicentre
1976	6,45	Friuli
1936	6,06	Alpago Cansiglio
1928	6,02	Carnia
1887	6,27	Liguria Occidentale
1873	6,29	Alpago Cansiglio
1794	5,96	Prealpi Friulane
1695	6,4	Asolano
1511	6,32	Friuli-Slovenia
1348	6,63	Alpi Giulie
1117	6,52	Veronese

Some insights:

- in the reference timeframe, 549 earthquakes (Magnitude > 2) with epicentre in the Alpine area were observed
- the event with highest Magnitude (6,63) occurred in 1348 and had its epicentre in the area of Alpi Giulie
- this is the list of the 10 earthquakes with highest Magnitudes observed (ordered by date)
- the majority (59%) of the Italian Municipalities in the Alpine Space area belong to Seismic Zone 3 and less than 1% belong to Seismic Zone 1 (all of them in the Eastern part of Italy, between the provinces of Udine and Pordenone)

Hydrogeological Risk

In Italy, the landslide hazard and risk zoning is in charge of the River Basin Authorities, within the Plans for Hydrological Management ("*Piani di Assetto Idraogeologio*", PAI). In compliance with Governmental requirements, these Plans organize the mapping of areas exposed to landslides and set four hazard classes:

- Very High (P4)
- High (P3)
- Medium (P2)
- Low (P1)
- Areas of Attention

The following map shows the regional rates of areas exposed to High (P3) or Very High (P4) hydrogeological hazard levels:

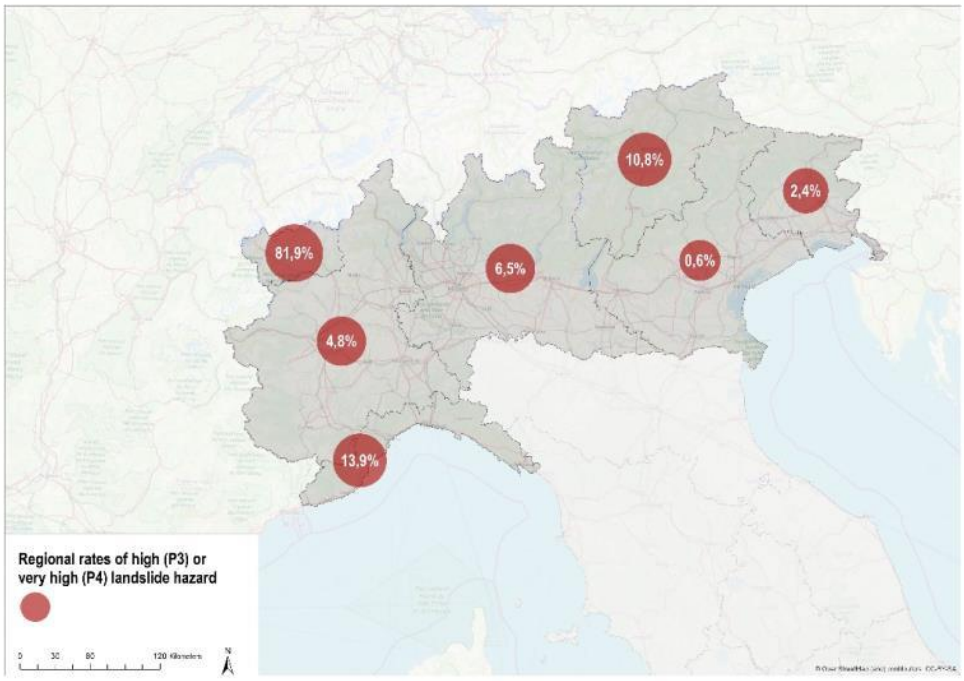

Figure 24 Regional rates of high or very high landslide hazard

With the same approach, the next map shows the distribution of hazard levels (P3 and P4) at municipality level:

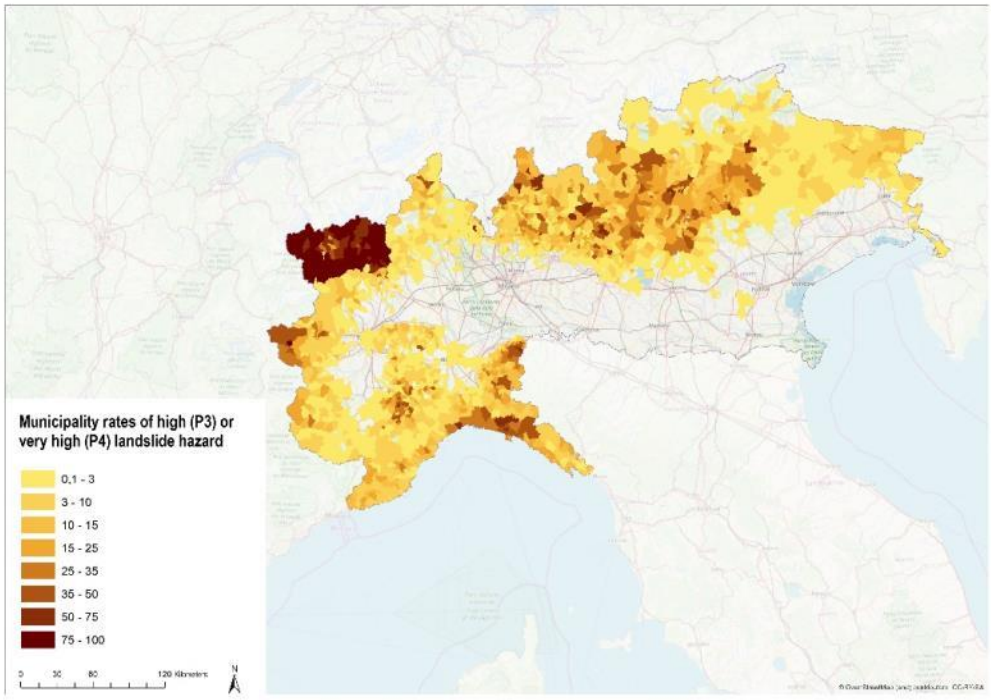

Figure 25 Municipality rates of high or very high landslide hazard

The following Graph shows, per region, the relative extension (%) of areas with increasing hydrogeological hazard levels:

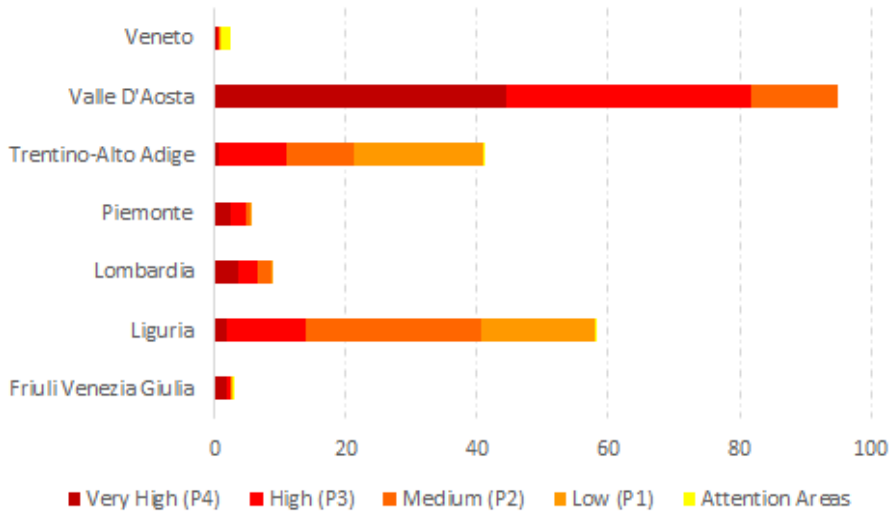

Figure 26 Regional rates of landslide hazard

Some insights:

- in the Italian side of the Alpine Space, the overall extension of areas exposed to High (P3) or Very High (P4) hydrogeological hazard amount to 7.960 km^2, approximately corresponding to 8% of the overall territory
- the Region with the largest rates of areas exposed to High or Very High landslide hazard is Valle d'Aosta (81,9%), whilst Veneto Region shows the lowest amounts (0,6%)

Hydraulic Risk

An overall picture about the spatial distribution of areas potentially exposed to floods can be derived from the mosaic, produced by ISPRA (Istituto Superiore per la Prevenzione e la Ricerca Ambientale), putting together the maps generated by the different Regions, to accomplish Flood Directive provisions.

These data map areas at different hazard levels, namely:

- areas potentially exposed to floods with a return period of 20 – 50 years (High Risk, P3)
- area potentially exposed to flood with a return period of 100 – 200 years (Medium Risk, P2)
- areas exposed to extreme floods (Low Risk, P1)

The following maps compare the regional rates of areas potentially exposed to Medium (P2) levels of hydraulic hazard and those which could face extreme floods (P1):

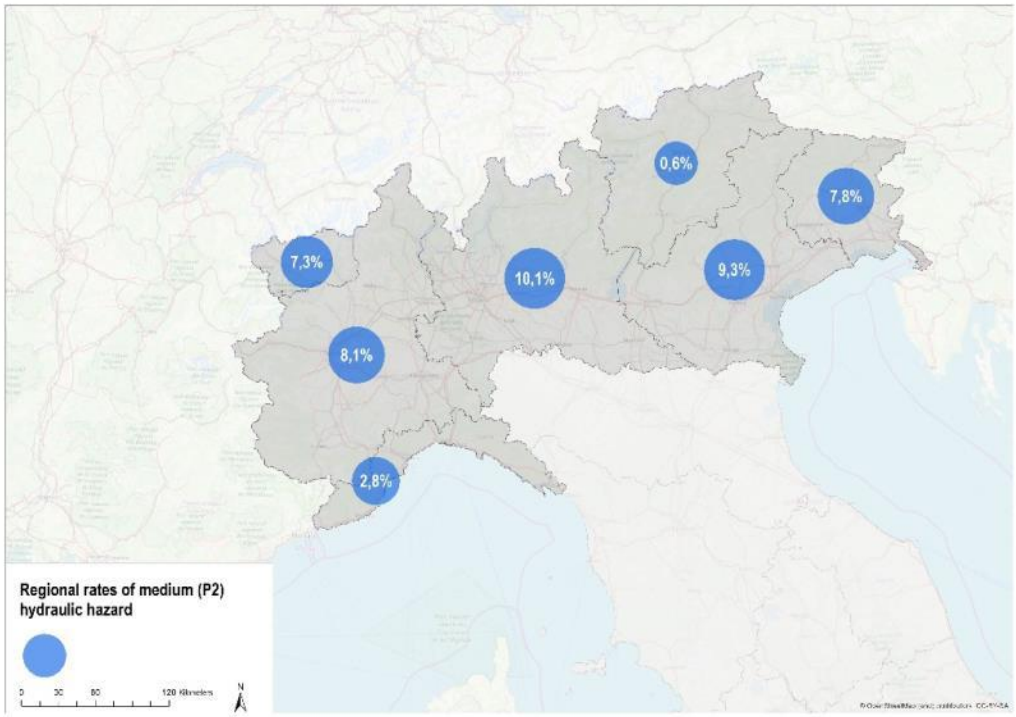

Figure 27 Regional rates of medium hydraulic hazard

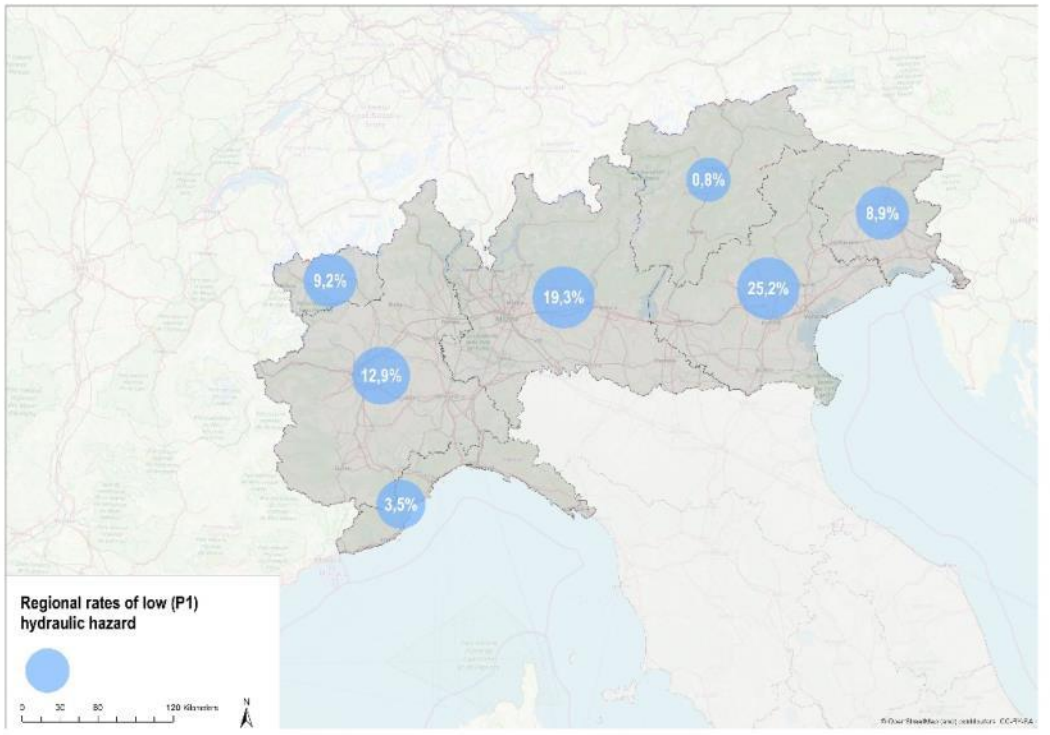

Figure 28 Regional rates of low hydraulic hazard

Some insights:

- in the Italian Regions belonging to Alpine Space, the overall extension of areas exposed to Medium (P2) or High (P1) floods hazard respectively amount to 7.267 $km^2$and 13.807 km^2, approximately corresponding to 7,4% and 14,2% of the overall extension of the area
- referring to Medium Risk areas, the highest rates of exposure respectively pertain Lombardy (10,1%) and Veneto (9,3%) whilst the lowest values are referred to Trentino Alto Adige (0,6%)
- with regard to Low Risk areas (those potentially struck by extreme floods), the highest exposure rates are referred to Veneto (25,2%) and Lombardy (19,3%) with lowest values still pertaining Trentino Alto Adige (0,8%)

Forest Fires Risk

An overall picture of forest fires in the Italian regions of Alpine Space can be derived from both the data produced by the Corpo Forestale dello Stato and by the dedicated database, generated in the framework of the Alpine Space project MANFRED (*Management strategies to adapt Alpine Space forests to climate change risk*).

The following Graph shows, based on the data produced by the Corpo Forestale dello Stato for the period 2009 – 2014, the overall burnt area (ha) per each Italian Region belonging to the Alpine Space:

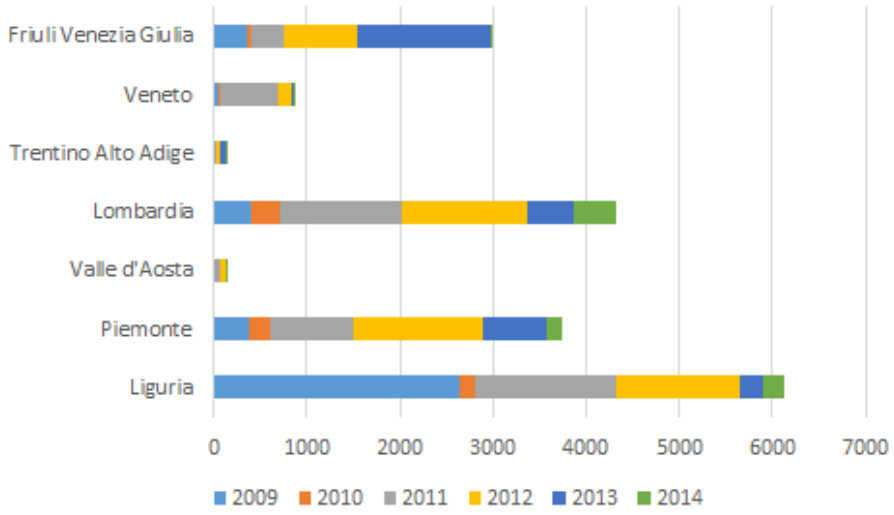

Figure 29 Overall burnt area (ha) per each Italian Region belonging to the Alpine Space

The map below shows, from MANFRED database on the time horizon 1981 - 2010, the distribution of the points of ignition of forest fires with overall burnt area > 20 ha:

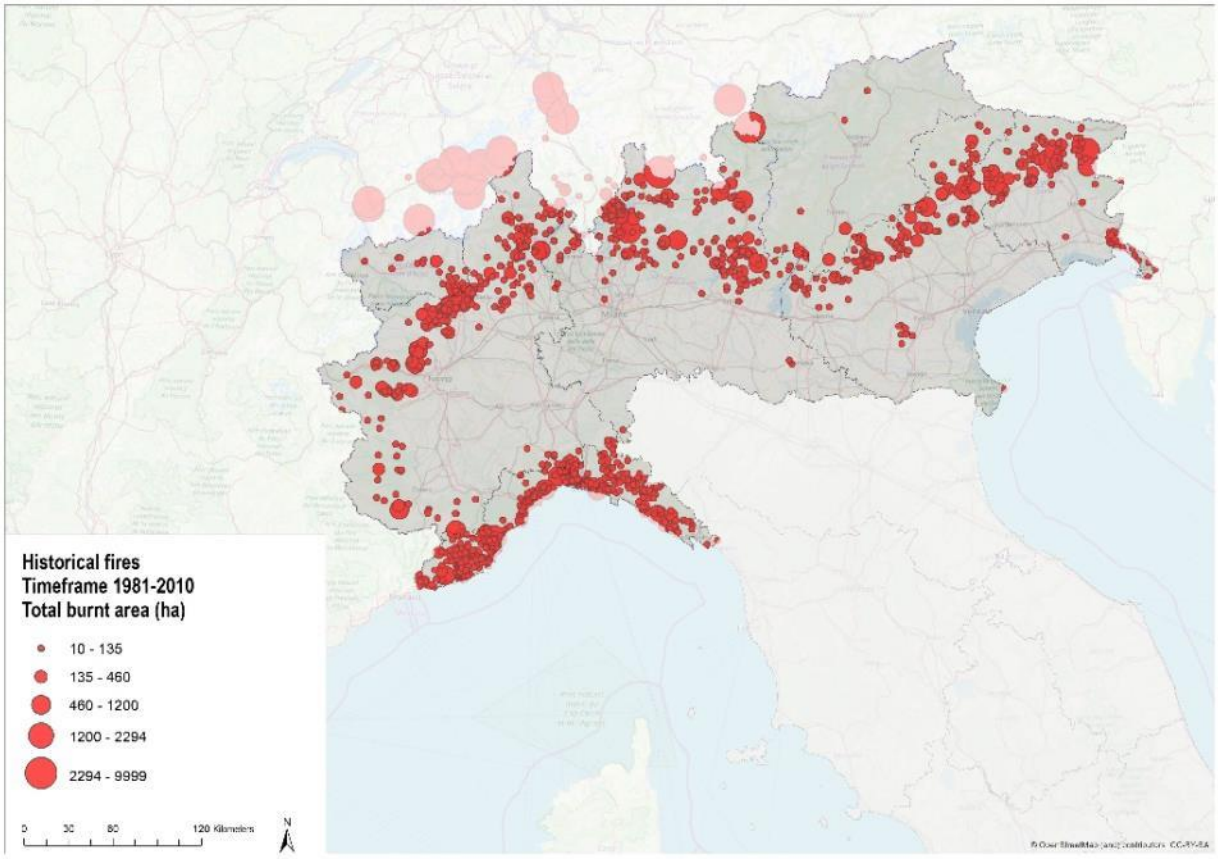

Figure 30 Fires and total burnt area (ha) from 1981 to 2010

Some insights:

- in the timeframe 1981 – 2010, more than 20.000 forest fires had their points of ignition in the Italian side of Alpine Space
- in the time period 2009 – 2014, the Italian regions with the highest extensions of overall burnt area were Liguria and Lombardy, with respectively more than 6.000 and 4.000 ha
- in the same period, the regions with the lowest rates of burnt area were Trentino Alto Adige and Valle d'Aosta, with few hundred burnt ha

Cultural Heritage and Natural Hazards

The Report "*Dissesto idrogeologico in Italia: pericolosità e indicatori di rischio*" (Istituto Superiore per la Prevenzione e la Ricerca Ambientale - ISPRA, 2018) provides a set of statistics that allow to derive a first picture on the exposure of cultural heritage both to landslides and flood scenarios.
With regard to hydrogeological risk, the statistics were derived by integrating data from the Plans for Hydrological Management (mapping landslides and related hazard levels) and information on cultural heritage derived from the "*Vincoli in rete*" platform, an initiative carried out by the Ministry of Cultural Heritage and Activities and Tourism (MIBACT).

The Table below summarizes, for the Italian regions belonging to Alpine Space, the overall exposure of cultural heritage to High (P3) or Very High (P4) hydrogeological hazard:

Region	*Number of cultural heritage assets*	*Number of cultural heritage assets in hazard areas*			
		High (P3)	*Very High (P4)*	*P3 + P4*	*%*
Piemonte	13.512	246	316	562	4,2
Valle d'Aosta	351	163	43	206	58,7
Lombardia	17.274	204	160	364	2,1
Trentino Alto Adige	1.773	108	20	128	7,2
Bolzano	888	28	20	48	5,4
Trento	885	80	0	80	9,0
Veneto	23.978	42	63	105	0,4
Friuli Venezia Giulia	5.008	47	41	88	1,8
Liguria	14,651	747	143	890	6,1

The map below shows, at regional level, the rates of cultural heritage exposed to High (P3) or Very High (P4) hydrogeological hazards:

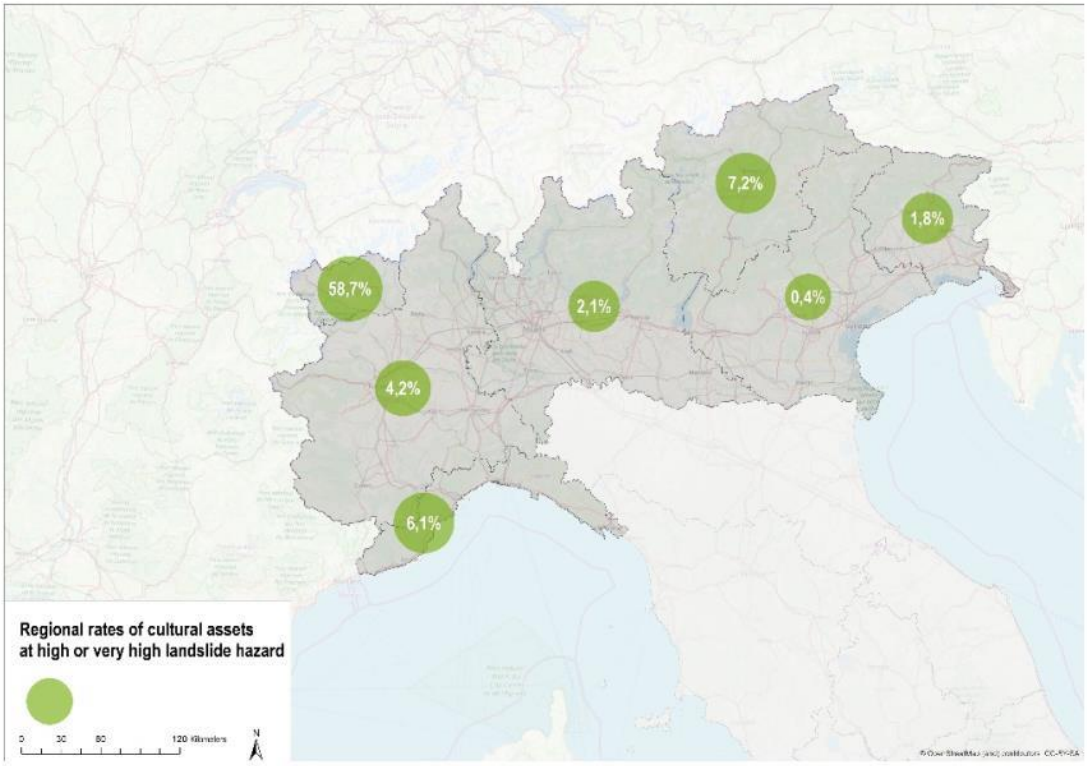

Figure 31 Regional rates of cultural assets at high or very high landslide hazard

Pertaining with flood risk, the picture on the exposure of cultural heritage was derived through an integration of the "*Vincoli in rete*" data and maps produced by the Regions to accomplish the Flood Directive provisions.

The following Table synthetises, for the Italian regions belonging to the Alpine Space, the overall exposure of cultural heritage to High (P3), Medium (P2) and Low (P1) hydraulic hazard:

Region	*Number of cultural heritage assets*	*Number of cultural heritage assets in hazard areas*					
		High (P3)	*%*	*Medium (P2)*	*%*	*Low (P1)*	*%*
Piemonte	13.512	705	5,2	1.311	9,7	2.791	20,7
Valle d'Aosta	351	47	13,4	50	14,2	63	17,9
Lombardia	17.274	898	5,2	1.443	8,4	3.563	20,6
Trentino-Alto Adige	1.773	8	0,5	8	0,5	146	8,2
Bolzano	*888*	*0*	*0*	*0*	*0*	*0*	*0*
Trento	*885*	*8*	*0*	*8*	*0*	*146*	*16,5*
Veneto	23.978	4.034	16,8	4.397	18,3	7.036	29,3
Friuli-Venezia Giulia	5.008	269	5,4	630	12,6	800	16,0
Liguria	14,651	2.825	19,3	3.712	25,3	4.434	30,3

The map below shows, at regional level, the rates of cultural heritage exposed to High (P3), Medium (P2) and Low (P1) hydraulic hazard scenarios:

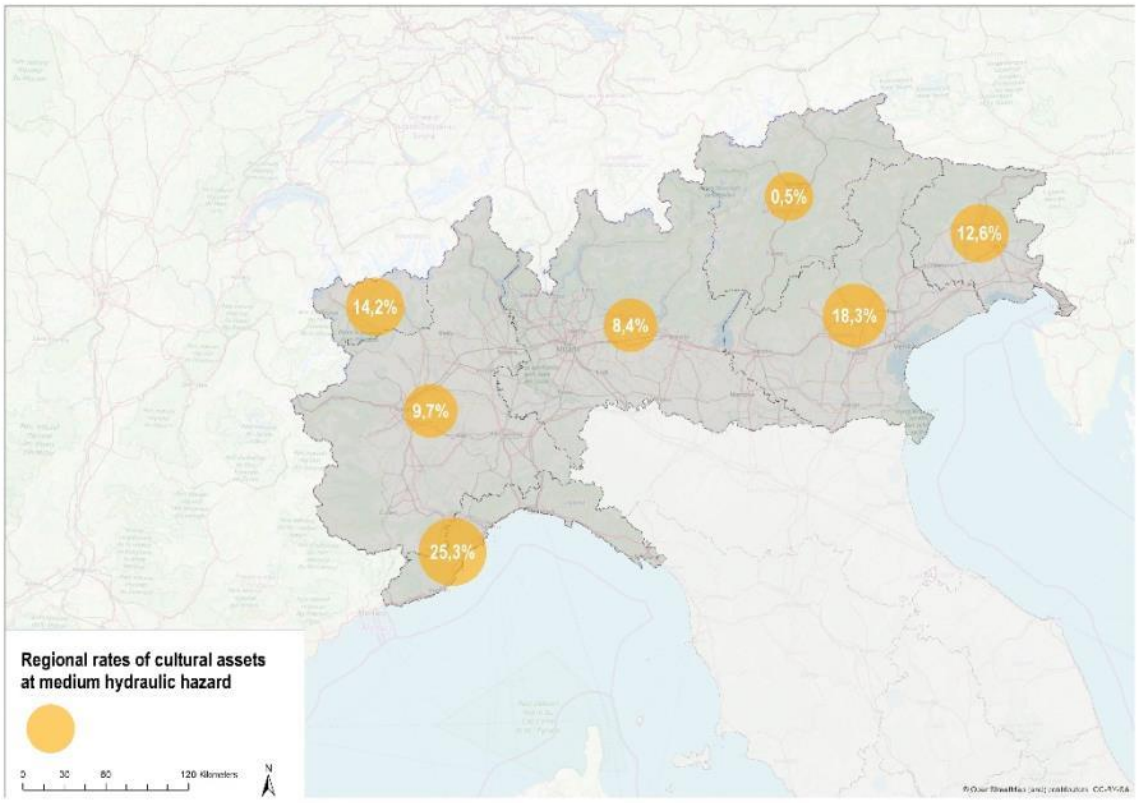

Figure 32 Regional rates of cultural assets at medium landslide hazard

Some insights:

- with regard to hydrogeological risk, the regions with the highest amounts of cultural heritage in areas at High (P3) or Very High (P4) landslide hazard are represented by Liguria (890), Piedmont (562) and Lombardy (364). In terms of rates, the highest value is observed in Valle d'Aosta, where more than 50% of cultural heritage is located in P3 or P4 areas
- referring to hydraulic phenomena, Liguria, Veneto, Piedmont and Lombardy show the highest rates of cultural heritage in areas potentially exposed to floods, respectively 30,3%, 29,3%, 20,7% and 20,6%

Occurrence of natural disasters in case of Switzerland

Switzerland is characterized by four geographic regions: Jura, Swiss Plateau, Prealps and Alps each characterized by distinct geological peculiarities. The Alps occupy the southern part and constitute about 60% of the country, however this region is relatively sparsely populated, except for larger valleys like Valais. Most people live on the Plateau.

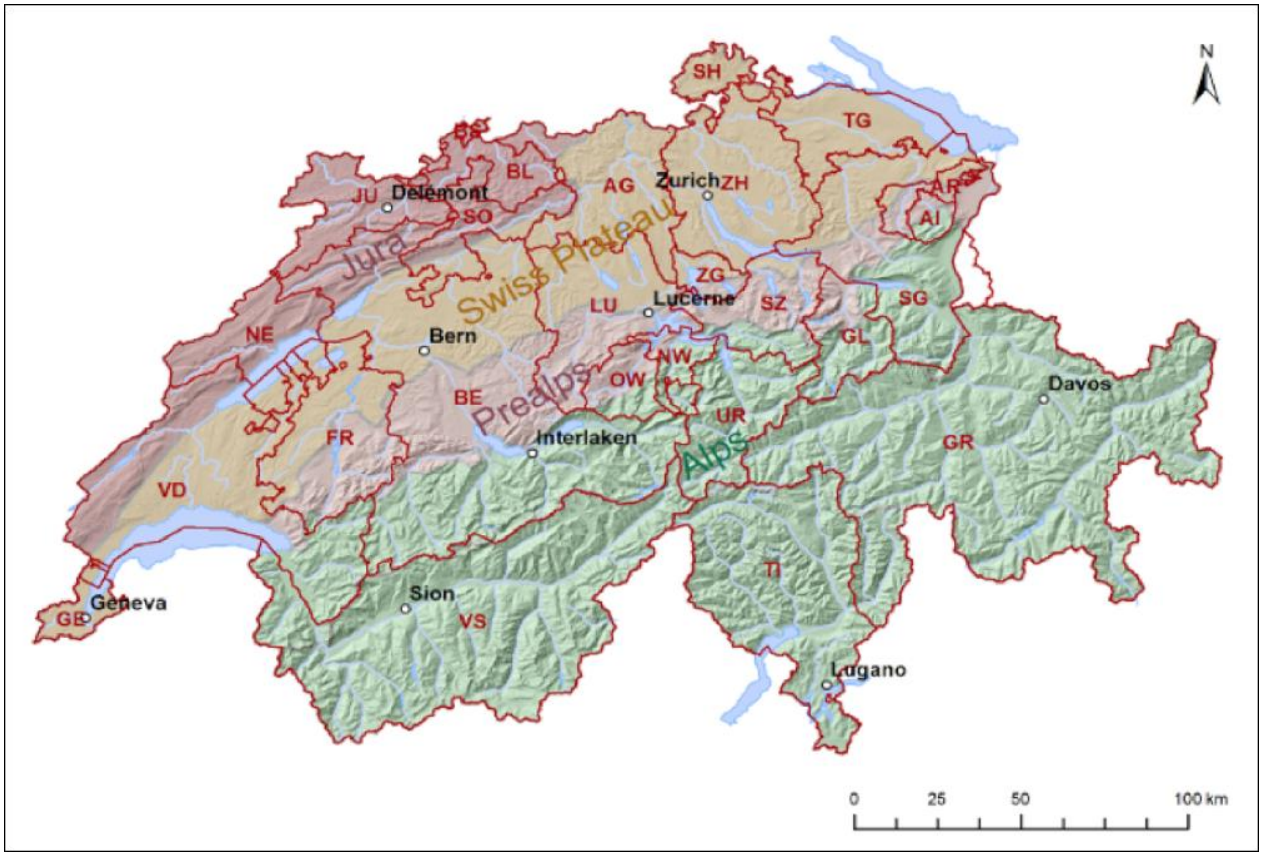

Figure 33 Study area showing the Swiss stream network, the Swiss cantons (red polygon with abbreviations), the geomorphologic-climatic regions Jura, Swiss Plateau, Prealps and Alps (areas with different background colours) and several key cities. (DHM source: dhm25 2016 swisstopo, 5704 000 000). From Badoux et al. (2016).

A study conducted on the natural hazard fatalities in Switzerland from 1946 to 2015 (Badoux *et al*. 2016) shows a quite homogenous distribution of natural disaster events over the country. Looking at the spatial distribution of fatalities by typology of natural hazard event it emerges that the mountainous parts of the country, and specifically the alpine region, have registered more frequent multi-fatality events resulting from a higher occurrence of avalanches, landslide processes and rockfall events. Flood fatalities instead occurred in almost all regions over the last 70 years. (Fig. 34)

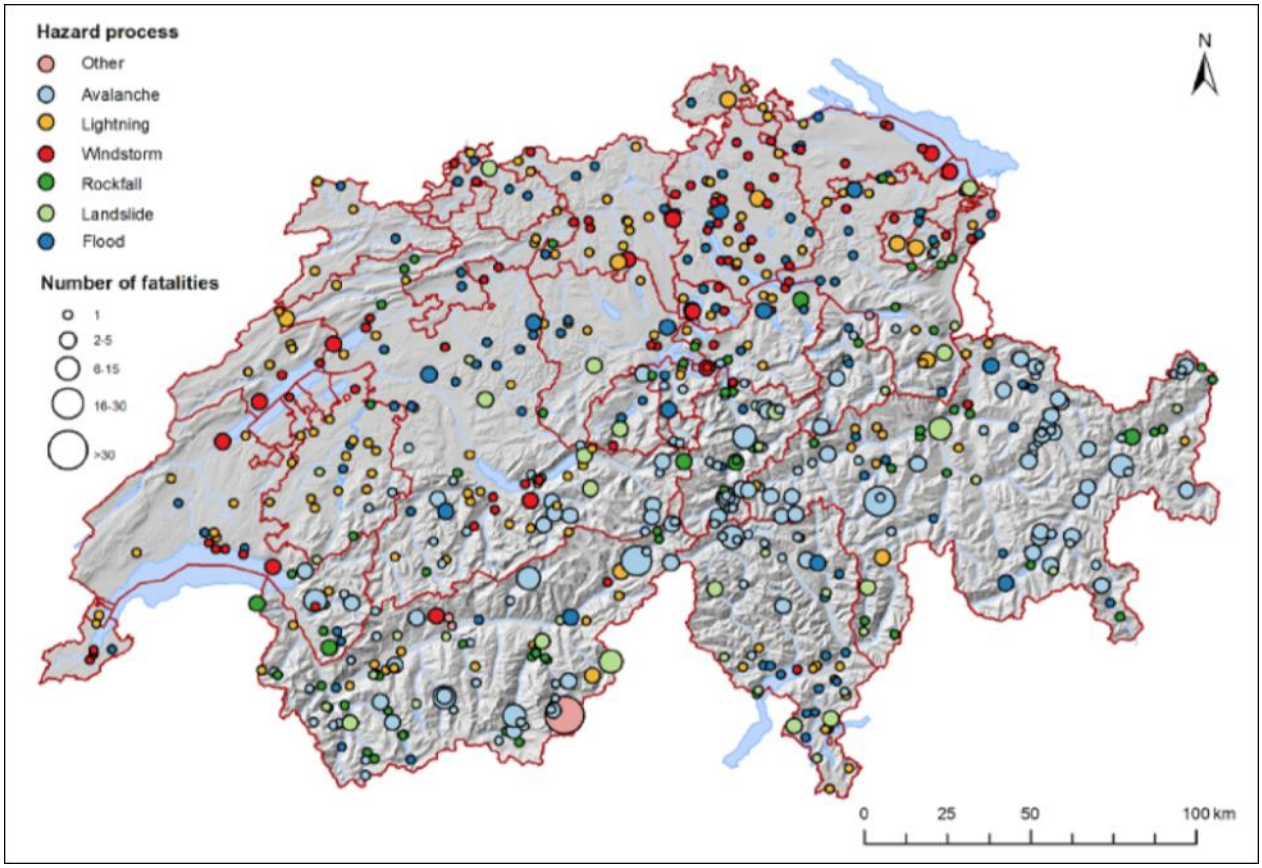

Figure 34 Spatial distribution of fatalities caused during natural hazard events in Switzerland from 1946 to 2015. The color of each data point indicate the process category, and the size of the symbol shows the number of deaths per fatal accident (DHM source: dhm25 2016 swisstopo, 5704 000 000. From Badoux et al. (2016).

The alpine region of Canton of Ticino

The territory of the Canton of Ticino is entirely located within the Alpine Space and it presents different topographic and morphological characteristics of making it subject to almost all types of natural danger occurring in mountain ranges: floods, debris flows, avalanches, landslides, rockslides and rockfalls. Several natural disasters have followed over the years, causing extensive damage who hit both the population (over 300 victims) and the urban areas. The Monte Crenone rock avalanche of 1513 and the subsequent mega flood known as *Buzza di Biasca* of 1515, the Great Flood of 1868, and the avalanches of 1951 are just some of the historical events that have devastated the population, the territory, and its heritage. The knowledge, experience and collective strategies matured over time to cope with the management of avalanche danger, represents today a real living tradition of Alpine populations, which has been registered in 2018 on the representative list of UNESCO's intangible cultural heritage.

All information related to natural events of rock falls, debris flows, landslides and avalanches occurred in Ticino since 1570 are collected and available online in the StorMe land registry of natural hazard: http://www.sitmap.ti.ch/index.php?ct=storme. The StorMe Land Registry has been systematically updated since 2000 with detailed data, maps and images on natural hazard events. It also provides a description of the causes and repercussions caused by the event in order to limit the risks and to estimate the frequency of dangerous processes.

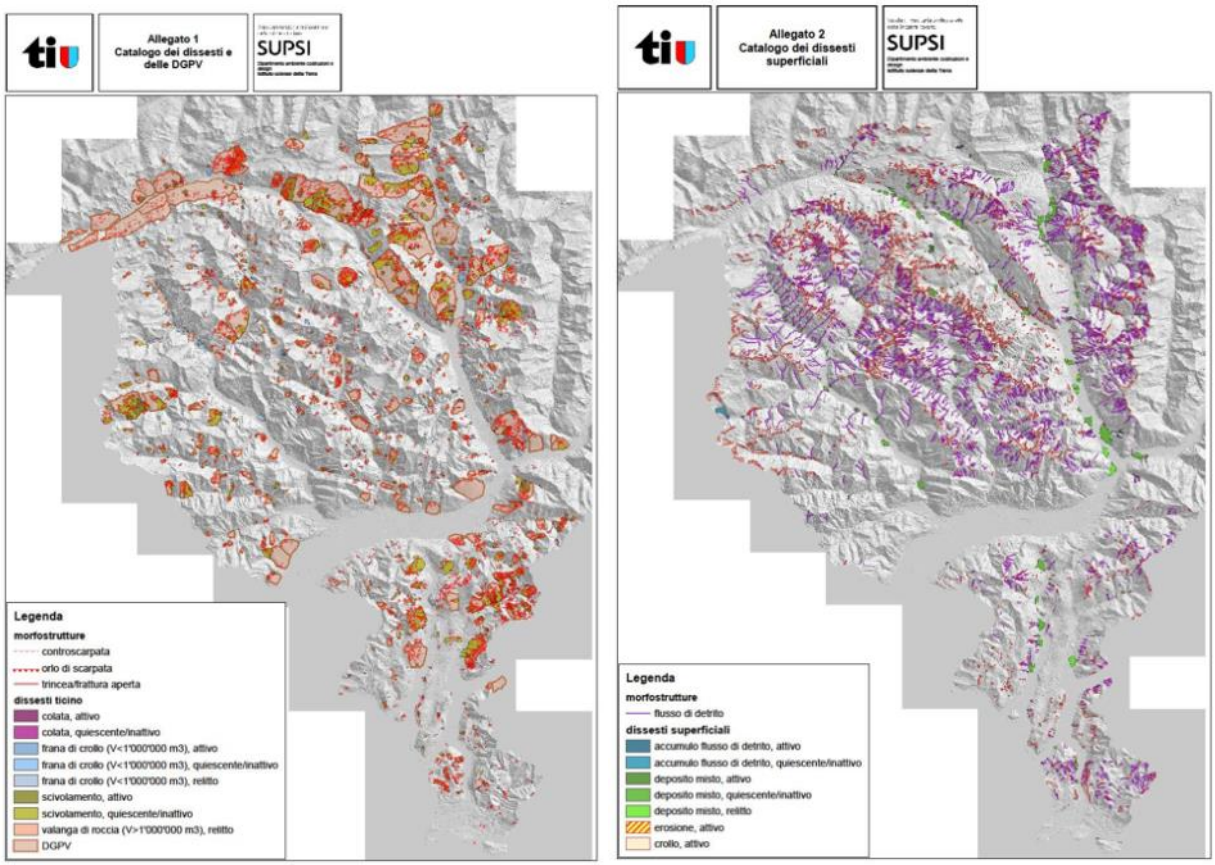

Figure 35 Spatial distribution of fatalities caused during natural hazard events in Switzerland from 1946 to 2015. The color of each data point indicate the process category, and the size of the symbol shows the number of deaths per fatal accident (DHM source: dhm25 2016 swisstopo, 5704 000 000. From Badoux *et al*. (2016).

StorMe is an essential document for the drafting of the Hazard Zone Map (PZP – Piano Zone di Pericolo), for the local planning of the territory, and for the management of emergencies (Fig. 37-38). The PZP integrates all the hazard maps of the regions which are based on the parameters of Intensity (energy from phenomena) and Probability (return time) (Fig. 36). For continuous processes, the probability is not defined and the danger depends only on the intensity (velocity or degree of magnitude of displacement). The degree of danger is defined separately for each process. The final degree is the degree of danger determining the highest degree of hazard.

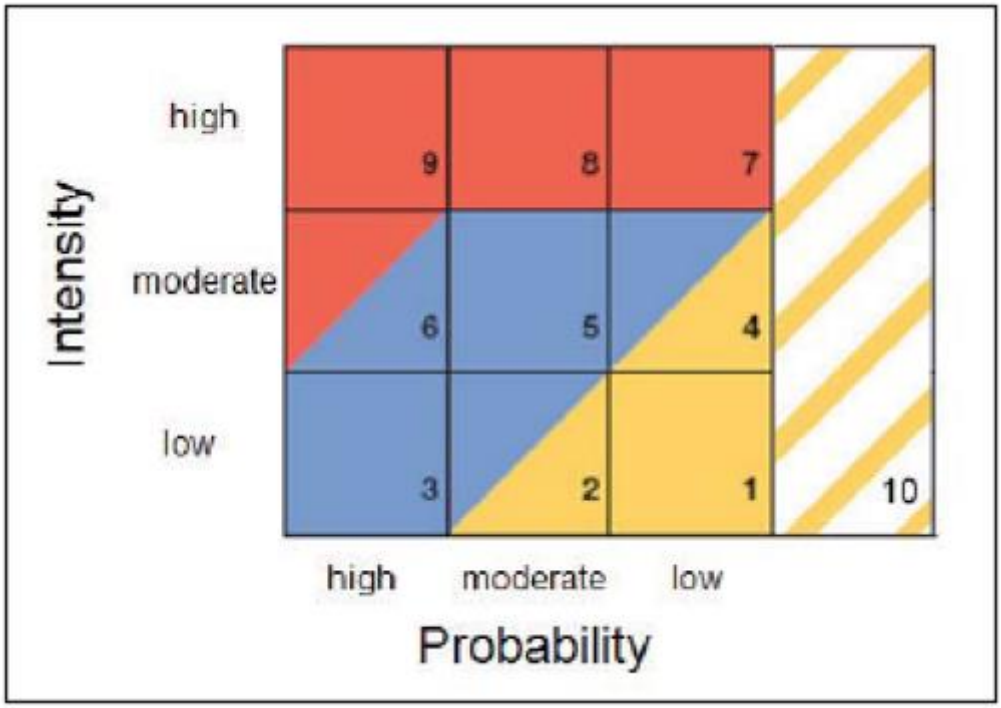

Figure 36 Hazard Zones: Red (High hazard), Blue (Moderate Hazard), Yellow (Low Hazard). White/yellow hatched (residual danger, high intensity but very unlikely). Source: Kunz & Hurni (2008).

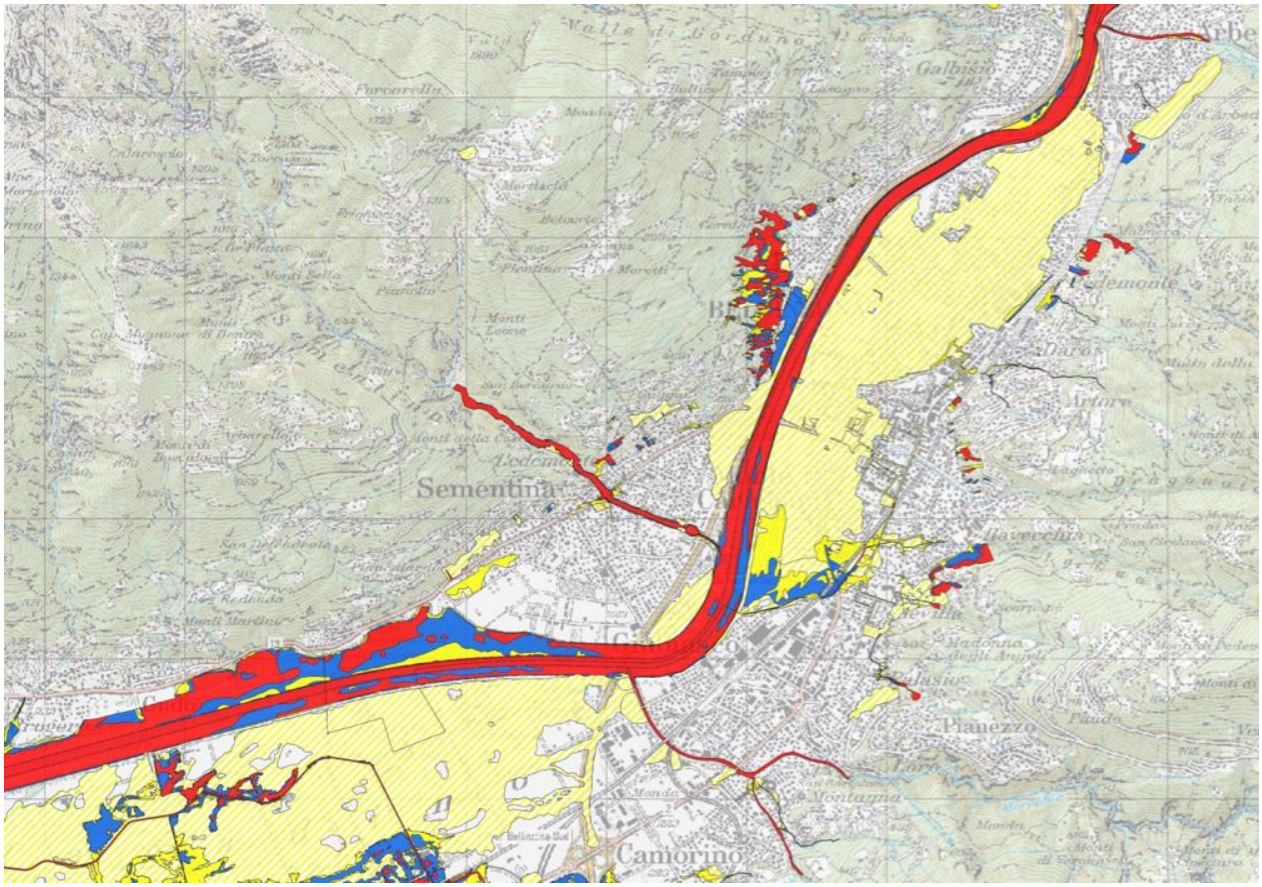

Figure 37 The Hazard Zone Map of the Canton of Ticino for the central part of the Town of Bellinzona (fractions of Bellinzona, Sementina and Camorino), focusing mainly on flood hazard on the valley floor and on rockfall hazard on the lower part of valley slopes.

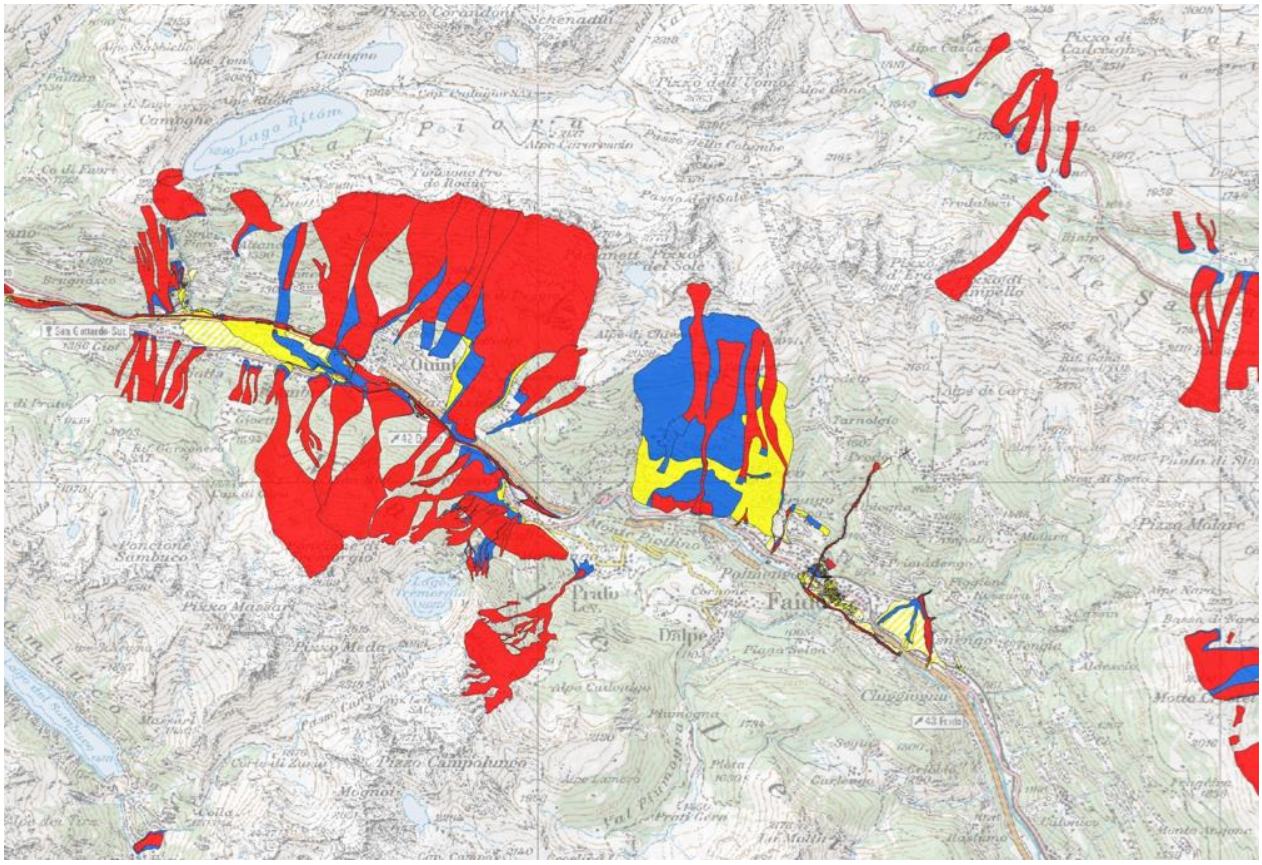

Figure 38 The Hazard Zone Map of the Canton of Ticino for the highest part of Valle Leventina (Municipalities of Faido, Dalpe, Prato Leventina and Quinto), focusing mainly on avalanche, debris flow and rockslide hazards on the valley slopes.

The landslide and rock glacier inventory map of Canton Ticino was recently upgraded joining many studies performed since 2005 following a multi-method approach combining 2D and 3D digital photointerpretation.

This mapping allowed the inventory of 6599 hillslope landforms, from which:

- 2035 were classed as landslides (covering a surface of 184.4 km^2);
- 4376 as shallow landslides (covering a surface of 133.7 km^2);
- 188 as Deep-Seated Gravitational Slope Deformations (DSGSD).

Landslides are composed by:

- 1494 slides;
- 86 flows;
- 390 falls (comprised between 100 and 1.000.000 m^3);
- 5 rock avalanche deposits (> 1.000.000 m^3).
- 334 landslides were considered as active (238 slides, 17 flows and 79 falls).

Shallow landslides include:

- 1532 erosion areas;
- 2000 talus slopes, scree slopes, scree slopes, coarse-scree slopes and rockfall deposits (< 100 m^3);
- 27 debris flow deposits (from which 16 are considered as active);

- 817 mixed cones composed both by rockfall and debris flow deposits (from which 97 are considered as active).

Governance

The StorMe Land Registry and the Hazard Zone Plans (PZP) are built on the SIT-TI, a Geographical information system for the management of all spatial data in Canton of Ticino. SIT is a software aiming to facilitate the visualization and analysis of information related to geodata. The development of the SIT is based on the federal law called Geoinformation Act (GeolA, 1 October 2009). The SIT system includes and integrate also land-use development plans as well as information management system which report georeferenced data, such as the system used to manage the protection of cultural heritage with the aims to facilitate the research, analysis and representation of data as well as to evaluate the numerical consistency and geographical location. The collection of reports of natural events is a task of the Forestry Section (*Sezione Forestale*) and the Waterways Office (*Ufficio dei Corsi d'acqua*), in collaboration with the District Forest Offices (*Uffici forestali di circondario*) and the Consortiums for the Maintenance of Hydraulic Works (*Consorzi di arginatura o correzione dei corsi d'acqua*). The documentation on natural events plays a central role in the context of hazard assessment.

To reduce the damage extent of natural hazards and the areas vulnerability, Switzerland proposes an integrated risk management approach, sharing the reasonability between federal, cantonal and communal authorities. The integrated risk management follows the subsidiary principle and it is grounded on three main corners stones: preparedness, response and recovery (Figure 39).

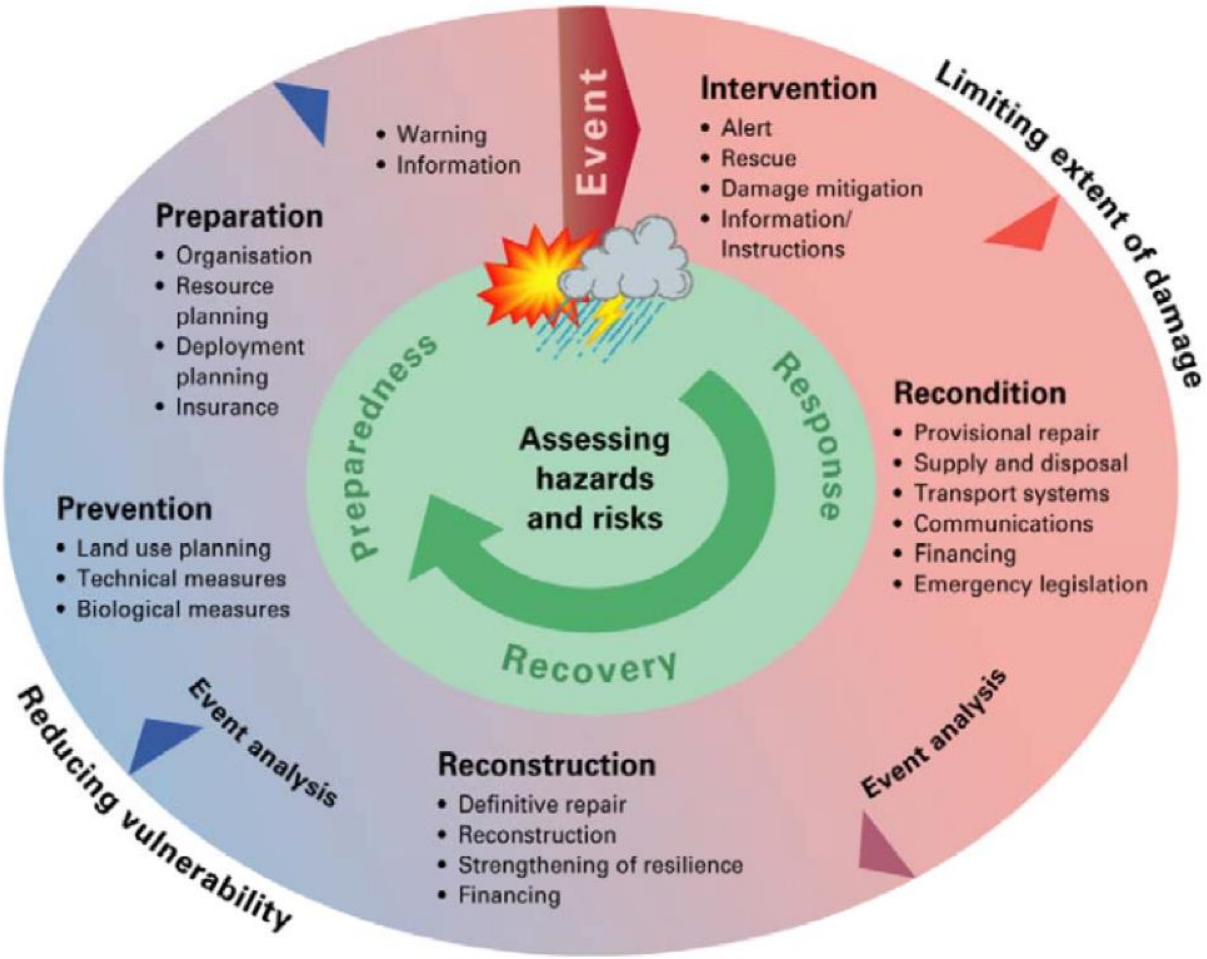

Figure 39 Integrated risk management plan. Source: Loat (2010).

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Occurrence of natural disasters in case of France

The approach adopted for the French part of Alps to present natural hazard events was grounded on municipal area level as a basic unit of spatial reference. Statistical analysis of the natural hazards is considering several different types of events, which are further investigated and presented in text:

- seismic hazard;
- floods;
- avalanches;
- mass movements.

Some of them cross the concerned regions independently form the elevation, and the landform may represent intensity amplification factor as such as the soil characteristics. For example, the seismic risk threatens the PACA on the coast as much as, or more then, on the mountain range. Other hazards may relate the mountain range and the underlying floodplain as source and target areas of phenomena that exist and possibly hit the target with different severity and frequency, depending on the land management carried out in the source area, as is the case of flooding. It is still more important to take into account the dynamics of this critical physical interconnection and the spatial extent of the institutional entity that can exert a unique control on it, when the overall aim of the analysis is to support policies and suggest best regulatory practices in disaster risk reduction and climate change adaptation.

The French regions participating the Alpine Space cooperative programme show specificity both in terms of landform systems and land use/land cover history.

Provence-Alpes-Côte d'Azur (PACA) in the Southern East of France, hosts probably the wider variety of landscapes among them, with the French Riviera, dominated by the Esterel and the Massif des Maures and the white limestone cliffs, broken by gorges, before dropping in the delta Rhone forming the vast ponded area of Camargue. The floodplain formed by the Rhone and its tributaries is surrounded by other mountains and the Prealps. But the highest peaks, beyond 4000 msl are represented by the Mercantour and the other massifs of Maritime Alps. This region has a strong touristic vocation and host notorious archaeological sites.

The French law n°2015-29 of 16 January 2015 on the delimitation of regions redistricted the regions. In particular, the Rhône-Alpes region is grouped currently in Auvergne-Rhône-Alpes region, Franche-Comte region grouped in Bourgogne Franche-Comte region, and Alsace grouped in Alsace Champagne-Ardenne Lorraine region. Those are the 3 old regions which are included in the Alpine Space area and considered in next paragraphs.

The Rhône-Alpes old region delimiting PACA at the north, aggregates very different environments and cultures, preserving strong folkloric traditions and monastic domains, very remarkable with respect the European identity. Because of its morphology, the mountains, and the large rivers that cross it, the Rhône-Alpes region is particularly subject to natural hazards.

The Franche-Comte region delimiting Rhone-Alpes at the north. This region is particularly rich in cities of art and history, castles, museums and wine terroirs. Natural hazard in this region are consists mainly in floods, landslide and seismic activity.

With more than 250 museums and collections, the Alsace region is the richest region in Europe in terms of concentration of feudal castles. In more than 95% of the cases, natural disaster phenomena are represented by floods, more locally by mass movements and ground deformation, and at less extent, by seismic risk.

The advantage from the CHEERS project is to improve the safeguarding of cultural heritage under risk in mountain areas, and its surrounding. We should research all cultural heritage that is under risk generated or exasperated in mountain areas, due to the worsening of climate and increasing anthropogenic impacts. Most of the cultural heritage we will consider consists in structural elements and the mobile heritage they contain, and in general we assume that they survived a long history of hazard events. If today they are threatened more than in the past, we can probably better understand how to continue preserving them – with recognizing the most critical changes. Even the best rescue practices for safeguarding the mobile goods will be useless, if the structure where they are located remains under risk during an emergency.

Seismic hazard

The distribution of the seismic risk for Alpine Space regions is obtained by the seismic zoning defined following scientific studies of seismic hazard assessment, based on a probabilistic method, with a reference return period of 475 years, in accordance with EC8 standards.

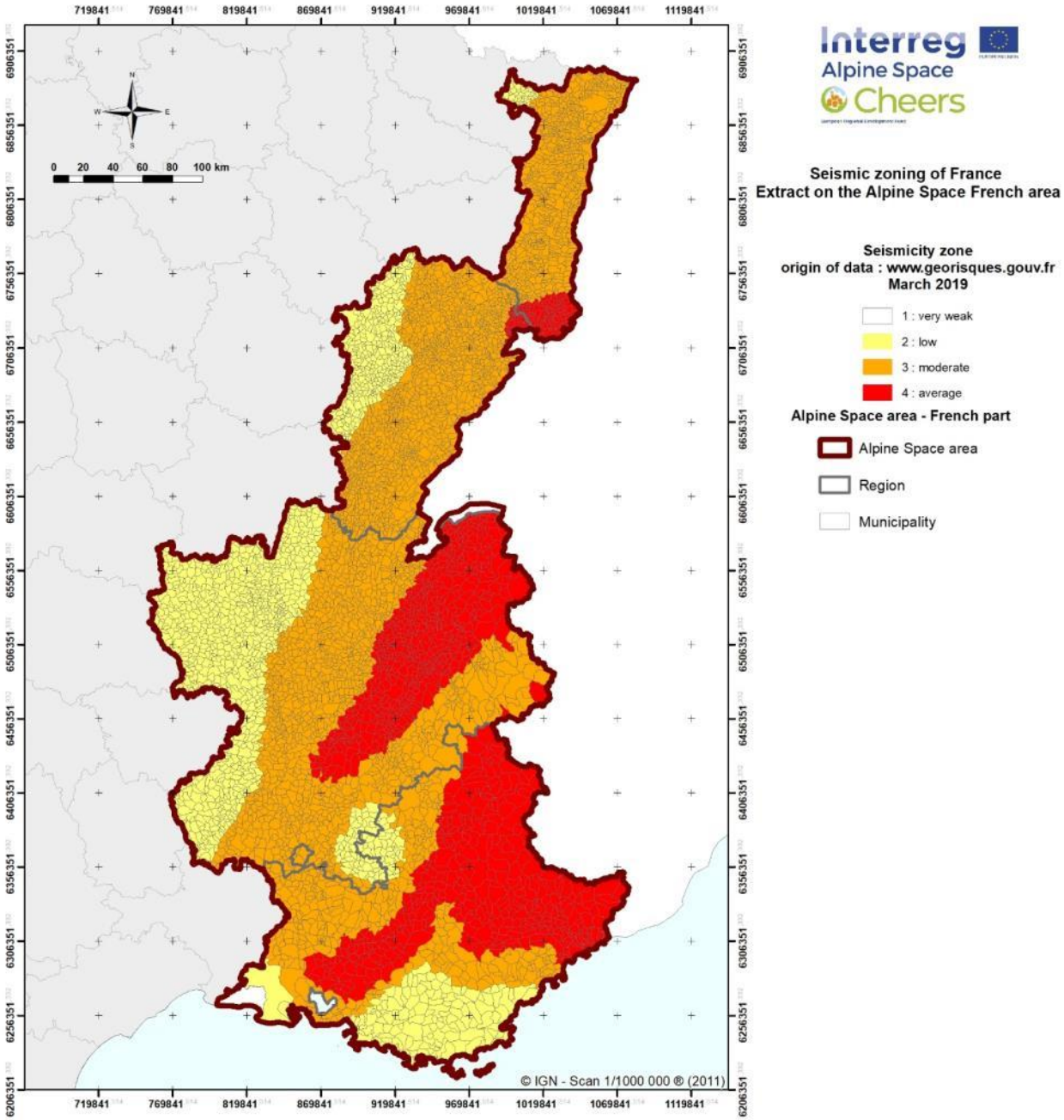

Figure 40 Seismic zoning of France extract on the French Alpine Space area

This regulatory map takes also into account the improvement of the knowledge of the historical seismicity and the active seismotectonic faults, as well as new data of instrumental seismicity on the French territory. The "Seismic zoning of France" (came into effect in May 2011), divides the national territory into five zones of increasing seismicity, being the higher grade attributed only to the French West Indies.

The highest seismicity grade of seismicity considered in France, affects wide extent also in PACA and ARA, from the Alps to SW, and most of the remaining part is characterized by a moderate level of hazard. This pattern is effectively represented even by the distribution of relevant buildings, selected as susceptible of cultural interest (fig. 41). Considering the total of around 24.150 elements, almost the 50% is located in municipalities classified as "3 – moderate" according to the Seismic zoning. The remaining part is located in almost equally percentage in territories higher and lower seismic risk.

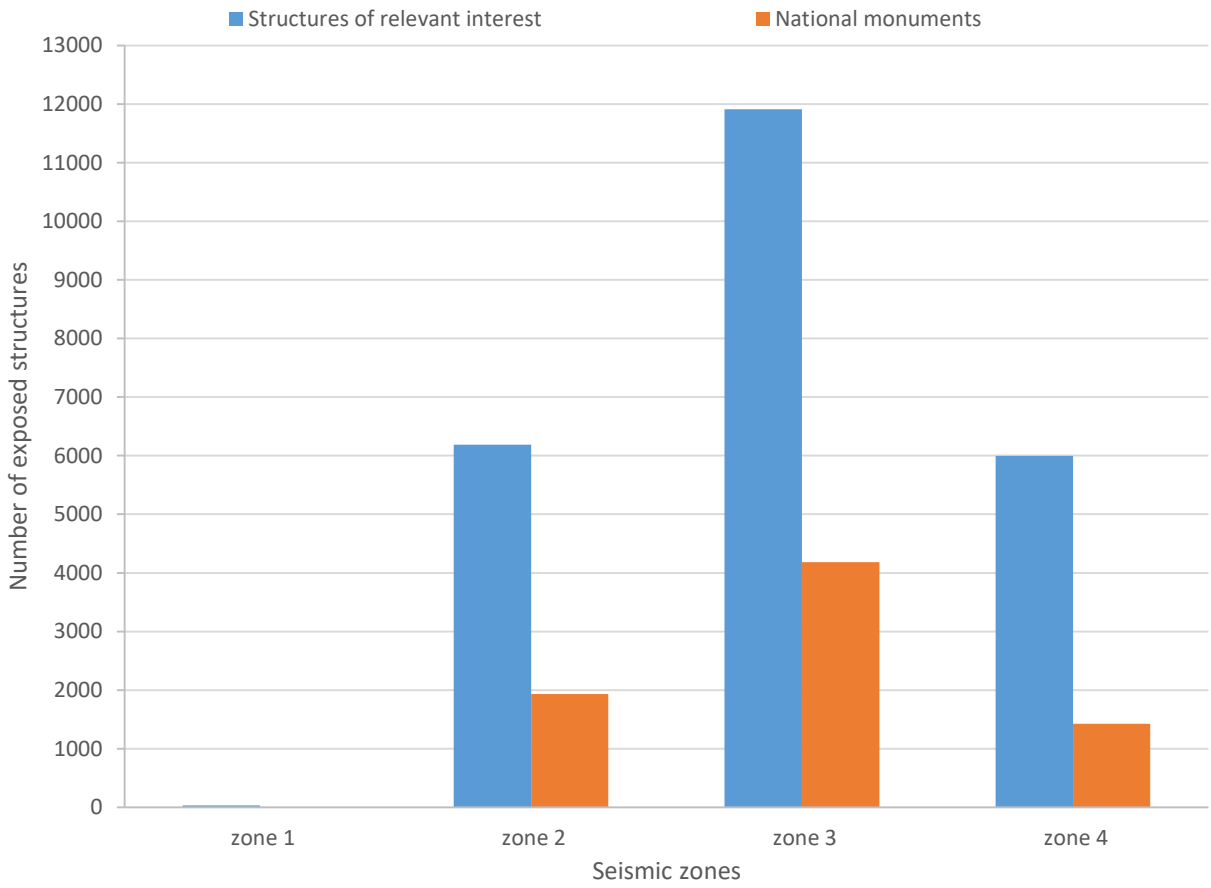

Figure 41 Distribution of exposed asset to seismic hazard qualified in terms of seismic classification of the municipality they are located (see the legend in the map above for the meaning of the seismic zones)

It is remarkable to note that the proportion of Historic Monuments in the zones exposed to the highest class of seismic risk is lower than the respective category of the structures susceptible of cultural interest, suggesting the in the past the asset exposed was smaller or it has already partially demolished by past events.

Floods

The map representing the hydrological hazard, mostly floods and flash floods, is based on the occurrence of events recorded at municipal level, as major natural contingency.

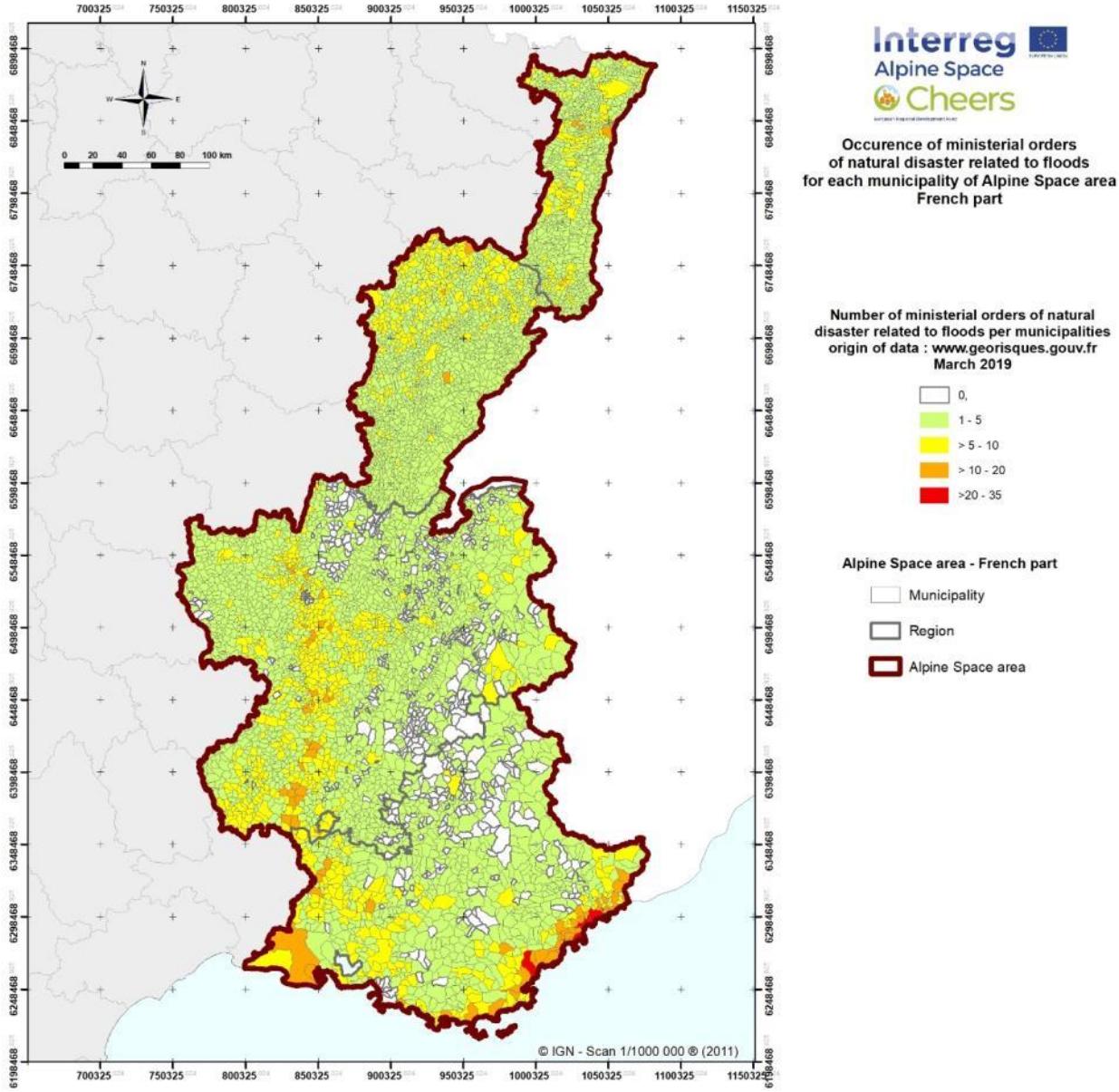

Figure 42 Occurrence of ministerial orders of natural disasters related to floods for each municipality of the French Alpine space area

The crisis management procedure in France, as in Italy and other European countries, in order to operate with supplementary resources for the disaster recovery, foresees that the government shall issue an order that contain hit municipalities and the type of event. The archive of these orders has been used to refer to each municipality the amount of floods occurred since 1982. The typology of floods considered within the scope of this introductory study for CHEERS, includes type of event more and more frequent, triggered by extreme rainfalls. Most of the municipality in the area of the French Alpine Space experienced at least one inundation and the most affected are along the coast of the aforementioned mountains in PACA.

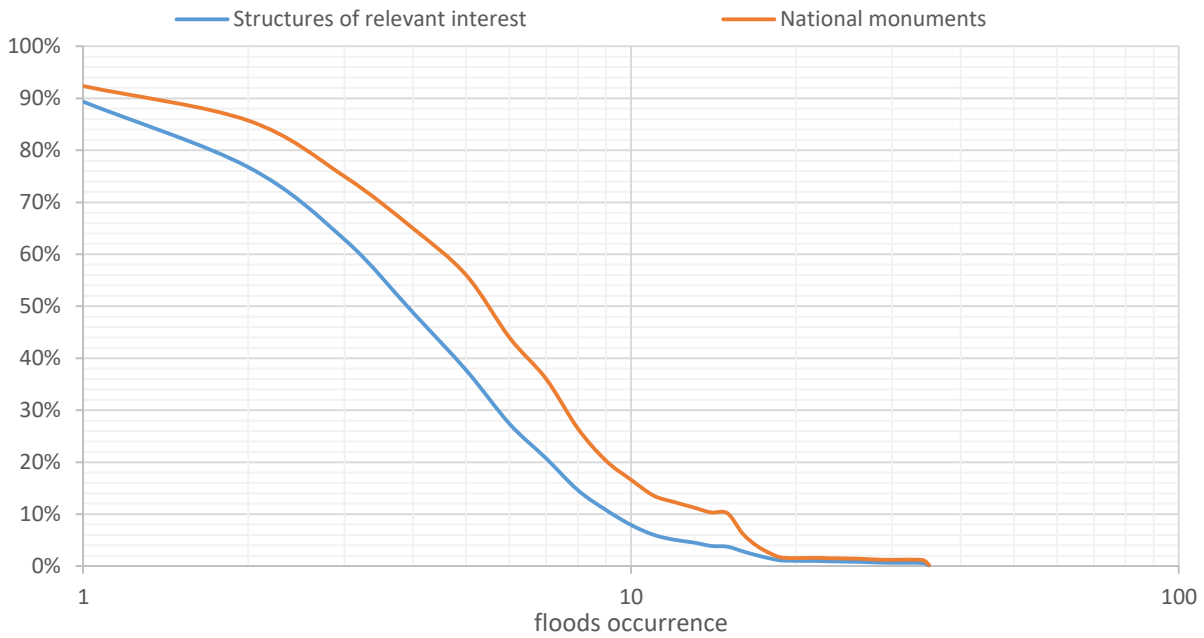

Figure 43 Distribution of exposed asset to inundation by events occurring in the municipality they are located

Due to this pervasive presence of flood risk, almost the 90% of structures susceptible of cultural interest, i.e. museums, churches and castles, even not protected by the government, are hosted in municipality that already suffered at least one flood event, while the 10% is located in areas prone to flooding, with around 10 occurrences in the archive of contingency orders. Looking at the presence of historic monuments, the level of exposure is even worst, as in the past most of communities developing activities in mountain areas had usually their permanent settlements in the valleys and on the alluvial fans, forced by the persistence of water availability and the mitigation of winter conditions. As consequence, the French partners are particularly interested, within the scope of this project, in to improve prevention and mitigation of damages to Cultural assets caused by inundations and catastrophic soil erosion.

Mass movements

The mass movement, that in mountain areas can represent an emergency collateral to a major disaster, such as earthquake or floods, are documented on the base of the GeoRisque portal archive (http://www.georisques.gouv.fr/), managed by the French Ministry of the Environment.

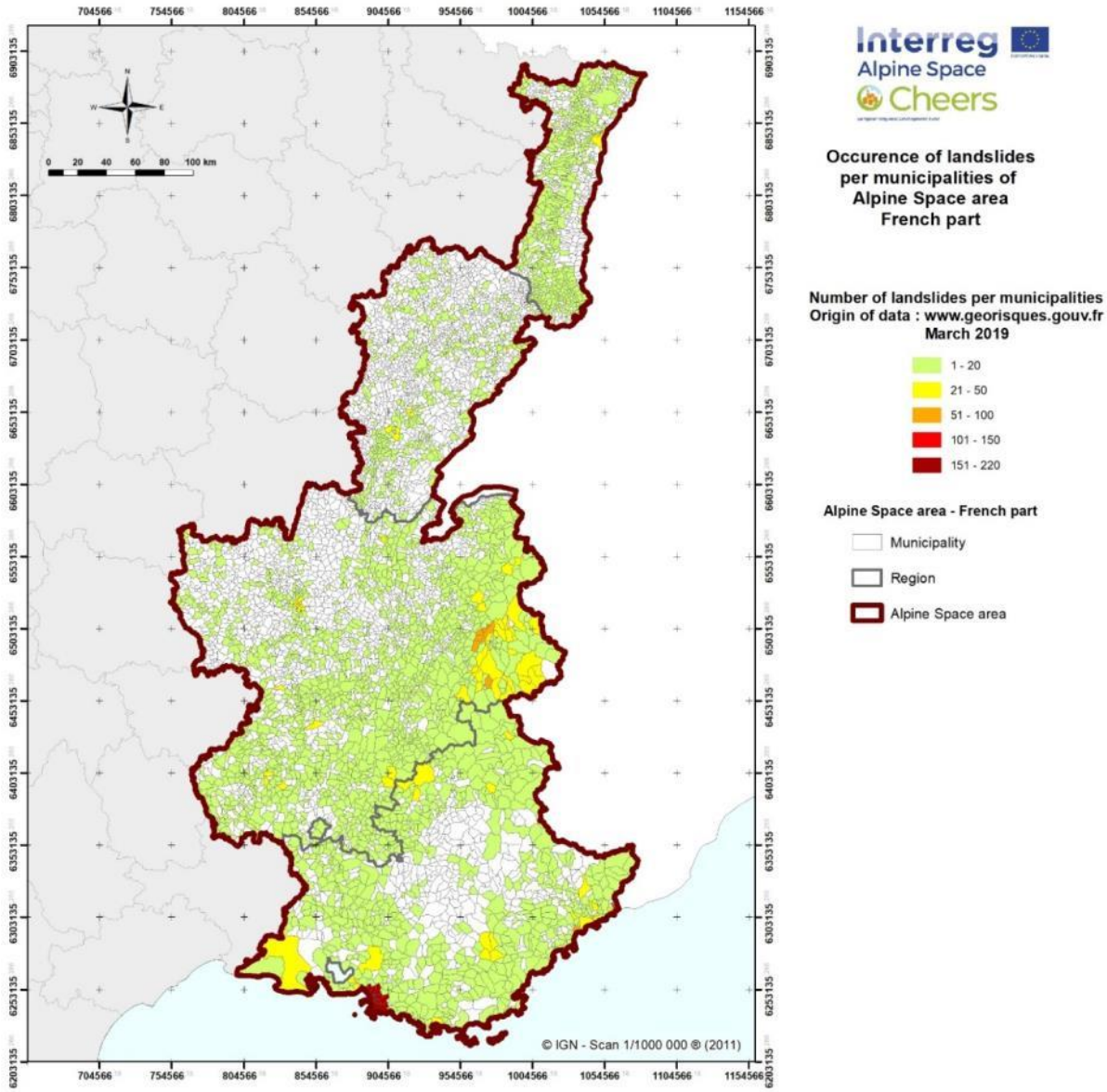

Figure 44 Occurrence of landslides per municipalities of the French Alpine space area

In this case the archive contains the position of individual occurrences. The same phenomenon, if recurrent, is repeated in the archive every time it occurs. The data collection is quite complete for the event occurred in the last 150 years, and includes sporadic records concerning displacement occurred before 1500AD. The database of mass movement events includes different type of phenomena: Slip, Falling blocks – Slumping, Cast, Collapse and Erosion of banks.

For the purpose of this review, all of them have been used to define the level of hazard due to ground deformation in each municipality. Some of them has more than 100 episodes documented and, once again, they are not only affecting the mountain areas.

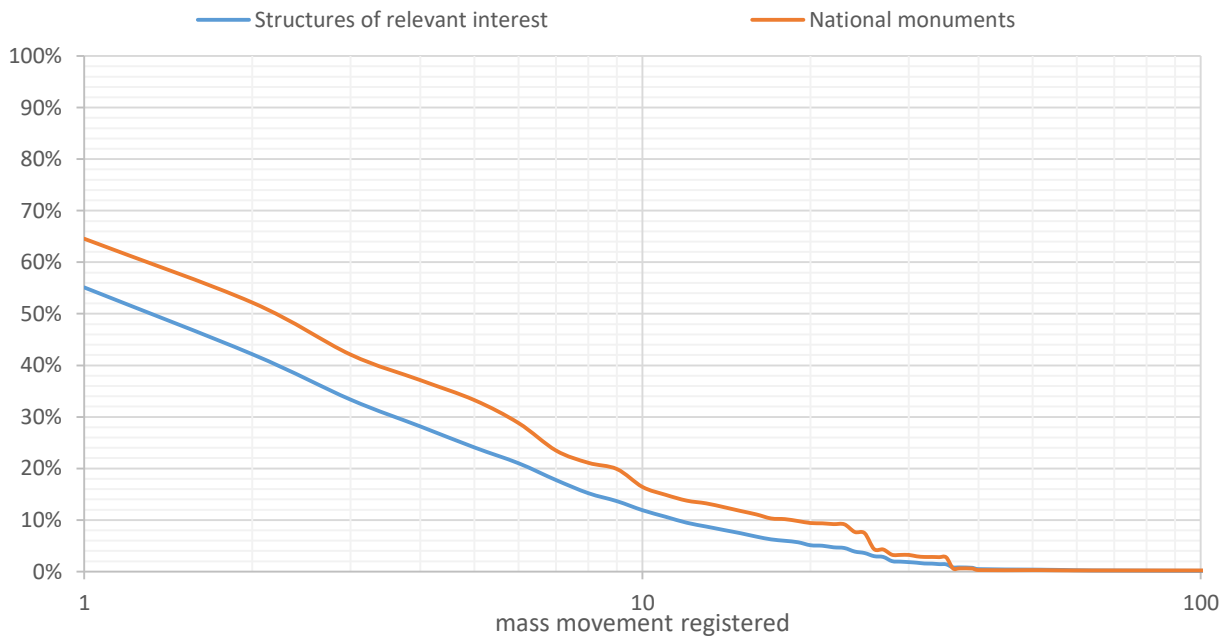

Figure 45 Distribution of exposed asset to mass movements by events occurring in the municipality they are located

In the case of geomorphological hazard, almost the 55% of the structures considered for the exposure assessment are situated in municipalities affected by landslides. Even in this, the 10% of this asset is located in municipalities damaged at least 10 times by a slope displacement in the last century.

Avalanches

The snow avalanche is a hazard that is becoming more and more critical in the alpine region, due to the warmer winters and the episodes of massive precipitations of snow.

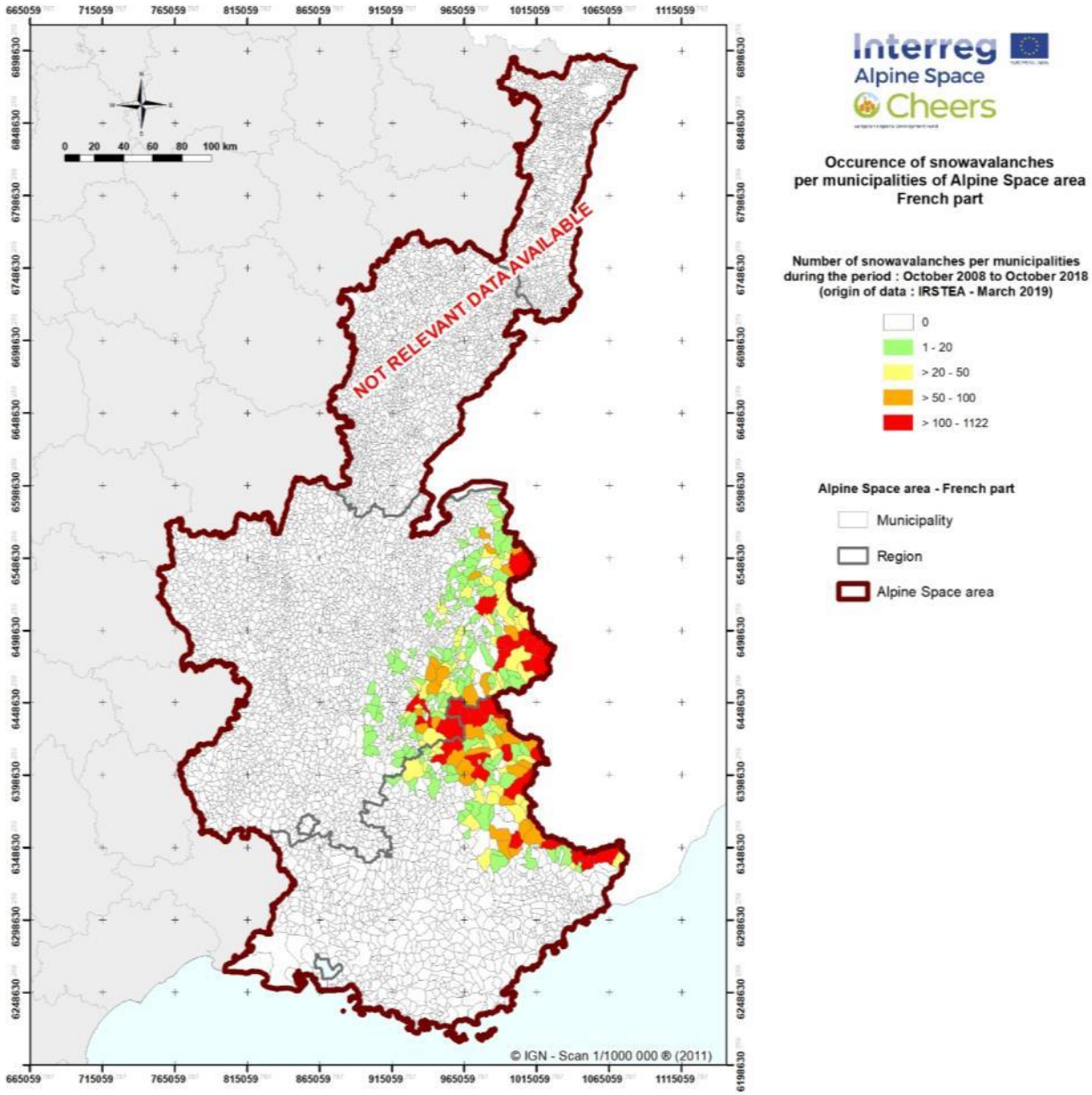

Figure 46 Occurrence of avalanches per municipalities of the French Alpine space area

To consider the risk of the cultural asset with regard to this sort of hazard, we used the Permanent Survey of Avalanches (EPA) maintained and updated by IRSTEA and funded by the Ministry of the Environment. It is a collection of historical chronicles concerning events of snow avalanches observed on selected sites, which provides a clear understanding of characteristic rates of avalanches in different sectors of the Alps. The data collection is carried out by 260 NFB (National Forest Office) observers who survey about 3900 sites spread over 11 departments (in the whole France). Every time an avalanche takes place on an EPA site, observers note the characteristics of the event on avalanche advisories: dates, snow cover, departure and arrival altitudes, type of avalanche and description of the deposit. All this information is reported to this database. Data

from visual proof of more than 90.000 events covering all the high mountain ranges in France, from 2008 to 2018, are now available. This amount of information just regarding spontaneous avalanches is almost unique in the world.

The sites, often easily observable and plotted on the EPA observation charts, were originally selected based on forest damage. Today, it is rather the human asset (roads, homes) and the scientific knowledge of avalanches that are privileged. The nature of this dataset limits the availability of information to a small part of the region considered for the other hazards, but it provides at least a qualitative picture of the frequency and, as consequence, the exposure of cultural heritage in avalanche prone areas.

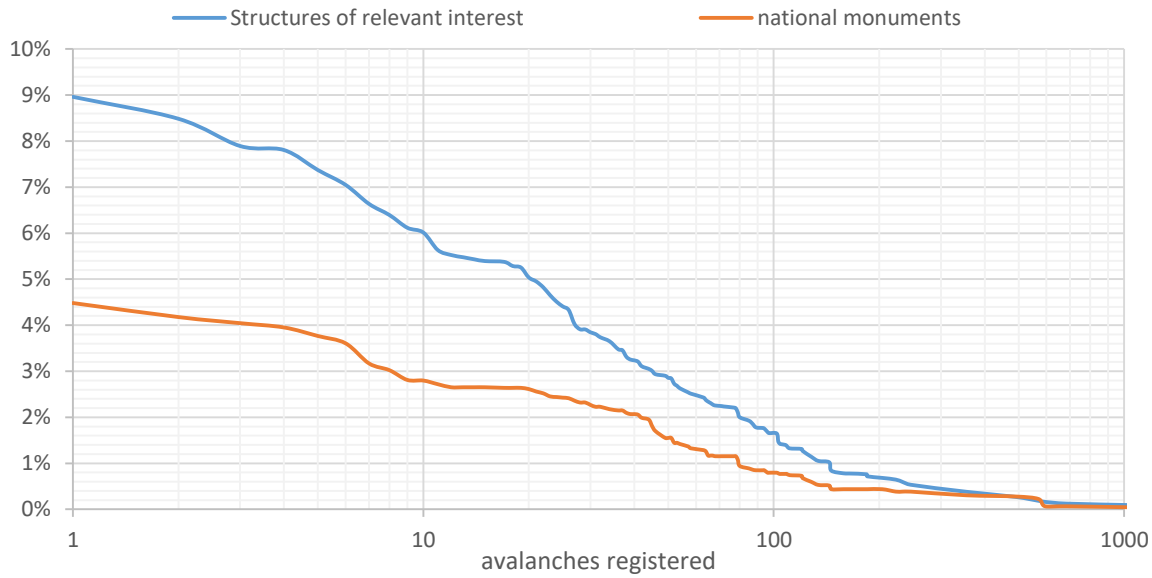

Figure 47 Distribution of exposed asset to avalanches by events occurring in the municipality they are located

The percentage of remarkable structures and national monuments in this case is relatively small, limited to almost 10% and 5% respectively, of their total amount in the Alpine Space area, but the comparison of the exposure of the municipalities hosting them, helps to figure out the potential impact of avalanches to the cultural heritage with respect to the other hazards.

The CHEERS project & Conceptual assumptions

The CHEERS project & Conceptual assumptions

In following pages brief description of aims of CHEERS focused on Action T1 *Alpine Cultural Heritage: value and vulnerability* is presented. The importance of having a semi-quantitative valuation approach serving as grounds for prioritization in salvage activities – in this respect CHEERS is unique!

All project partners contributed to a preliminary analysis with visions and approaches to the theme of Alpine cultural heritage with initial evaluations, supported by analysis on past disaster occurrences, on its exposure to natural hazards.

Conceptual assumptions

First work package frames the topic of the definition of Alpine cultural identity, analysing the issue of its exposure to natural hazard and it investigates the related economies, focusing on values in terms of identity, cultural function and income generation. It produces a methodology for assets evaluation and prioritization in salvaging interventions. Package proposes relevant elements for future policy making in the field.

A capitalization process is framing the state and the definition of the concept of Alpine cultural heritage. It reflects the relation to the specific environment where it developed and the natural hazards it is exposed to in the Alps. A review of previous project results, initiatives, strategic documents from the Alpine area and analogous regions, integrated with inputs from relevant sources at national and transnational level (e.g. expert interviews). Major contributions were made from all project partners.

The definition of the evaluation and prioritization methodology will benefit from the confrontation with domain experts and will be (in next phases of project) tested on local realities (interviews and workshops at expert but also public level, plus business (tourism & leisure) supporting organisations). Policy making structures at various level are going to be involved in process as well, both as project observers and through consultation loops and dedicated participatory events.

The evaluation methodology hereby developed will be compiled as a reference sourcebook, conceived as a replicable step-by-step guide, built on a review of the most up-to-date domain knowledge, capable to be applied under changing boundary conditions. Relevant networks and key players to be actively involved will be identified as targets of an effective promotion of the methodology. They will support the rank of a reference practice for the Alps, thus fostering its prompt uptake.

The link between A.T1.1 and other project activities

Action T1 (*Alpine Cultural Heritage: value and vulnerability*) is heavily related to T2 (*Advancing Hazard&Exposure Assesment methodologies applicated to the field of cultural heritage protection*), especially in terms of setting a common empirical framework. Terminology and basic concept need to be harmonized in order to provide results relevant for all project activities, which can then be cross-linked and utilized consistently – e.g. activity A.T2.1 (*Conceptual toolkit for the*

identification of actual exposure of cultural assets to risk) is to provide an overview of hazard mapping/assessment methodologies within the Alpine area, which will be already investigated within this part (A.T1.1.). The latter activity is also related to A.T1.2 (*Set up of a methodology for the evaluation of cultural assets and prioritization of securing & salvaging interventions*), which is to provide a conceptual tool for evaluation of cultural assets – this will also be addressed in this review by investigating previous research and projects.

The review list

All project partners contributed to a preliminary analysis of versions and approaches to the theme of Alpine cultural heritage. All data regarding initial evaluations, supported by analysis on past disaster occurrences and its exposure to natural hazards were involved.

The empirical framework of the investigation defined the scope of the review and then all information sources were listed (A.T1.1. review list). In the following Annex a large number of data on cultural heritage and related NH in Alpine area are to be found.

The empirical framework

The review relates to:

- the assets within the Alpine area,
- tangible CH, which can be either mobile or immobile,
- the asset actually/potentially subjected to one of NH,
- aspects of
  - assessing the likelihood of NH, or
  - assessing the vulnerability of CH, or
  - mitigating the effects of NH, or
  - rescue and evacuation, or
  - safe storage of CH.

These are the aspects that set criteria, which limit the scope we had investigated during years 2018-2019 within the review.

Data sources

The review is partitioned into five sections (i.e. Annex subchapters):

- projects,
- research studies,
- strategies,
- initiatives, and
- showcase interventions**.**

Projects cover research or implementation activities funded by various sources and are commonly policy driven, meaning that they are related to implementation of either international (EU), regional (alpine area) or national policies. Partners were advised to investigate past or ongoing

project from several different funding programmes like Interreg (Alpine Space, Danube, Central Europe, bilateral projects …), Horizon 2020, IPA, LIFE, JPI, Euro. Investment Fund, Euro. Regional Development Fund, Euro. Social Fund, etc.

A preliminary list of projects has been provided (from a recent EC study). Additional (complete) information has been input of SFI.

Research studies are commonly either very problem-focused and detailed or smaller than projects in terms of activities. Studies can be master/PhD thesis, specially-designated assignments from the ministries/government focusing only on a specific aspect of CH-NH relation, etc. Research studies are usually done by smaller groups – can be only one organisation/person.

Strategy is the approach you take to reach your objectives, while **initiatives** are action items guided by the strategy that you undertake to achieve your objectives.[10]

Showcase interventions are activities done specially to represent an event/exercise on how to prevent a negative effect of NH on CH, how to act in case of NH, to show which institutions are responsible, and to transfer know-how among stakeholders.

[10] http://www.answers.com/Q/What_is_the_difference_between_initiative_and_strategy

Review results

Review results

Extensive review of the results of previous projects (at the national and European level), initiatives, strategies and policy documents involving or dedicated to the cultural heritage of Alpine area and analogous regions is provided in this chapter. It is integrated with inputs from relevant sources at national and transnational level.

A table with all projects/studies and policies/initiatives, which were collected by the project consortium and include descriptors, was prepared (**see Annex**), indicating:

- types of cultural heritage covered,
- natural hazard addressed,
- outcomes achieved.

After review we could pinpoint the potential gaps in addressing the problems of natural hazards relevant for cultural heritage:

- types of natural hazards, which might be very relevant but are not addressed sufficiently,
- spatial levels where natural hazards issues are being assessed,
- the means of projects and correlation among means and results,
- differences among countries – finding gaps,
- possible lack of showcases.

Natural hazards in Alps and their connection to cultural heritage

Selected natural hazards has been studied in its own subparagraphs. Common description of natural hazard and its specifics are first written to avoid misunderstandings between countries. Two or more illustrative case studies tightly connected to specific damages (impacts) caused by the natural hazard in Alpine area on cultural heritage are depicted after every description of natural hazard.

Research projects and studies addressing effects of natural hazards on cultural heritage are emphasized as a final word – showing the research rate of certain natural hazard till now in Alpine region. It is obvious that there are only few projects dealing specifically with relation between natural hazards and cultural heritage.

Also, technical problems like lack of documentation, unspecified structural condition and assembly, unknown material characteristics and parameters of exposure require intense investigations in determining saving procedures on cultural heritage sites.

There are no reliable and available data that would determine the share of cultural heritage loses. Lack of data is connected also with lack of methodology for assessing damage in monetary terms.

Landslides and avalanches

Both landslides and avalanches are mass movement events, which are controlled by gravity forcing either rocks, soil, snow or other debris on the slope to shift downwards. Speeds at which material moves is usually either slow or rapid, but not very slow, and shift can occur in upper layers only or throughout the complete profile. Term landslides includes several phenomena, rockfall, mass movement and subsidence, which are all classified as geological or geophysical hazards. Those are usually triggered by different hydrometeorological events, such as severe local storms with heavy rain or snow, river floods, and other factors as erosion, earth tremors and even human interventions like mining, building, gas/oil extraction, farming and forestry.

Rockfall is an event, where a quantity of rocks or boulders fall freely from a cliff's face and shift downslope rapidly. It is stopped by either decrease in slope or a barrier like a tree, building or another rock, all absorbing the kinetic energy of a falling/rolling rock.

Subsidence is motion of Earth's surface shifting downwards and can be either wet (e.g. changes in soil water content, permafrost degradation or karst phenomenon) or dry, which is triggered by isostatic rebound, geological faulting or human activities like mining and extraction of oil/gas.

Mass movements relate to land, snow, ice or debris sliding downslope due to gravity and lack of friction among layers of materials. This also erodes materials underneath the layers, which are moving and carries it downwards as well.

Both rockfall and mass movements are usually very quick, whereas subsidence may not be as rapid and can thus be managed more efficiently to prevent damage to some extent. Warning period is in such cases longer.[11]

There are reportedly severe impacts of landslides on socio-economic situation of population (Canuti et al., 2000) as loss of lives, assets and business is worldwide large. However, such events do not occur everywhere because mountainous areas are more prone and affected (Nadim et al., 2013). Landslides can also have a detrimental effect on cultural heritage, especially buildings and cultural landscape. They can be very large in affected area and can happen rather quickly, thus presenting a cause of irreparable damage. Object or other assets can be either dislocated from the original position and damaged or severely distorted, which shows as cracks in walls and floors, tilted construction, broken glass or covered in mud and earth debris. If large amounts of material are accumulated near objects of cultural heritage it can take substantial amount of time to remove it, while in the meantime levels of damage usually increase even more. Wet conditions can multiply detrimental effects as structures, colouring and textures, which all make cultural heritage unique, further disintegrate and further reduce historical, touristic and identity value of an asset. One of the key issues related to landslides is also that not much can be done to prevent it, especially in cases when they are not human induced. Additionally, preventive measures can be extremely expensive and since cultural heritage can hardly be reallocated, only early warning and evacuation seem mostly reasonable.

Two illustrative cases are depicted in the next section. The first one is a recent event of heavy snowfall in Germany, which caused collapse of buildings and posed risk to cultural heritage by

[11] https://www.ifrc.org/en/what-we-do/disaster-management/about-disasters/definition-of-hazard/geophysical-hazards-mass-movement-dry/

loading lots of weight and triggering snow avalanches. The second one occurred in Slovenia in 1989 when heavy rock-fall from the slopes of a nearby mountain damaged Franja partisan hospital.

Case study: Extreme snow load situation in regions of Berchtesgaden and Traunstein, Germany[12]

The two districts in southern Germany are dominated by a rural small-scale forest and agricultural industry. Since the end of the Second World War the area became interesting for the townsfolk of Munich a recreational area, so the structure of small villages and the local culture survived there until now.

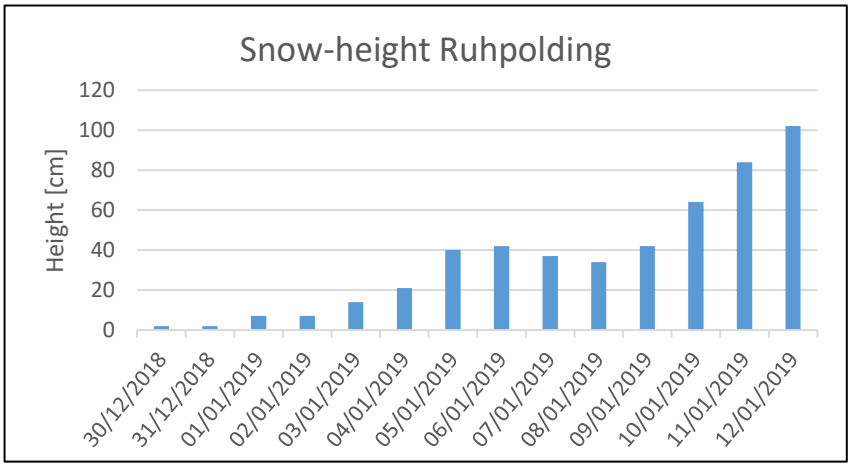

Figure 48 Snow height in Ruhpolding, close to the pilot site Glockenschmiede, Germany

The inhabitants of the smaller cities and villages are strongly connected between each other and they are used to help without hesitation. As this area is in the alpine area, many natural hazards take place every year.

As an early example of a catastrophe in this area caused by heavy snowfall it is the collapse of the ice dancing hall in 2006 (Figure 49). The weight of the snow, which was around 400 kg per square meter at that time, triggered the collapse of the roof.

Heavy snowfalls in the pilot area started at the very end of December 2018 and lasted through January 2019. The German weather agency (DWD) declared already the highest storm/snow warning level for this area but snowing will not stop in the next days. In addition, heavy rains were

Figure 49 Lack of maintenance and bad construction as a reason for the collapse of the ice stadium in Bad Reichenhall, 2006 and collapse of a small barn less then 15km from the Glockenbachschmiede, 2019/01/11

[12] Personal data; David Benedikt Staeblein, David.Staeblein@ku.de

predicted as the temperature were to rise just above the freezing temperature. This would enhance the weight of the snow loads on the roofs. Most of the roofs in this area are constructed to hold such a mass of snow (more than 650 kg per square meter) but old buildings like cultural buildings which cannot be strengthened to increase the roof load, were in danger (Figure 49).

The Bavarian state had declared emergency alerts for many southern districts like Traunstein and Bad Reichenhall because of the heavy snowfalls. The emergency units (Federal Agency for Technical Relief and fire brigades) had no capacities to support every household and of course not every cultural heritage. Freeways, highways and public grounds were buried in snow and gain a higher priority by the emergency units. Even the local brigades of the German armed forces joined the local emergency units to free the roofs and streets of snow. On the roof of the **Glockenbachschmiede**, one of Rachel Carson Center's pilot area, more than 1 meter of snow piled up. It was caused not only by heavy snowfall but also by snow drifts. Unfortunately, the snow had already became solid and gained weight by the recent rain (Figure 49). The roof was renovated a few years ago but no roof reinforcement for such a mass of snow was integrated.

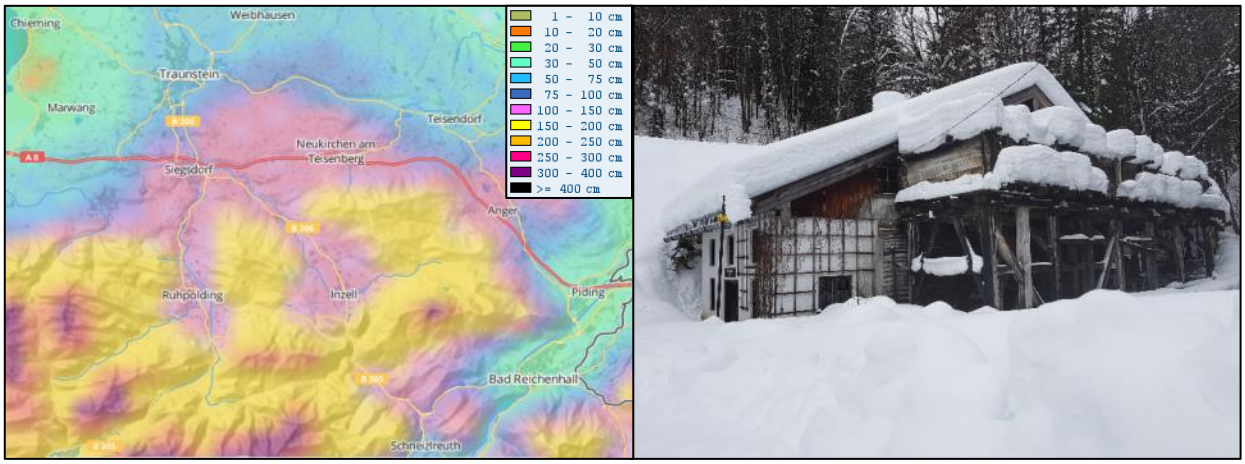

Figure 50 Snow-model "SNOWGRID" for snow heights in cm of 2019/01/13 and snowed in Glockenbachschmiede of 2019/01/13

As a result of such event, cultural heritage needs a small unit of volunteers to assist them, because the emergency units have other priorities before saving a cultural heritage. Those people in this area where such events have a specific repetition interval should know the maximum capacity of snow load on the roof and should be able to remove the snow before it is getting to big and solid to avoid any catastrophe.

Case study: Rockfall damage to the Franja partisan hospital, Slovenia

During the night of January 7-8th of 1989, part of the well-known Franja hospital near Cerkno, where more than 900 wounded partizans and some Italians, French, Russians, Poles, two Americans and one Austrian were nursed during Second World War, between December 1943 and May 1945, was buried by heavy rock-fall from the slopes of a nearby mountain Veliki Njiveč. Three of the original hospital buildings, the entrance kiosk, and all the bridges which had led to the hospital across a series of attractive waterfalls, were buried by an estimated 6-8 thousand cubic meters of material. The face of the rock-fall extended for 100 meters and geologists were estimating that additional 30 thousand cubic meters could slide into the gorge.

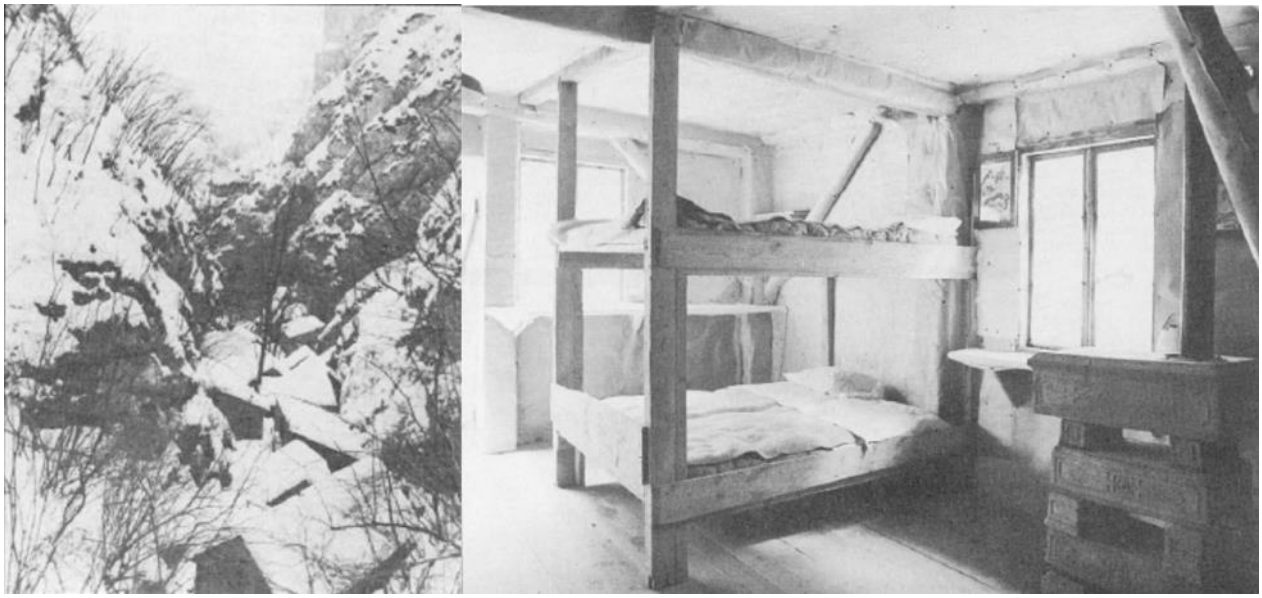

Figure 51 The location of the hospital in the gorge (left) and the interior of the barrack for the wounded (right)

Since the gorge behind the fallen rock was liable to be flooded, mountaineers evacuated all movable equipment and exhibits from the remaining buildings, while foresters constructed a large drain through debris, which let flood water flow through the gorge. Those responsible for restoration had hoped that water flow would erode the accumulated debris and move it downstream. In this way the extent of mechanical removal could be reduced and so would the costs. In the opinion of geologists, there were numerous other potential slip surfaces in the large block of rock above that from which the recent fall took place. Further rockfall could cause even greater blockage and potential flooding of the Pasica gorge. Thus, the greatest problem remaining is how to stabilize the area of potential future rockfall, and how to evacuate additionally blasted-off material from the bottom of the Pasica gorge.

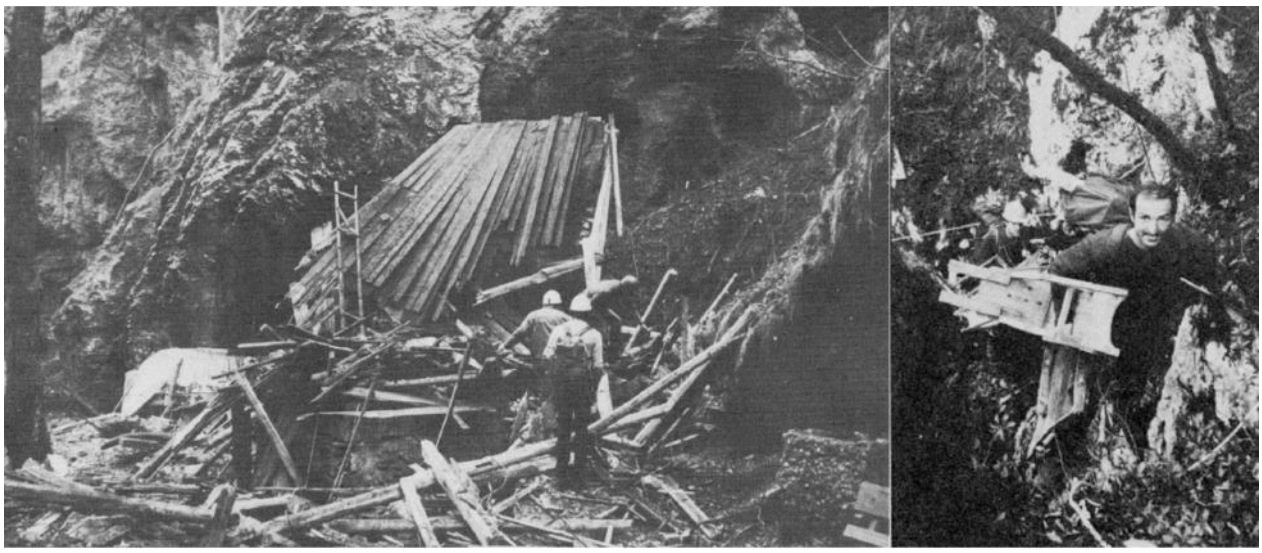

Figure 52 Demolished barracks (left) and an alpinist rescuing exhibits after the rockfall (right)

The final re-establishment of the hospital museum will be carried out based on exceptionally accurate plans and documents which have been prepared over the years by the Municipality Museum of Idrija and the Restoration Centre of Socialist Republic of Slovenia.

Research projects and studies addressing effects of landslides and avalanches on cultural heritage

Cases described above and events of different types of mass movements, like landslides, rockfall and snow avalanches have prompted several research initiatives addressing various challenges related to such events. Dissertation Risikobetrachtung von gravitativen Naturgefahren im alpinen Bereich (Rönnau, 2005) investigates risk of mass movements (debris flow, landslide, rockfall andavalanche) in the study area Hallstatt/Plassen, which is part of the UNESCO Worldheritage in Austria. The risk assessment combines different natural hazard processes with an index of potential damage, which was examined in an interpretative, mathematical and mapping way. Proposals of defence measures were made for minimizing the risk in the study area.

There are only few projects dealing specifically with relation between landslides and cultural heritage. **SAMCO** (Society Adaptation for coping with Mountain risks in a global change COntext) project was, among other challenges, addressing both, cultural heritage and issue of landslides in terms of mountain communities' vulnerability due global change. The project was focusing on factors of mountain community resilience or simple ability to cope with changing physical, social and economic environment triggered by changing climate (IPCC 2007), especially in terms of altered frequency and extent of landslides. It developed first conceptual and then methodological framework to define the level of vulnerability of communities in mountains due to simulated climate changes, which, according to different future scenarios alter the occurrence of natural hazards. In line with modelling outcomes, new management strategies were designed. Both methodological framework and scenario modelling were tested in two mountainous areas, the Pyrénées and French Alps. Likewise, climate change was the focus of **NOAHS ARK** (Global climate change impact on built heritage and cultural landscapes) project as well, as it was to determine meteorological parameters most critical for built cultural heritage, to predict the effect of simulated climate change on monuments over Europe in the next 100 years, and to design management strategies that would mitigate those impacts. However, the project did not focus on landslides or snow avalanches but provided applicable research insights for the Alpine area as well. It considered natural hazards as rising see levels, floods and droughts. In addition, a large FP6 funded project called **LESSLOSS** (Risk Mitigation for Earthquakes and Landslides) was focusing on landslides and cultural heritage (historic bridges), however not related to impacts of global changes as SAMCO and NOAHS ARK. The goal was to technologically relate development of improved tools for landslide monitoring complemented by GIS methodologies, to elaborate innovative approaches for forecasting occurrence of landslides by designing deterministic tools, which link topography and site conditions, to develop innovative methods for stabilising landslide-prone areas, and to improve the accuracy of disaster scenario modelling and estimation of losses due to landslides.

A few other projects are relevant as well. **Prothego** (Protection of European Cultural Heritage from Geo - Hazards) was investigating ways to detect multiple natural hazards and to monitor tangible cultural heritage in Europe in terms of exposure. Landslides and subsidence were one of focuses as they can seriously jeopardise various monuments, cultural landscapes and historic urban centres. However, the project was to implement not in-situ field observations approaches but rather innovative remote sensing techniques to assure efficient and low-cost solutions. A geo-database of hazards over Europe was designed and coupled with of European UNESCO heritage locations and this enabled the analysis of potential causative factors and triggering mechanisms of landslides and subsidence for relevant cultural WHL sites. Landslides were one of hazard types addressed in

project **'**Management of natural and technical hazards in Central European candidate countries **(PECO)'**, which was to improve know-how of civil protection agencies on natural and technological risk management in at that time 10 EU candidate countries. Actions were directed into implementing the Seveso II directive Project was covering the Alps only very partially through involving Slovenia, where is explicitly stated that among others, landslides are an important hazard. Project delivered a few priorities dealing with natural hazards – to implement improved landslide control measures, and to complete field studies of landslide areas – both referring to Romania. It was considered as highly vulnerable to landslides, like Slovakia and Slovenia.

Two other projects, **CHIC** and **CulturALP** were dealing with cultural heritage in Alps, but not so directly linked to natural hazards. Both were to obtain, synthesize and provide 'inventory' data on cultural heritage. Improved data would enable more efficient management, and in turn, also protection against natural hazards.

None of the abovementioned project dealt solely with situation in the Alps, which indicates that Alpine area, although a place of frequent landslide event and snow avalanches, is not receiving attention, which it obviously deserves. Few had pilot areas located in the Alps like SAMCO and Management of natural and technical hazards in Central European candidate countries (PECO), others had more EU perspective.

Projects LESSLOSS and SAMCO seem to address the issue of landslides in most detail, as LESLOSS devotes several project activities to this hazard only. SAMCO tends to be a more overall project addressing several types of natural hazards. Both can offer substantial amount of information and insight for CHEERS project dealing with the Alps. In terms of types of cultural heritage all projects described cover several different types, but some, however, focus more on one or few types. LESSLOSS for example was dealing mostly with historic bridges and SAMCO with historic structures and historic materials.

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Floods

A flood is an overflow of water that covers land that is usually dry. Flooding may occur as an overflow of water from water bodies and streams, in which the water overtops or breaks banks. It may occur due to an accumulation of rainwater on saturated ground in a flood areal. Some floods develop slowly, while others such as flash floods, can develop in just a few minutes.

General floods can be predicted in advance. The impact of flooding can include destruction of infrastructure, crops, cattle and people. We have some time to safeguard or even move cultural heritage on safe areas.

Flash floods, common in Alpine region, are sudden and extreme volume of water that flow rapidly and cause inundation. Because of its rapid nature flash floods are difficult to forecast and give people little time to escape or to safeguard or even move cultural heritage on safe place.

Floods can be local, impacting a small valley, or very large, affecting entire river basins. They can damage property, infrastructure, take lives or drown domestic animals. Large amounts of water often cause also landslides and similar post-disasters as mud and/or debris flows, rock falls and avalanches.

Case study from Slovenia demonstrates exceptional destructive power of flash flood, which destroyed the Franja Partisan hospital. The second case study is from Austria and describes the huge damage of stored exhibits in Zeughaus due to heavy rain and floods.

Case study: Franja Partisan Hospital, Slovenia

Figure 53 Narrow Alpine Pasica gorge, the origin of the Partisan Hospital Franja

After the Second World War, the Franja Partisan Hospital became a symbol of the partisan movement and its extensive and well-organized medical activities.

On 18 September 2007, heavy rains were occurring in the wider forested Franja area, and it even intensified by the afternoon. Heavy torrential flow through the Pasica gorge, where the renowned Partisan Hospital Franja (known as open air museum) stood, rose in a matter of minutes and literally sank wooden objects. Severe rainfall caused the destruction of 13 of the 14 huts of the Franja hospital, with the impact of the usually small Alpine stream. The caretaker was hardly able to save himself during the storm in the hospital. During this time, due to bad weather in the gorge, luckily there were no visitors.

The entire museum was destroyed, only two barracks remained in place. High water took away most of the original museum exhibits, so in the restoration process they managed to find and restore only 225 of more than 800 objects. The cost of restoration of the Franja hospital amounted to 2,375 million euros.

Because Franja's hospital was a very important historical monument from Second World War many parties were interested in the decision to restore Franja hospital.

A complete reconstruction followed in May 2010 followed by the total arrangement of the hinterland of the gorge in order to prevent the possibility of a similar event.

Since 2000 Franja Partisan Hospital has been entered in the UNESCO World Heritage Testing List. The modern European Union has also given her a gift, and for her values, prior to the mischief of 2007, it was awarded the European Heritage Label among the first in Slovenia.

Figure 54 Restored hospital includes only 225 of more than 800 medical items and objects

Case study: Zeughaus, Innsbruck, Tyrol, Austria

The Zeughaus (German for "armoury"), located at the banks of the river Sill in the Tyrolean capital Innsbruck, is a former military arsenal and barracks built at the beginning of the 16th century by Maximilian I. Due to the arms manufacture, it was used well into the 19th century.

Figure 56 Flooded Zeughaus in 1985(© M.Pizzinini)

Since the renovations in the 1960s, it has housed a branch of the Tyrolean State Museum.

On 5 and 6 August 1985, heavy rains caused a 30-year flood which significantly affected the Zeughaus. At that time, the museum was exhibiting around 400.000 preserved plants from the herbarium of the Ferdinandeum in Innsbruck. The water that penetrated the basement severely damaged and even destroyed many of the stored exhibits.

Figure 55 Restauration work (© Tirol Landesmuseum)

The substantial harm suffered by the collection was restored and digitalised by 2015 and additional measures worth around 800.000 euros were taken to avoid such situations in the future. The diameter of the river Sill was expanded to accommodate up to 20% more water and around 400 sandbags were stored in the Zeughaus to help in the event of future flooding. It first opened to the public in May 1986, after extensive renovations of the indoor spaces, the heating and the security system.

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Case study: Floods in the city of Bellinzona, Switzerland

With regard to water floods danger, the fact that the River Ticino crosses the city of Bellinzona makes the area particularly exposed to natural disasters, which in the past had strongly damaged not only the population but also the urban and morphological asset of the city.

Between the events which marked its history, the Buzza of Biasca, dated back to the 20th May of 1515, is relevant: a huge wave of water and mud which devastated the city, the Riviera, all the area around Bellinzona and the Plain of Magadino, destroying all the communication routes which linked the River Ticino to the Lake Maggiore, including the Torretta's bridge, built by the dukes of Sforza in 1487, and a part of the Murata which connected it to Castelgrande (today UNESCO heritage site).

Figure 57 The Buzza di Biasca water flood in Bellinzona

The disaster was caused by the cave in of a dam containing a lake which was created by a landslide affecting Mount Crenone on the 30th September 1513 and which blocked the Valley of Blenio.

As a consequence of several weather phenomena occurred across the centuries and intensified by climate changes, the Canton of Ticino, first in Switzerland, made and issued the *Law on the areas subject to natural dangers*[13] (LTPnat, updated in 2017) in order to rule the processes of verification, protection and restoration of the areas which are potentially or historically exposed to natural disasters.

The Law considered the creation of a *Hazard Plan*[14] as the main verification instrument, as well as a basis for an efficient territorial planning and for the realisation of correct response and recovery measures. The areas subject to natural disasters were identified according three parameters: soil surveys, past events registry and a qualitative risk evaluation concerning all the municipalities. The built-up areas (80 cases) were subjected to further in-depth analysis in order to evaluate the quantitative risk assessment. All of these data (risk zones and related assessment, event registry and protection interventions) have been collected and made accessible online within the so-called SIT - System of geographical Information of the Territory (http://www.sitmap.ti.ch) which is characterised by two main goals: the evaluation of each new territorial incidence and the realisation of protection and risk management measures.

The current Bellinzona's Hazard Plan (Fig. 58) shows a high level of flood danger which is highlighted in red close to the banks of the River Ticino. The Swiss Confederation's Cartographic Portal[15] completes the data concerning the Register for the Protection of Cultural Heritage Goods

[13] Legge sui territori soggetti a pericoli naturali: https://m3.ti.ch/CAN/RLeggi/public/index.php/raccolta-leggi/legge/num/402
[14] Piano delle Zone di Pericolo
[15] map.geo.admin.ch

with objects of national importance (Federal Office for Civil Protection) which are supervised by the Law for the Protection of Cultural Heritage (1997)[16].

Therefore, it is possible to identify the exact collocation and the type of heritage which needs protection and security measures in case of natural disaster. The current Bellinzona's hazard map shows yellow and white areas (residual risk) where we can find the Murata, the ancient defensive wall completed by the dukes of Sforza in the years 1487-89, characterised by merlons and storm drains along its length, reinforced by a series of bastions and dominated by a long walkway which arrives to Castelgrande.

Figure 58 Extract by Bellinzona's Hazard Map

Moreover, all the collections to be protected are mentioned within one public building, between them the Canton of Ticino's State Archives, where all the documents of historical interest produced by the government and all the significant regional publications printed in Ticino (such as newspapers, magazines, private funds of families or associations) are stored, the State Archaeological Collection, managed by the Department of Cultural Heritage, and the State Ethnographic Collection, supervised by the CDE, the Centre of Dialectology and Ethnography.

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[16] The Law for the Protection of Cultural Heritage of the 13th May 1997 allowed to start on 2002 the census of all the cultural goods set in the Canton of Ticino area (more than 120,000), to index them in the SIBC-Information System of Cultural Goods and to prepare a registry of the goods of local or cantonal interest to be protected in case of natural disaster (almost 5,000) according to the federal regulations. Canton of Ticino's cultural goods registry only includes the goods of cantonal or local interest whose protection has already been ascribed with in a Cantonal Use Planning or in a Municipal Development Plans, collects administrative, estate, descriptive, typological, scientific and geo-referenced information and it is accessible on the Net.

Case study: An extreme meteorological event in the North-East of Italy in 2018

Figure 59 High river flow

Between 27th and 29th October 2018, a severe meteorological event hit the North-East of Italy, causing diffused damages over the area with relevant consequences also in the province of Trento (pilot case in CHEERS project).
Based on the analysis carried out by Meteotrentino, the meteorological Agency of the Autonomous Province of Trento, the event can be defined as "exceptional".

The overall precipitation that fell during the event (mean of 273,8 mm with local peaks exceeding 600 mm of rain), in fact, highly exceeded the precipitation rates observed during the two main previous historical floods, which respectively occurred in 1882 (232,6 mm of rain fell between 15 and 17 September) and 1966 (185,1 mm between 4 and 6 November).

Besides precipitation, the exceptional nature of the event was also connected to strong winds. In this regard, Meteotrentino experts highlight that instantaneous wind speeds highly exceeded the maximum values observed in the past. At Manghen Pass, the average wind speed, observed over 10 minutes, amounted to 90 km/h, with peaks exceeding 191 km/h.

The event developed in two different phases, interspersed with 8 - 10 hours of low intensity phenomena. The combination of these periods, both extremely intense, resulted in an exceptional event for size, intensity and damages to both people and goods.

As a consequence of this event, the Superintendence of Cultural Heritage of the Autonomous Province of Trento received 35 notices of damages affecting cultural assets under its responsibility (the Superintendence of Cultural Heritage of the Autonomous Province of Trento oversees approximately 3.700 assets).

Injured assets were mainly represented by churches (14, interested by 40% of the damaging occurrences) and castles (8, 23% of the occurrences).

Strong winds were the main damaging factor (94%), whilst impacts due to rainfalls and runoff respectively represented 17% and 8% of the overall occurrences (some cases of damages from combined effects, wind plus water, were observed hence the total exceeding 100%).

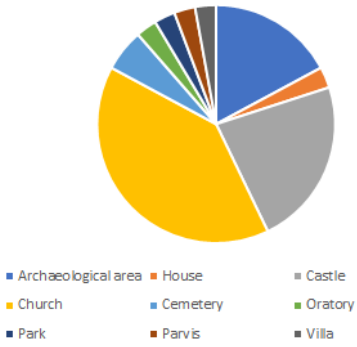

Figure 60 Injured cultural heritage in the event 27 – 29 October 2019 (source: Superintendence of Cultural Heritage of the Autonomous Province of Trento)

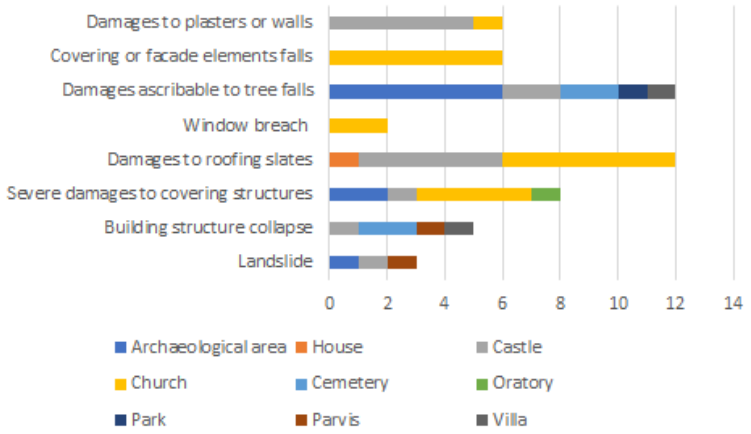

Figure 61 Type of damages that injured cultural heritage in the event 27 – 29 October 2019 (source: Superintendence of Cultural Heritage of the Autonomous Province of Trento)

Impacts on cultural assets mainly consisted in:

- **damages ascribable to tree falls**
- **damages to roofing slates**
- **severe damages on covering structures**
- **damages to plasters or walls**
- **covering or façade elements falls**

Impact of floods on cultural heritage

In plain parts of Alps, waterways prone to floods are often managed. But in steeper Alpine regions many waterways are narrow and hardly accessible. Water management is expensive and technically difficult. Waterways are poorly managed, often full of biomass and other residues, impacting negative on power of water.

Defences against high waters such as detention basins, flood banks, bunds, reservoirs, and weirs are used to prevent waterways from overflowing their banks. When these defences fail, emergency measures such as sandbags or portable inflatable tubes are often used to try to stem flooding.

Cultural heritage is in case of floods often severely damaged, its loss and damage substantially influences resilience processes and characteristics of CH. Cultural heritage objects mainly consists of materials susceptible to moisture. Organizing logistics, transport and save keeping of cultural heritage is complicated, since the regional infrastructure during and after flooding is often damaged.

For avoiding or mitigating flood-related damage of cultural heritage, a multitude of aspects have to be considered, like historic significance and context of the object, building structure and its location in risk areas. Some of the object are historically more important than others, and only some of them are possible to save in the case of severe flooding.

Research projects and studies addressing on effects of floods on cultural heritage

The volume of books and studies on flood management, warning, resilience and training is, after large flood events in Europe around 1990, increasing. Although few of them are tightly connected to cultural heritage prevention and management. Our project managed to divide some of them, directly connected to cultural heritage in Alpine region (see bold text).

A comprehensive analysis of protective measures before, during and after flood in central Europe has been carried out within the project **Cultural heritage protection against Flood (CHEF)**[17], including technical and administrational measures regarding cultural heritage. An overview of these measures is given also in a book[18], followed by recommendations on how to establish the most effective protective strategies.

The project summarized the available knowledge and data on case studies on protective measures in recent flood events in central Europe. The book emphasizes that the most effective flood protection happens before the event and the key for successful flood management is awareness and preparedness.

Project on risk assessment and sustainable protection of cultural heritage in changing environment (ProteCHt2save, still running)[19] is expected to proactively target the needs and requirements of stakeholders and policy makers responsible for flood and heavy rain mitigation. Still running project wants to enhance safeguarding of cultural heritage assets and foster the active involvement of citizens and local communities in the decision-making process (more effective stewardship).

Web-based inventory, maps and tools (decision support tool, best practices manual, handbook on transnational rescue procedures) for risk management and protection of cultural heritage in central Europe will be produced. Pilot actions will test the approach and tools in flood and heavy rain prone areas with cultural heritage vulnerabilities to improve the existing disaster risk management plans and policies in municipalities. Input to adaptation policies of government organizations thereby promoting improved strategies and plans for the protection of cultural heritage will be ensured as major impact.

Safeguarding Cultural Heritage through Technical and Organizational Resources Management (STORM, still running in 2019)[20] integrated platform delivers a set of applications and services for the protection by climate changes and extreme weather events. Project proposes a set of novel predictive models and improved non-invasive and non-destructive methods of survey and diagnosis, for effective prediction of environmental changes and for revealing threats and conditions that could damage cultural heritage sites. For experts in the field of cultural heritage also cooperation platform for collaboratively collecting and enhancing knowledge, processes and methodologies on sustainable and effective safeguarding and management of account environmental and anthropogenic risks, and of using Complex Events processing is a useful tool.

Project **Increasing Resilience of Cultural heritage: a supporting decision tool for the safeguarding of cultural assets (ResCult)** worked on enhancing the capability of civil protection, prevention and mitigation impacts of disasters (also floods) on cultural heritage. This was done through the realization of an integrated European Interoperable Database for CH, designed to provide a unique framework for civil protection, national Ministries, the European Union and local authorities.

[17] Project Cultural heritage protection against Flood, Berlin, Germany, https://opus4.kobv.de/opus4-bam/frontdoor/index/index/docId/38546

[18] Miloš Drdácký, Luigia Binda, Insa Christiane Hennen, Christian Köpp, Luca G. Lanza and Rosemarie Helmerich. CHEF - Cultural Heritage Protection Against Flooding. Institute of Theoretical and Applied Mechanics AS CR, v. v. i. Prague 2011, ISBN: 978-80-86246-37-6.

[19] project ProteCHt2save. https://www.interreg-central.eu/Content.Node/ProteCHt2save.html

[20] project STORM.http://www.storm-project.eu/

RESCULT provided a disaster risk reduction strategy identifying tailored actions and investments to improve both prevention and resilience capacities. It increased cooperation and interoperability between EU member states for the sake of protecting Cultural Heritage information sharing, interoperable protocols, best practices dissemination, alignment with EU policies/standards.

More general publications as "**Management of natural and technological hazards in Central and Eastern European countries**"[21] prepared by projects of European Commission were taken in study, since they represent wider scope of problem. It summarizes information's on central information systems to support management of disasters and emergency situations due to natural and technological hazards. Between the countries, authors recognize great variation concerning data and data availability, tools and expertise applied to risk assessment and risk management of natural and technological hazards.

Some of the research projects focus on distinctive types of cultural heritage – two of them are representing research on special artefacts - masonry arch bridges and underwater cultural heritage (mines).

Masonry arch bridges constitute a significant proportion of existing bridges in Europe and Alpine region. Many of these structures are designated as cultural heritage of high importance. The **FRAMAB project** aims at defining a flood risk assessment framework for masonry arch bridges combining a realistic description of the hazard (probability of exceeding a given flood discharge) with an accurate assessment of the structural vulnerability (probability of exceeding a given damage level in the bridge components for a flood with a given intensity).

The second project aims on restoration of cultural heritage already flooded (**UNEXMIN**). The project and its products will be able to present a kind of cultural heritage that could not ever be seen by human again, if the UNEXMIN technology (submersible robotic system) did not exist. This non-invasive 3D mine mapping will gather valuable geological, mineralogical and spatial information on flooded mines.

[21] Management of natural and technological hazards in Central and Eastern European countries.
https://minerva.jrc.ec.europa.eu/EN/content/minerva/e7876bf1-ed38-4611-a9d7-1dbbb2479c62/peco_report_2002

Earthquakes

Earthquakes are the result of forces deep within the earth's interior. Sudden break within the upper layers of the earth, sometimes breaking the surface, resulting in the vibration of the ground, which are strong enough to cause the collapse of buildings and destruction of life and property. They strike with no early warning and can be devastating, but after a major one, aftershocks may be as strong as a new earthquake. Earthquakes usually happen along a fault plate, the borderline between plates (e.g. European and the African). Earthquakes often trigger landslides, tidal waves and tsunamis.[22] Amongst natural disasters, earthquakes are one of the most lethal kinds due to their unpredictable nature and devastating impact they can have in a matter of seconds.[23]

Seismic hazard models for Europe clearly indicate that the most seismic areas are in the Mediterranean area (Turkey, Greece, Italy, especially along Central-Southern Apennines, some sectors of the Balcanic region and Southern Spain).[24] EM-DAT data indicates that 34 earthquakes occurred in Europe between 2000 and 2017 (average magnitude 5.7), affecting 13 different countries, mainly Italy and Greece. The impact of which resulted in 701 deaths, 257,303 people affected (including 95,189 homeless and 3,103 injured) and almost US$ 29 billion in economic damages. In 34 earthquakes captured, 15 had a magnitude higher than 6.0.[25]Since plate tectonic processes take place over geological time scales, it can be assumed that the current seismicity in the region of the Alps will remain the same for millions of years to come.[26]

Earthquakes cannot be prevented but the potential damages can be reduced with development of possible warning indicators, land-use regulations, building regulations, relocation of communities, public awareness and education programs.[27] In case of cultural heritage assets (built or movable), the economic damage caused by a catastrophic seismic event are difficult to assess given that the historic value of such assets are very difficult to be measured or quantified. [28]

Two cases of earthquakes with severe consequences are described in the next section. The first one was earthquake in Liguria and south France in 1887 and the second one was earthquake in Northern Italy in 2012. Both caused human victims and significant economic loss including cultural heritage assets.

Case study: Earthquake in Liguria and south France in 1887

The 23rd February 1887, at 5:50 an earthquake of estimated intensity 9 (MKS 1964) hits the Riviera di Ponente, in Italy, with epicenter between Imperia and Bussana. It was felt throughout a vast territory, out of Montpellier to west, to Bâle to nord, to Roma and Venezia to est. It was shaking the Corsica and the North of Sardinia, covering a radius of 300 km from epicenter. It

[22] https://www.ifrc.org/en/what-we-do/disaster-management/about-disasters/definition-of-hazard/geophysical-hazards-earthquakes/
[23] https://www.emdat.be/cred-crunch-51-earthquakes-europe
[24] http://www.prothego.eu/docs/PROTHEGO_D.01.01.pdf
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[26] http://www.seismo.ethz.ch/en/knowledge/earthquake-country-switzerland/earthquakes-and-the-alps/
[27] https://www.ifrc.org/en/what-we-do/disaster-management/about-disasters/definition-of-hazard/geophysical-hazards-earthquakes
[28] https://publications.europa.eu/en/publication-detail/-/publication/8fe9ea60-4cea-11e8-be1d-01aa75ed71a1

represents the last and most catastrophic seism that has known the southern region of France and Maritime Alps. It caused 635 death and 555 injuries in Italy. The epicenter of the main shock was approximately 30 km away from Nice and the cost east of Marseille was stroke by a tsunami wave with height between 0.5m (at Nice) and 1m (at Antibes). Nice was strongly affected together with Menton, Castillon, Peille, la Bollène Vésubie, Bouyon, Clans, Bar-sur-Lou and other villages in the region. The damages were caused by the main shock and the following ones occurred after, 10, 20 and 150 minutes. In the French Maritime Alps the earthquake killed 8 and injured 51, other than a victim in Saint-Pierre d'Entrevaux on the Alpes de Haute Provence and another one at Marseille. In Nice there were 2 killed and 13 injured, whereas the record of damages would suggest a magnitude of 8 on the macro seismic intensity (EMS98) scale. Neighborhoods bordering streams on alluvial land have suffered significant damage in Nice and Menton, probably related to the phenomenon of liquefaction of the soil. In Nice, the damage was significant: collapse of buildings (some schools in the Saint-Etienne district), parts of buildings (chimneys, low walls, partitions ...) appearance of large cracks on walls of houses. Within a perimeter including the district of St. Etienne and the south of the station from the valley of Magnan, to the avenue of the Station (bd Jean Médecin), 18 houses were evacuated for major repairs. In the area between the railroad, Boulevard Carabacel, Avenue de la Gare and Paillon, 14 homes suffered the same fate for the same reasons. Between the Paillon, the road of Turin, the boulevard of Riquier and the sea, 15 buildings will undergo a similar treatment.

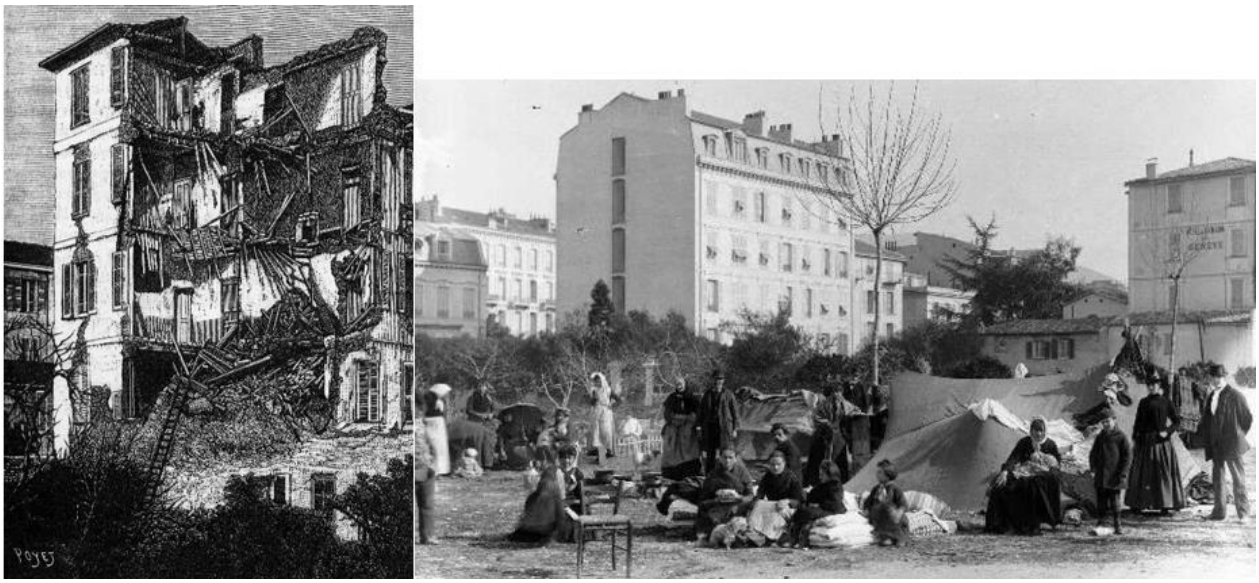

Figure 62 Left: Effects of earthquake in Nice; Right: Outdoor camp in the Saint-Etienne district

Saint-Etienne is one of the most troubled neighbourhoods. Just opposite the church, the great house of the priest Camous serving as a communal kindergarten, had the right wing completely collapsed on four levels. Firefighters supported by the military, did search among the huge amounts of rubble the lifeless body of a 45-year-old victim. « The church is cracked on all sides, the bell tower only stands by a miracle, a wide crevasse cuts it obliquely into two parts. A cordon of gendarmes and policemen prevents the approach deemed dangerous » Le Petit Niçois journal reports on the 24th February 1887. Contrary to what one could have imagined, the seismic shakes had only side effects in the old Nice and the heights of Cimiez. In Old Nice, only «the bell tower of St. Augustine Church near the infantry barracks, was destroyed». The local chronicles of that days report: «Everything cracks, the walls, the furniture, the bells ring, the dogs scream at death», «We are resolutely abandoning homes to reach as quickly as possible the least discovered areas: beach,

countryside, squares, avenues. Indeed, camps were built on the Boulevard de Cimiez». At that time the town of Nice wasn't so urbanized and extent as nowadays and Cimiez hill was still an area covered by olive trees and vineyards, pertaining to large villas such as Villa Gubernatis, nowadays hosting the Matisse Museum, and the Cimiez Monastery. Here the chronicles report that «the roof of the hospice for elders collapsed, injuring two people. In that area, six houses are declared as uninhabitable. In the climb of Cimiez, the conciergerie of Sainte Ursule cloister burned». Other similar damages occurred to further 6 of the very few existing houses. The crops on this hill did hide just partially the ruins of a gallo-romaine city, namely Cemenelum. This city was the prefecture of the Roman province of Alpes-Maritimes. Nowadays, even if only a tiny part of the ancient city of Cemenelum has been searched, three thermal complexes, an amphitheatre a cardo and a secondary decumanus have been cleared and identified. The last excavations ended in 2004 and the archaeological site represent a significant tourist destination, together with the afore mentioned Matisse Museum, the Marc Chagall Museum and other buildings registered as Historic Monuments, as such as the spectacular ancient Palace Excelsior Hotel Regina. From the beginning of XX. century, Cimiez did see the establishment of palaces and villas that host sovereigns and aristocratic wealth from all over Europe. Today the hill of Cimiez is a residential area of Nice, and, together with the Castle Hill, one of the main historical sites of Nice.

The increase of both the elements at risk and the level of vulnerability due to current conditions of their own and the surroundings, since the 80s, triggered many seismic studies in the town of Nice. They have shown that "site effects", wave propagation effects leading to amplifications that can be very high, mainly affect two locations in the city of Nice: Cimiez, as well, among the others. In terms of risk prevention, the magnitude of the site effects in Nice, combined with the importance of the building's vulnerability, was demonstrated in a meaningful way to risk management stakeholders, but still the implementation of cultural heritage safeguard initiatives is lacking.

Case study: Earthquake in Northern Italy in 2012

In May 2012 a seismic sequence struck a large area in Northern Italy, through Emilia Romagna, Lombardy and Veneto regions. The seismic disturbances, mainly located in the provinces of Modena, Ferrara, Mantua, Reggio Emilia, Bologna and Rovigo, were clearly perceived in a broader area comprising, in addition to Central and Northern Italy, large parts of Switzerland, Slovenia, Croatia, Austria, South Eastern France and South of Germany.

The highest magnitude tremors occurred on 20th of May (Richter 5,9), 29th of May (four distinct earthquakes, respectively: Richter 5,8, 5,4, 4,9 and 5,2) and 31st of May (lower magnitudes). The seismic shakes resulted in 27 victims (22 died under structures collapses, 3 due to heart attacks and 2 from wounds). The majority of the victims died because of the collapse of industrial premises.

Figure 63 Compliance with safety standards of high value buildings

The province of Mantua is one of the areas which suffered the highest rates of damages. Based on the Report "La ricostruzione post sisma del 20 – 29 maggio 2012" (Lombardy Region, 2016), the overall amount of economic losses that affected public infrastructures, cultural heritage and places of worship amounted to approximately 299 M€.

The same Report highlights that, after the earthquake storm, the Superintendence of Cultural Heritage of Mantua declared as condemned or temporarily condemned 195 high value buildings, 102 of which hosted mobile cultural heritage.

The analysis of the Index of Damage (0-1), computed for each building, points out that approximately 75% of the assets suffered low damages (1st quartile) whilst for 5 buildings the damages can be considered very high (4th quartile).

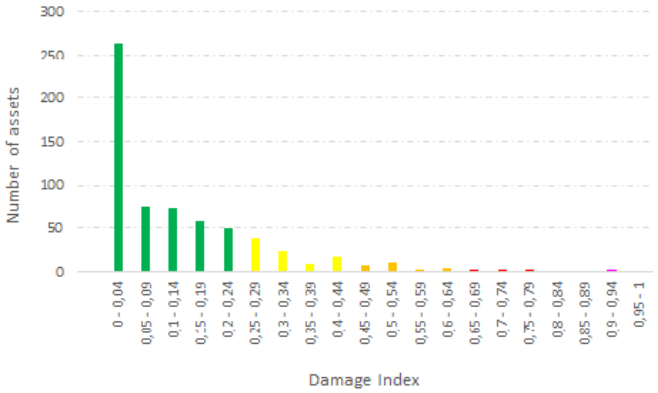

Figure 64 The analysis of the Index of Damage

The document "*Conoscenza, prevenzione e metodologie per la salvaguardia dei Beni Culturali e del patrimonio diffuso sul territorio regionale. Caso studio: i 57 comuni lombardi in zona sismica 2*" (Lombardy Region, 2017), synthetizing the lessons learnt by the Regional Administration of Lombardy in securing activities on cultural heritage on the occasion of two mayor earthquakes that hit Lombardy in 2004 (Salò) and 2012 (Mantua), dedicates a special focus to the interventions on the places of culture (e.g. Museums or Libraries). It includes a brief interview, gave by the Director of Mantua City Museums (City Museum of Te Palace and San Sebastiano Palace) in the presence of an officer of the Civil Protection Department, synthetizing the first interventions carried out to safeguard the buildings and the cultural heritage they contain.

A brief preface:

- after the first tremor, occurred on the 20th of May, the city was locked down
- the heads of the places of culture were waiting for instruction from the technicians of the Ministry of Cultural Heritage and Activities and Tourism (MIBACT), busy with hundreds interventions mainly on Ducale Palace

- the early recommendation provided by MIBACT was to wall fasten the highest value paintings, even if inspections to verify their stability hadn't been started

On 29th of May, after a second strong earthquake:

- at 09:00 am the Security Plan has sprung into action, with the evacuation of the Palaces within 2 minutes
- in the afternoon, a first inspection has started in the presence of both the Public Works Director of the Municipality of Mantua, the Director of Mantua City Museums and a trusted restorer
- with regard to Te Palace, both the "Hall of the Horses", the "Loggia of the Muses" and the "Chamber of the Sun and the Moon" resulted to be damaged. In the "Chamber of the Giants" moderate to severe cracks in the walls appeared
- a similar inspection has been carried out at San Sebastiano Palace, where lower damages were observed
- at a later stage, a complete damages mapping has been carried out
- on May, the 30th, the technicians of the Superintendence of Cultural Heritage of Mantua completed their inspection and ornamental equipment have been secured. Wall fastening was recommended for mobile assets, whilst statues were removed from their basements and put into storage
- on the 31st of May, the static analysis of the building structures has been carried out, with verification of the structural integrity of both crawl spaces and roofs
- on the 9th of October a press conference has been organized, to communicate both the conclusion of the making safe phase and the opening of the Museum
- on the 4th of November the securing and restoring interventions were completed

Research projects and studies addressing effects of earthquakes on CH

Some European projects dealing with relation between earthquakes and cultural heritage. **P.A.T.C.H.** for example contributed to guidelines, protocols and procedures for the rescue of cultural heritage items during seismic events. **NIKER** exploited existing materials and components in terms of strength and energy dissipation and contributed to optimization of interventions under real life conditions. Most of the mentioned projects focused on Mediterranean area. Region Provence-Alpes-Cote d'Azur made a map of exposure of protected sites, monuments and museums to seismic hazard. There are no specific projects in Alpine Space region dealing with impact of earthquakes on cultural heritage. Some projects are interesting, because they have methodological aspects focused on earthquakes.

Part of the **LESSLOSS** (Risk mitigation for earthquakes and landslides) project was focusing on earthquakes and on the built cultural heritage. The objectives of this project were also improvement of disaster scenario prediction and loss modelling and improvement of pre-disaster planning and mitigation policies. **Prothego** (Protection of European Cultural Heritage from Geo - Hazards) was investigating active tectonics, which is in connection with earthquakes. Aim was to monitor monuments and sites in Europe which are inscribed on UNESCO's World Heritage List in

terms of exposure. Focus of the project **CHIC** (European cultural heritage identity card) was on identifying and monitoring tangible cultural heritage across Europe and its neighbouring countries and to create the capability to monitor and systematically report on various human and natural impacts in the provision of the most relevant and economic choices for effective preventive conservation. Project **CulturAlp** focused on Alpine area. The main goals are to improve the knowledge of alpine historical settlements system and to develop innovative operational policies for protection and enhancement of this distinctive cultural heritage.

Earthquakes were one of hazard types addressed in project 'Management of natural and technical hazards in Central European candidate countries **(PECO)**, which was to improve know-how of civil protection agencies on natural and technological risk management in at that time 10 EU candidate countries. Actions were directed into implementing the Seveso II directive. Project was covering the Alps only very partially through involving Slovenia, where is explicitly stated that among others, earthquakes are an important hazard. Project delivered a few priorities dealing with natural hazards – to identify communities and buildings in high risk seismic zones, and to select facilities for seismic risk mitigation funded by national and international projects – both referring to Romania. It was considered as highly vulnerable to earthquakes, like Slovakia and Slovenia.

Fires

Fires occur when all three key elements are available – fuel, oxygen and heat. All are very commonly abundant in relation to some types of cultural heritage, especially in case of museums, libraries, churches, archives, galleries etc. Fires are very often man-made and thus occurs frequently where high density of people are to be found. Even in nature, when large swaths of either forest or agriculture lands are crossed by flames, humans are usually to blame. Slash and burn practices, farming, rail roads are the most important causes of wild fires, which can have devastating effects on cultural heritage. Both urban and wild fire can completely destroy historical buildings, which can be made entirely out of wood, making them extremely vulnerable. Paintings, frescos and written materials are highly flammable, either because of the fact they are made from paper or pigments, which can contain ignitable compounds. Substantial damage can be made also from smoke and soot, which can colour artefacts. Even fire suppression by applying water can cause damage by soaking the materials, loosening structures and inducing decomposition by fungi (mould) and bacteria[1]. In case of Alpine area, damage to historic districts is relevant as well, as is damage to cultural landscapes and archaeological sites. Forest fires or fires across cultural landscape change the landscape matrix substantially, removing plants (trees, grasses, crops) and dead woody material they can alter the visual character of the land and affect its aesthetic appeal. Fire also depletes organic matter in soil, which jeopardizes stability of terrain and can trigger landslides or rockfall.

Since circumstances in which fires occur can be controlled easier than those related to some other natural hazards, like landslides and floods, many technological solutions have been developed to prevent it. Controlled climate, fire alarms and extinguish equipment are effective ways to combat fires, however despite those there have been numerous examples cultural heritage being torched down. In September 2018 an event of fire devastated almost a complete collection of more than 20 million artefacts in the national museum of Brazil. An immense repository of South America' cultural heritage was lost. However, this is not the first time in recent years a large natural history museum was lost. In 2016 India's National museum of Natural History was destroyed by fire, and in 2010 a major biomedical research laboratory in São Paulo, the Instituto Butantan was lost due fire[2].

The following text describes the violent fire of the Church of Santa Maria delle Grazie in Switzerland 1996 in which some parts of the church were destroyed and the others seriously damaged.

Case study: Catastrophic fire of the Church of Santa Maria delle Grazie, Bellinzona, Switzerland

The city of Bellinzona, County Seat of the Republic and Canton of Ticino, is an exceptional case study: it was at the centre of restorations after the catastrophic fire of the Church of Santa Maria delle Grazie, it is the location of monuments and buildings of national importance (including the State Archives, the State Archaeological Collection, the State Ethnographic Collection and the lower part of the Murata, which belongs to the "Three Castles, Defensive Wall and Ramparts of the Market-Town of Bellinzona" complex, UNESCO world heritage site since 2000), and it is today still in danger of flood waters.

From the historical point of view, the Church of Santa Maria delle Grazie is one of the most

significant cases with regard to fire response and recovery operations. It is the ancient church of the Franciscan convent which dates back to the last decades of the 15th Century and where the Canton of Ticino's most important Lombard school Renaissance frescos can be found. Inside the building, the spaces dedicated to worshippers (a quadrangular room with three chapels on the North side) and to monks (a square plan room with a choir at the bottom, quadrangular as well) are separated by a frescoed partition wall dated back to 1510, which stands above a central hall and two lateral chapels. A violent fire occurred on the 31st December 1996, developed from a Nativity set placed in one of the chapels dedicated to worshippers, seriously damaged part of the wall structure and the decoration, while the roof, the wooden ceiling and a huge part of the furniture were destroyed. The emergency operations and the restoration took almost ten years and the reconditioned church was inaugurated on the 17th March 2006.

With regard to the preventive measures concerning the protection of cultural goods (the church is classified as a building of Cantonal interest), only a year after the fire, the 13th May 1997, the Law for the Protection of Cultural Heritage was issued, specifying responsibilities, instruments and measures of protection in case of natural disaster.[29]

Figure 65 External view of the Church of Santa Maria delle Grazie after the fire occurred on the 31 December 1997. Photo by Fabrizio Savioli

In the wake of the measures issued by the Law (except for the emergency intervention on heritage which belongs to the Canton), after the fire was extinguished, between January and April 1997 the Municipality of Bellinzona started a series of stabilisation works in order to avoid the building's collapse, and developed analysis concerning its state of conservation which allowed to begin the restoration project. The building was cleaned up from the traces of smoke and soot which damaged the precious frescoes, it was protected by a modern anti-fire system, while the church and the annexed monastery were stabilised. The analysis of the state of conservation allowed to identify, between the several causes of the structure's collapse, the fine-grained nature of the soil and the quality of the building materials. As a consequence, the need of a static restoration was evident.

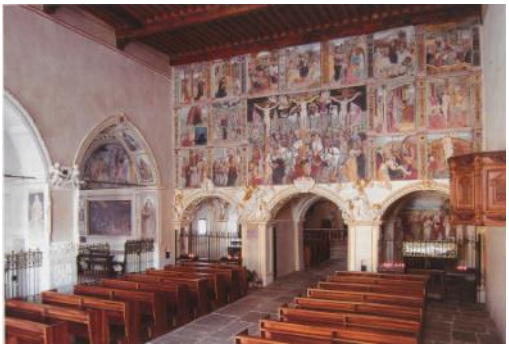

Figure 66 Worship room after the restoration in 2006. Photo by Fabrizio Savioli

After the State Council's approval following the proposal made by the Municipality of Bellinzona on the 11th July 2000, the interventions of restoration were started and led by a team of experts. The photographic and photogrammetric surveys following a cartography of the degradation allowed to eliminate the building's modifications and instabilities and to start the restoration and the rebuilding of the parts damaged by the fire, such as the ceiling and false ceiling, plasters, frescoes, wooden beams, vaults, plants and floors.

[29] The State Council is the institution which carries out the needed security measures, while the authority of the Municipality is limited to protected cultural heritage goods of local interest (between them the development of surveys and the stabilization and maintenance interventions) within 6 months from the event in case of a non-protected heritage. Immediate measures are taken by the Civil Protection Department (Art. 17 and 18).

The restoration works were made possible by the contribution of the Municipality of Bellinzona, the Canton of Ticino, the Swiss Confederation, the Association for the renovation and the private community.

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Storms

Storms and storm winds are atmospheric disturbances with wind speeds of 89 km/h or more. Gusts of wind of 100 km/h or more are able to uproot trees or move heavy objects. Additionally, storms can be accompanied with heavy precipitation (rain, snow) and thunder and lightning, which might trigger avalanches, landslides and flooding. Air currents in the mountains from mountain ridges and tops channelled by narrow valleys often create very strong gusts in underlying areas or valleys, which cause great damage. North and south of the Alps such phenomena are also known as Föhn, in Friuli and Slovenia as Bora and are infamous.

During the 1980s and 1990s the occurrence of several storm events lead to assumption that these events will increase in future due to rising (air) temperatures, but this concern was unfounded as this did not happen[30] at least not in the Eastern Alps of Austria; Switzerland on the other hand reported an increase of wind velocity and strengths of wind fields (Usbeck et al., 2010[31]). Another storm related hazard are the windstorms during the winter period which have reportedly destroyed forest (e.g. winter storm Wiebke in 1990, as the last of eight winter storms in this year) and infrastructure[32] along the whole alpine space. Nevertheless, the windstorm hazard in mountainous areas may be subject to extreme small-scale changes due to topographical features like river valleys[33]. One of the most recent storm events were the thunderstorms in the Alps-Adriatic region in October and November 2018 (a low-pressure system in Germany called “Vaia” and in France “Adrian”) which caused serious damage of more than 3 billion Euros.

Case study: Storm damages at the Fortress of Hohensalzburg, Salzburg, Salzburg, Austria, 2018

Figure 67 Fortress of Hohensalzburg towers

The Fortress of Hohensalzburg towers over the Austrian city of Salzburg. Erected at the behest of the Prince-Archbishops of Salzburg in the 11th century, and gradually expanded to its present length of 250 m and width of 150 m, making it one of the largest medieval castles in Europe. The fortress is situated 82 m above the city itself, at an altitude of 506 m.

In the morning of 30 October 2018, a heavy storm accompanied by a powerful gust lifted the roof above the arsenal and carried the wooden shattering away onto neighbouring buildings, into the courtyard and on pathways through the complex. A hole with the size of about 5x7 m was knocked into the roof of the old granary and left the historical rooms bellow exposed to the elements. The financial damages are estimated in the hundreds of thousands of Euros.

[30] Compare e.g.: APCC (2014): Österreichischer Sachstandsbericht Klimawandel 2014 (AAR14). Austrian Panel on Climate Change (APCC), Verlag der Österreichischen Akademie der Wissenschaften, Wien, Österreich.
[31] Usbeck, T.;Wohlgemuth, T.;Dobbertin, M;Pfister, C.;Bürgi, A.;Rebetez, M.(2010)- Increasing storm damage to forests in Switzerland from 1858 to 2007.- Agricultural and Forest Meteorology,150, 47–55.
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[33] https://www.munichre.com/touch/naturalhazards/en/naturalhazards/meteorological-hazards/storm/index.html, accessed 25.3.2019.

Figure 68 Emergency services

Emergency services, as well as structural engineers, carpenters and officials from the Federal Monuments Office were on location, trying to clean up the damage and working on a provisional solution that would hold until the reconstruction planned for the spring of 2019. The fortress was partially open to the public on the next day, but the affected areas remain closed and a warning was issued to the owners of the properties on the south side of the hill, below the fortress about debris that might still roll down.

Figure 69 Missing ceiling of the mayor's tower

The management of the fortress is still facing issues beyond the renovation itself, regarding the emergency cover that would have to last through the winter, as well as the future protection against extreme weather events, given the fact that there are no such damages that had been historically documented before the storm "Emma", which swept the ceiling of the mayor's tower in 2008.

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Research projects and studies addressing effects of fires on CH

Two projects were dealing specifically with the issue of fires in relation to cultural heritage. Both **FiRE-TECH** and COST action C17 – **Built Heritage: Fire Loss to Historic Buildings** were investigating fires occurring in the historic buildings, mostly from in terms of technological solutions to either prevent or mitigate impacts of fire. Cases studies were scattered across Europe with seemingly no link to Alpine area, however, since historic buildings can occur anywhere, project results are relevant for CHEERS as well. The general aim of FiRE-TECH was to evaluate the risk that fire poses to our cultural heritage and to suggest methods by which that risk can be quantified and managed using the systems and components that are currently available. A decision support procedure has been developed to enable selection of the system with the highest positive impact on protection against fires. Optimality of the system was assessed in terms of reliability, acceptability and the costs. Like FiRE-TECH, project C17 was also dealing with statistical analysis of past fire event to elaborate on most frequent causes and gaps of existing fire protection systems to define the main pitfalls of the current management frameworks. Both were trying to provide suggestions for further development and guidance for managers and owners on how to minimize fire risk in historical buildings. In addition to this, C17 put much focus on latest state-of-art technological solutions and gave recommendations for future developments.

Legislation and regulation – its adaptation to natural hazards in Alps

European level state-of-art is very illustratively covered in a recent document *Safeguarding cultural heritage from natural and man-made disasters: a comparative analysis of risk management in the EU* by European Commission, which originates from commitments of Workplan for Culture (2015-2018)[34]. Workplan was considered as one of tools for meeting the goals of European Agenda for Culture[35], a strategic policy aimed to promote cultural diversity and intercultural dialogue; to promote culture as a catalyst for creativity, innovation, employment and competitiveness; and to promote culture as a vital element in the Union's international relations. The New European Agenda for Culture was adopted by the Commission in 2018 and is to focus on positive contribution culture is making for Europe's societies, economies and international relations. This document also sets framework for the next phase Work Plan for Culture (2019-2022), which is setting five major priorities: sustainability in cultural heritage; cohesion and well-being; an ecosystem supporting artists, cultural and creative professionals and European content; gender equality; and international cultural relations. One of the 17 specific actions is 'Quality principles for cultural heritage interventions' (under the first priority), which is to address issues of reconstruction via developing guidelines governing the next generation of EU funds, ensuring quality principles for conservation and safeguarding in heritage. This indirectly relates to natural hazards as reconstruction is a logical step after disaster event occur, even though it is not explicitly written so.

On a global level, the Sendai Framework for Disaster Risk Reduction 2015-2030[36] is a global non-binding agreement on how to manage risk of disasters in order to reduce global disaster mortality, reduce number of affected people, to reduce economic loss and damage on infrastructure, to enhance international cooperation and to foster development of warning systems and disaster risk information. Among its priorities it also covers the issue of damage on cultural heritage, public awareness and governmental preparedness to tackle the link between disaster events and cultural heritage. In its Action Plan on the Sendai Framework it also focuses on the need to develop good practice related to integration of cultural heritage aspect into national disaster reduction strategies, which are to be developed by Member States.

There is no special initiative or political framework for addressing the issue of cultural heritage and its exposure to natural risks, except for Alpine Convention, which highlights the importance of culture and refers to it within the work of the Platform on Natural Hazards of the Alpine Convention PLANALP, especially in the protocol 'Spatial Planning and Sustainable Development'. In general, individual Member States are encouraged to adopt those proposals into their national frameworks.

In addition to above mentioned initiatives, there are several others, which are also important for protecting cultural heritage in terms of natural hazards. Within the European framework, the report "Towards an integrated approach to cultural Heritage for Europe" highlights cultural

[34] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.C_.2014.463.01.0004.01.ENG#https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.C_.2014.463.01.0004.01.ENG
[35] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32007G1129%2801%29
[36] https://www.unisdr.org/we/inform/publications?p=0&type=18

heritage as a shared resource and a common good and considers it as an irreplaceable repository of knowledge and a valuable resource for economic growth, employment and social cohesion. It does not consider natural hazards indirectly, however it stresses the need to protect and conserve it. Similarly, The Council of the EU (Conclusions on cultural heritage as a strategic resource for sustainable Europe - Education, Youth, Culture and Sport Council meeting in Brussels in 2014) emphasized the need to safeguard and enhance cultural heritage as it plays and important role in meeting the goals of Europe 2020 strategy – smart, sustainable and inclusive growth. Again, it does not relate to natural hazards specifically, but environmental sustainability and economic potential.

An extensive study, '*Cultural Heritage for Europe (CHCfE)*' was commissioned in 2013 and has provided a panacea of information related to cultural heritage related to four major fields – economic, social, cultural and environmental impact of cultural heritage. It covers research/case review, conceptual discussions, practical guidelines and assessment of different methodological approaches for those tackling issues linked to conservation and use of cultural heritage on EU-level. However, it did not address natural hazard in any direct way.

Slovenia - Definition and categories of Cultural Heritage

The Cultural Heritage Protection Act (CHPA) adopted in 2008 aimed to turn heritage conservation from a preventive into a co-creative heritage's conservation (with owners of heritage, commercial entities, non-governmental organizations and the civil society). In this vein the heritage protection policy until 2019 established strategic goals to ensure the protection and the inclusion of the heritage in the modern life, ensure stable financial resources to the national public service, improve its organization, working practices, and homogenous activities, prepare public service expert standards, raise awareness on the heritage and its protection, and ensure a larger role of the Slovenian heritage at international level. CHPA embodies four internationally adopted conventions relevant for cultural heritage; The Granada Convention (ratified 1993), The Valletta Convention (ratified 1993), The European Landscape Convention (ratified 2003), and The Faro Convention (ratified 2008).

The issue of heritage conservation is included also in sustainable development and protection of heritage from natural and other disasters.

Cultural heritage in Slovenia is protected according to three different grades:

1. Cultural monument of national importance gains the protection with designation decree issued by the Government.
2. Cultural monument of local importance gains its protection with designation decree issued by the representative body of the municipality (as *Decree on the proclamation of cultural and historical and natural sights in the area of …)*.
3. Cultural heritage is protected on the basis of spatial plans adopted by the municipality, after its identification and after registration on the Immovable Cultural Heritage Register of Slovenia.

Only the latter two are tightly connected to local climate situation (as occurrence of natural hazards). The recognition of possible troubles in preserving cultural heritage is more recognized by local people who live in the region.

There are eight categories of immovable cultural heritage:

- archaeological sites,
- buildings,
- parks and gardens,
- buildings with parks and gardens,
- commemorative structures and places,
- facilities and installations,
- settlements and parts thereof,
- cultural landscape.

In addition to CHPA, there are several other documents important for cultural heritage:

- The Constitution of the Republic of Slovenia (1991), which establishes obligation of the state, local communities and individuals regarding cultural heritage protection while also introducing constitutional rights to expression and fostering of culture.
- National Program for Culture 2018-2025 (2017), which is a strategic document for planning Slovenian Cultural policy and was adopted by the government.
- Rules on the Registry of Types of Heritage and Protection Guidelines (2010).
- Rules on the Conservation Plan (2009).
- Rules on the Cultural Heritage Register (2009).
- Rules on the Registry of Types of Heritage and Protection Guidelines (2010).

In 2017, the Ministry of culture, which is responsible for cultural heritage policy, started the adoption of Cultural Heritage Strategy. When adopted and implemented, the Strategy shall become one of the main integrated tools for the sustainable management of Historic Areas.

Regulation especially related to link cultural heritage – natural disasters is the Protection Against Natural and Other Disasters Act (1994, amended in 2006 and 2010), which regulates natural and other disasters in general, but within this, also addressed cultural heritage:

- It defines what is a natural disaster event, what are other types of disasters (e.g. industrial accident), and how the significance of a disaster can be pinpointed.
- It defines cultural heritage, which is in harmonized with the CHPA.
- It defines which are measures of protection (organizational, technical and other measures for mitigating the risk, prevention and decrease of harmful effects of natural and other disasters on cultural heritage) and what is covered by actions of rescue of cultural heritage.

- It lists rights and obligations of the owners of cultural heritage assets and enables owners to seek help if needed.
- It also defines the role of civil protection, firefighting associations and of other services for protection, rescue and relief.
- It defines the role of the owner/user in assuring necessary measures and means (funds) for protection, rescue and aid in managing cultural heritage.

Italy – Definition and categories of Cultural Heritage

The Executive Decree no.42 (January 22nd, 2004) carries the Codex for Cultural Heritage and Landscape (last updated by Executive Decree no.62 and 63 from March 26th, 2008 and national Law no.129/2008); it defines what is to be considered a cultural asset. In brief:

1. They are cultural assets the immovable and movable items which belong to the State, the regions, the other territorial public bodies, and to any other public body and institution and to no profit private legal entities, including the ecclesiastic bodies recognized by the State, which are relevant for art, history, archaeology, cultural anthropology.
2. They are also cultural assets: a) the collections of museums, galleries, and other exhibition spaces of the State, the regions, the other territorial public bodies, and to any other public body and institution; b) the archives and the single documents of the State, the regions, the other territorial public bodies, and to any other public body and institution; c) the library collections of the State, the regions, the other territorial public bodies, and any other public body and institution.
3. They are also cultural assets, when the formal declaration of cultural interest (as of the article 13 of the Executive Decree no.42, January 22nd, 2004) has occurred:
   a) immovable and movable items that have a particularly important artistic, historical, archaeological or ethno-anthropological interest, belonging to subjects other than those indicated in paragraph 1;
   b) archives and individual documents, belonging to private individuals, which are of particular importance to the historical interest;
   c) library collections, belonging to private individuals, of exceptional cultural interest;
   d) immovable and movable things, to anyone belonging, which are of particular importance due to their reference to political, military, literature, art, science, technology, industry and culture in gender, or rather as testimonies of the identity and history of public, collective or religious institutions;
   e) the collections or series of objects, belonging to anyone, which are not included among those indicated in paragraph 2 and which, by tradition, fame and particular environmental characteristics, or by artistic, historical, archaeological, numismatic or ethno-anthropological relevance, qualify as complex an exceptional artistic or historical interest.

   The law specifies even more in detail the variety of goods that are the subject to specific protection provisions.
4. Are included among the things indicated in paragraph 1 and in paragraph 3, letter a):
   a) items of interest for palaeontology, prehistory and primitive civilizations;
   b) items of numismatic interest which, in relation to the time, to the production techniques and materials, as well as to the reference context, are rare or valuable, or historical;
   c) manuscripts, autographs, correspondence, incunabula, as well as books, prints and engravings, with relative matrices, of rare and valuable character.

General roles and responsibilities in the field of the protection of Cultural Heritage

The same law enounces the need to define to define the choice of what is necessary to salvage, which are the priorities and the procedures to adopt. The law puts the Superintendence in charge of this responsibility on a general level.

According to the Constitution, legislative power in the matter of protection environment, ecosystem and cultural heritage falls among the exclusive competences of the State (Article 117, paragraph 2, letter s Cost.), while the legislative power in the matter of cultural heritage valorization is one of the subjects with concurrent competence between the State and the Regions (art. 117, paragraph 3 of the Constitution). Article 116 of the Constitution states however that, by law of the State, forms and particular conditions of autonomy in the matter of legislation concerning the protection of cultural heritage can be attributed to the Regions (art. 116 paragraph 3 of the Constitution).

The rules providing indications on how to operate in emergency situations are basically two: the Executive Decree no. 42 of January 22nd, 2004, which incorporates the "Code of Cultural Heritage and Landscape", (last updated by the legislative decrees nos. 62 and 63 of March 26th 2008, published in the G.U. no. 84 of 9.4.2008, as well as to the L. no. 129/2008, of conversion of the D.L. no. 97/2008), and the Decree of the President of the Republic no. 233 of November 26th, 2007, amended with Legislative Decree no. 91 of July 2nd, 2009, which regulates and reorganizes the Ministry at central and peripheral level.

Central organization of the Ministry of Cultural Heritage and Activities

The Decree of the President of the Republic no. 233 of November 26th, 2007, amended with Legislative Decree no. 91 of July 2nd, 2009, regulates and reorganizes the Ministry of Cultural Heritage and Activities both centrally and peripherally.

The main changes made by the Presidential Decree no. 91 of July 2nd, 2009, substantially reduce the general directorates, combining certain offices and skills. It preserves however the configuration for General Directions with the General Secretariat and the role of the central structure with respect to the peripheral one.

Offices and functions of general executive level

The Ministry of Cultural Heritage and Activities is divided into eight management offices at central level and in seventeen general regional executive offices, coordinated by a General Secretary, as well as in two general-level executive offices in the Cabinet of the Minister (Article 1 of Presidential Decree No. 233 dated November 26th, 2007).

The General Secretary, in implementation of the Minister's addresses, coordinates initiatives concerning the security of cultural heritage; coordinates the protection activity based on uniform and homogeneous criteria throughout the national territory; coordinates the initiatives aimed at ensuring the cataloguing of the cultural heritage, pursuant to Article 17 of the Code; coordinates the interventions resulting from national and international emergencies, the latter also in collaboration with the Civil Protection Department; (Article 2, paragraphs 1 and 3, Presidential Decree No. 233 of November 26th, 2007).

The regulation expressly entrusts to the General Secretariat the coordination of all the Ministry's initiatives in the event of national and even international emergencies and establishes the basis of the collaboration with the Department of Civil Protection.

According to the law, as far as the protection of cultural and landscape assets is concerned, the General Departments are in charge of all the functions and tasks not expressly attributed to the regional Departments and to the sector Superintendents.

Peripheral organization of the Ministry of Cultural Heritage and Activities

At the peripheral level, the Ministry for Cultural Heritage and Activities is structured in:
a) the regional offices for cultural and landscape heritage; b) the Superintendencies for archaeological heritage; for architectural and landscape assets; for historical, artistic and ethno-anthropological assets; c) archival Superintendencies; d) the state archives; e) state libraries; f) museums.

In the event of national emergencies (referred to in article 2, paragraph 1, letter C, of Law no. 225 of February 24th, 1992) it is possible that special ordinances may be issued in derogation of the current legislation, yet normally the regional departments for cultural and landscape assets are the offices of general managerial level. They carry out functions of direction, coordination and control of the Superintendencies of the sector, of the archival Superintendencies, of the State archives, of the State libraries and of the museums that represent articulation regional directorates on the territory.

The regional departments are reference subjects for everything concerning the protection of cultural heritage, while the competences of the individual Superintendencies of the sector for the different types of cultural heritage remain unchanged. In case of particular need and urgency, the regional department can take on himself and replace the functions of the Superintendence related to the protection of cultural assets, as coordinator of the Ministry's territorial branches. With regard to the interventions on the different types of cultural heritage, however, the Superintendents of the sector will have the task of authorizing any intervention, each for its own area of competence.

In urgent cases the removal operations (which can be assimilated to the interventions to be carried out in the event of disasters for the relocation of damaged works or those exposed to risk) can be authorized by the competent Superintendence.

Competences in the protection and conservation of Cultural Heritage

The Ministry for Cultural Heritage and Activities, in its central and peripheral structure, has the unique competence in the protection and preservation of cultural heritage, a competence that neither the mayors nor the Fire Brigade nor other subjects have. Yet, the law states that the safeguarding of the cultural heritage in Italy is the task of all citizens and all institutions. Also, it obliges the owners of the assets, either public or private, to guarantee their conservation.

• Conservative obligations: the State, the regions, the other territorial public bodies as well as every other institution and public institute have the obligation to guarantee the safety and conservation of the cultural assets of their belonging.

• The same subjects as of the previous paragraph, plus private non-profit legal entities and the civilly recognized ecclesiastical bodies, settle the cultural assets belonging to them, except for the current archives, in the place of their destination in the way indicated by the Superintendent. Private owners, holders or managers of cultural assets are also required to guarantee their preservation (art.30 D.L.42, January 22nd, 2004).

The law also regulates what are the prohibited interventions, the interventions subject to authorization (and possibly supervision) of the Ministry: particularly, the detachment, removal and handling, as well as all the specs for voluntary conservation interventions. In the law, there is no explicit mention of interventions in emergency situations connected to natural and anthropic risks, but some indications may come from the interpretation of existing articles.

• Required conservative interventions: the Ministry may impose on the owner or holder the interventions necessary to ensure the conservation of the cultural assets or provide them directly (art.32 D.L.42 of January 22nd, 2004).

• Compulsory custody: the Ministry has the faculty to have movable cultural assets transported and temporarily kept in public institutions in order to guarantee their safety or ensure their preservation in accordance with article 29 (art.43 D.L.42 of January 22nd, 2004).

Cooperation of Regions and other territorial public bodies in the protection of cultural heritage: the regions, as well as the other territorial public bodies, cooperate with the Ministry in the exercise of the protection functions. Certain cultural heritage protection functions may be delegated to the Regions and local authorities for certain types of assets not belonging to the State.

Cultural assets of religious interest

The Ministry of Cultural Heritage and Activities and the Italian Episcopal Conference (CEI) have reached an agreement that aims to increase collaboration for the protection of cultural assets of religious interest belonging to ecclesiastical bodies and institutions. Nevertheless, all the same roles and responsibilities established by the Code of cultural heritage and the landscape as stated in the previous paragraphs remain unchanged, and assets of religious interest constitute no exception to the law.

The agreement between the Ministry for Cultural Heritage and Activities and the CEI is mainly aimed at the activity of cataloguing the immense stock of cultural heritage owned by the Church in Italy. This activity is of fundamental importance also for organizing and planning interventions in the event of a disaster.

In the case of natural disasters involving cultural assets of religious interest, owned by the Church, the diocesan bishop transmits to the competent Superintendent by subject and by territory any useful information for the purpose of prompt assessment of damages and motivated considerations on the priorities of intervention. The competent ministerial and ecclesiastical bodies then agree to guarantee the temporary deposit of the same movable cultural assets in

ecclesiastical museums, if equipped with suitable security systems, or public museums present in the territory, or in suitable restoration laboratories, also in terms of safety, to carry out the necessary conservative interventions.

The National Civil Protection System

Following severe natural disasters that hit Italy, earthquakes and floods in particular, the area of territorial and population protection has been deeply reformed, up to the approval of the Framework Law of Civil Protection, February 24th, 1992, no. 225. This reform defined the system for coordinating the operational structures and resources owned by the State, the creation of the Civil Protection Department of the Presidency of the Council, the introduction of the concept of forecasting and prevention, distinct from the rescue activities, the organization of the national service in all its components and the enhancement of local authorities and volunteering.

The civil protection is organized as a "National Service", coordinated by the President of the Council of Ministers and composed by the central and peripheral Administrations of the State, by the regions, the provinces, the municipalities, by national and territorial public bodies and by any other institution and public and private organization present in the national territory.

The system is based on the principle of subsidiarity, according to which the most immediate and direct aid to the populations must be guaranteed by the nearest and next institutions. The first person in charge of civil protection in each Municipality is the Mayor, who organizes municipal resources according to pre-established plans to face the specific risks of his territory. Only where the resources available, due to the size of the event, are insufficient to deal with it, higher institutions will be mobilized: then, the provincial and regional levels are mobilized and, in the most serious situations, the national level.

From an operational point of view, the National Civil Protection Service relies on the national body of the Fire Brigade, the Armed Forces and the Police, the State Forestry Corps, the National Institute of Geophysics and Volcanology, the National Health Service and of all the other bodies and institutions indicated in article 6 of Law 225/1992.

In procedural terms, the civil protection system is regulated by the so-called Method “Augustus”. The instrument through which the system responds to an emergency is the Emergency Plan, a complex and heterogeneous scheme, to which several Entities and Administrations concur.

The Method “Augustus” identifies specific "support functions". In general terms, a responsible position must be appointed for each function. For instance, Function no.15 at the national level is the one about “Safeguarding of Cultural Heritage” and the Ministry for Cultural Heritage is responsible for it. At the local level, yet, the aforementioned function is rarely implemented in the Emergency Plans.

All the functions are coordinated in "tables" and in the operating rooms by special structures, such as the COC (Municipal Operations Center, responsible for activities at the municipal level), the COM (Mixed Operating Center), the CCS (Relief Coordination Center at the provincial level) and the DI.COMA.C (Direction Command and Control, organ decision-making at national level activated in major disasters), which oversee collaborative decision-making processes in real time.

In 1999, an inter-ministerial group was set up with the goal of safeguarding cultural heritage. The Group was composed of professionals from the Civil Protection Department, the Ministry of Cultural Heritage and Activities and the National Fire Department. The Working Group remained in office until 2006, year in which the Department of Civil Protection set up a new organizational structure and, within the Office for the evaluation of prevention and mitigation of anthropic risks, established the Safeguarding Service cultural heritage, with expertise concerning activities related to the cultural heritage sector.

Reference legislation for the Civil Protection System

- Law 24.02.1992 no. 225 "Establishment of the National Civil Protection Service";
- D.Lgs 31.03.1998 no.112 "Assignment of functions and administrative duties of the State to the Regions and to the local Bodies, in implementation of the Chapter I of the Law, March 15th, 1997 no.59"; D.P.R.08.02.2001 no. 194 "Regulation laying down new rules for the participation of voluntary organizations in civil protection activities"; D.L. 07.09.2001 no. 343 "Urgent provisions to ensure the operational coordination of the structures in charge of civil protection activities and to improve the logistic structures in the civil protection sector", converted into law with modifications by art. 1 of the L. 09.11.2001 no. 401;
- Constitutional Law 18.10.2001, No. 3 "Amendments to Title V of Part Two of the Constitution";
- D.L. 04.11.2002 no. 245 "Urgent interventions in favour of the populations struck by disasters in the regions of Molise, Sicily and Puglia, as well as further provisions on civil protection", converted into law with modifications by art. 1 of Law 27.12.2002, no. 286.
- Method “Augustus”, published in the issue October / November 1998 of the magazine "DPCinforma";
- Decree of May 3rd, 2001 of the Presidency of the Council of Ministers - Department of Civil Protection "Approval of models for the detection of damage to assets belonging to cultural heritage" – Official Gazette of the Italian Republic, general series no.116 dated 21.05.2001;
- DPCM February 23rd, 2006 "Approval of models for the detection of damages, following disasters, to assets belonging to the cultural heritage" - Official Gazette of the Italian Republic, general series no.55 of 07.03.2006.

Finally, the Directive April 23rd, 2015, which updates the directive December 12th, 2013, “Procedures for the management of the activities of putting in security and safeguarding the cultural heritage in the event of emergencies arising from natural disasters” is the most recent regulation on the topic of the protection of Cultural Heritage: it defines more clearly the chain of command and all the structures that are to be activated in case of calamity in order to ensure the protection of cultural assets, and determines all the respective roles and responsibilities.

Germany - Policies and Tools for the Protection of Cultural Property in Case of Disaster

The federal state (DSchG) is responsible for the preservation and protection of national heritage sites in Germany. As a result, the cultural heritage laws of each individual state align with federal policies; however, there are some minor differences. For practical reasons, these differences between state and federal laws do not to be detailed here. In this particular case, we are adhering to the Bavarian legal model for the protection of cultural property as the German alpine area is mostly located in Bavaria.

The guidelines of the Bavarian law for the preservation of cultural heritage sites (Generalinspektion der plastischen Denkmale des Reiches) were established by King Ludwig I in the seventeenth century. The first aim of the law was to record all sites of cultural heritage and to develop a model sample of what constitutes a cultural heritage site and what preservation guidelines were needed. The system integrated the ideas of the Hager Conservatorium of 1908, which meant that ground monuments, architectural monuments, and ensembles were evaluated as separate elements. In 1978, every cultural heritage object was evaluated once again and many new objects were added. Since the late 1970s, most of the municipalities and regions have listed their heritage sites in the *Denkmaltopographie Atlas*. This catalogue, which has been adopted by many countries, contains the identification and information about construction and renovations processes of various cultural heritage sites.

The administration for cultural preservation is subdivided into both higher and lower cultural heritage protection authorities. The higher authority is responsible for the guidelines and provides precedents for the lower authority. The lower cultural heritage protection authority provides owners of cultural heritage sites with assistance and issues permissions for funding and structural measures.

The definition and the guidelines for the protection of cultural heritage sites are defined by German law in the DSchG and specifically for Bavaria in the DSchG BW. The DSchG BW states that any object can be a cultural heritage site if:

- The object of interest is a manufactured product, which was built-up in the past.
- If the object is of scientific, artistic, local historical significance and public interest, its context and condition should be conserved (§19 DSchG BW).
- If accessories are part of the object, the object and its accessories should be seen as a unity. This means that the accessories should be protected too. This law also applies to tangible objects, especially in general space conception, such as garden areas and parks.
- The ensemble is created through the surrounding objects and is mostly not represented through the object itself. So, the appearance and the surrounding elements should always be considered (§15 DSchG BW).
- An ensemble can be a combination of many non-cultural heritage objects, which create a town centre or place.

In Germany the cultural heritage is differentiated in three classes:

- The cultural monument (one or more buildings).
- The ensemble monument (more than one object, which belongs to a complete scene).
- The ground monument (archaeological sites).

Compared to other European states, Germany differentiates between types of monuments in its classification system. This does not apply for World Heritage Sites as they are labelled separately.

Further Reading

Bayern.Recht. "BayDSchG." Accessed, March 26, 2019. http://www.gesetze-bayern.de/Content/Document/BayDSchG-1.
Denkmalliste. "Einführung in das Denkmalrecht." Accessed March 26, 2019. http://denkmalliste.org/denkmalrecht.html
Denkmalrecht Bayern. "Dieter Martin, Kritische Einführung zum Denmalrecht Bayerns 2018." Accessed March 26, 2019. https://www.denkmalrechtbayern.de/wp-content/uploads/2018/10/1-1-Beitrag-Martin-Kritische-Einfuehrung-zum-bayerischen-Denkmalrecht-2018.pdf.

Cultural Heritage and Natural Hazards

The protection and preservation of cultural heritage sites is subject to the laws of federal states in Germany. However, these measures are regionally organized. The higher cultural heritage protection is defined in section § 18 DSchG BW as the protection of cultural heritage sites against several catastrophic events as follows:

- If tangible objects are moved or stored in other places, the owner must inform the lower cultural heritage protection authorities.
- Cultural objects should be labelled and marked according to the system of international conventions.
- The owner must inform the authorities in case of rescuing and securing any objects, and transfer them to official places listed by the authorities.
- The owner has to tolerate the scientific recording of cultural monuments or other measures ordered for documentation, protection, or restoration by the Monument Protection Authority.
- If it is not possible to protect the monument or the registered movable monument from a hazard, expropriation in favor of the State or another legal entity under public law is permitted.

Further Reading

Bayern Recht. "Gesetz zum Schutz und zur Pflege der Denkmäler. " Accessed March 26, 2019. http://www.gesetze-bayern.de/Content/Document/BayDSchG/true?AspxAutoDetectCookieSupport=1.

Die Beauftragte der Bundesregierung für Kultur und Medien. "Völkerrecht." Accessed March 26, 2019. http://www.kulturgutschutz-deutschland.de/DE/AllesZumKulturgutschutz/Rechtsgrundlagen/Voelkerrecht/voelkerrecht_node.html.

Ministerium des Innern des Landes Nordrhein-Westfalen. "Geltende Gesetze und Verordnungen (SGV. NRW.). " Accessed March 26, 2019. https://recht.nrw.de/lmi/owa/br_bes_detail?sg=0&menu=1&bes_id=4488&anw_nr=2&aufgehoben=N&det_id=375897.

Austria - Policies and tools for the protection of cultural property in case of disaster

Legal foundations

The Austrian legislation takes cultural protection into account at the constitutional level and through federal legislation. The Austrian Constitution (art. 10 para. 13) places the protection and legislative measures in connection with cultural heritage in the responsibility of the Federal government. The corresponding federal law, related to the valid version from 17. June 2013[37], is based on the Monument Protection Act[38]. This act includes a definition of the cultural heritage as well as the scope of cultural heritage, the assignment of responsibilities and legal protective measures and penal provisions. There are also numerous comments and regulations dealing with practical implementation of the law and the legally compliant handling of cultural assets.

Implementation

The Bundesdenkmalamt[39] (BDA) (Austrian Federal Monuments Office) is the specialist body that receives, protects, cares for and researches Austria's cultural heritage in the public interest and under the legal mandate. It was founded in 1853, as a central commission for the preservation of National Heritage Sites. Its actual duties include the preservation, restoration and cataloguing of immoveable cultural heritage. The BDA also monitors the export provisions of the Austrian monument protection act for moveable cultural heritage. The BDA is divided into one central bureau and nine regional offices. Furthermore, the BDA is organized in the following departments:

- Archaeology
- Architecture and Civil Engineering
- Movable Cultural Heritage
- Inventory and Monument Research
- Conservation and Restoration
- Special Materials
- Information and training for the preservation of historical monuments

The Austrian State Archives[40] is also dealing with conservation of cultural heritage, which is stated in a special law (since the year 2000), the “Federal Act on the Safekeeping, Storage and Use of Archival Holdings of the Federal Government” (Bundesarchivgesetz, BGBl. I 162/1999). The Austrian State Archives keep, index and conserve a highly valuable cultural heritage with rich archival records from more than 1,000 years of Austrian history, which is of importance to all of Europe.

37 https://www.ris.bka.gv.at/eli/bgbl/I/2013/92

38 »Bundesgesetz betreffend den Schutz von Denkmalen wegen ihrer geschichtlichen, künstlerischen oder sonstigen kulturellen Bedeutung (Denkmalschutzgesetz – DMSG)” dated 05. October 1923 (BGBl.533/1923)

39 https://bda.gv.at/

40 https://www.statearchives.gv.at/the-mission

The organization ICOMOS (International Council on Monuments and Sites) Austria[41] supports above mentioned authorities and other interested parties nationally or internationally with technical expertise.

Austrian Cultural Property

The National list of monuments (Österreichische Denkmalverzeichnis)

The BDA is keeping a list of protected objects in Austria in accordance with the Austrian Monument Protection Law (BGBl. 533/1923; BGBl. I 92/2013), which reported over 16,000 listed properties in Austria. Since then the data base is continuously expanded, and today, more than 38,000 immobile objects are listed. A list of mobile objects is still in process.

Table: Holdings of legally registered immovable property in 2017 (sources: BDA, Statistic Austria)

Category	By notification	By regulation	Total
Archaeological sites	858	60	918
Parks and Gardens	29	0	29
Secular buildings	13,912	9,394	23,306
Religious buildings	1,249	10,640	11,889
Technical monuments	1,395	609	2,004
All objects	17,443	20,703	38,146

Some Austrian provinces (e.g. Vienna, Upper Austria, and Tyrol) operate their own directories of cultural heritage. These lists also serve as a basis for updates of the national list.

The city of Salzburg is the only Austrian town which is explicitly protected by a provincial law (Salzburger Altstadterhaltungsgesetz, LGBl.[42] 50/1980).

International Conventions

Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict:

The Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict is the first international treaty that focuses exclusively on the protection of cultural property in armed conflict. It was signed in Hague, Netherlands on 14th of May 1954 and entered into force in Austria 1964 (BGBl. 58/1964).

[41] http://icomos.at/wordpress/

[42] Landesgesetzblatt (Province Law Gazette)

The Austrian list includes 135 individual objects, historical monuments and ensembles, as of July 2017. The protected cultural properties are marked with the characteristic Blue Shield. However, in this case there are no objective criteria available for their worthiness of protection.
The Austrian Society for the Protection of Cultural Property[43] promotes the protection of cultural property in the sense of The Hague Convention of 1954 and the two Additional Protocols. The association sees itself as a cooperation partner of the Austrian Armed Forces within the framework of civil society - military cooperation. Regarding the protection of cultural assets in the event of armed conflicts, terrorist threats, technical and natural disasters, the association sees itself as a cooperation partner of Austrian authorities or government organizations responsible for the protection of cultural property.

Convention Concerning the Protection of the World Cultural and Natural Heritage

In 1992, Austria joined the UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage[44]. To date, 9 cultural sites are inscribed on the World Heritage List. Recently, one of them, the Historic Center of Vienna, was moved onto the Red List due to a high-rise project in the immediate neighbourhood of the city center.

Other International Conventions

The Monument Protection Act also pushes the adoption and entry into force of the "The Valletta Convention" (24.7.2015, BGBl. 22/2015) and "The Faro Convention" (01.05.2015, BGBl. III Nr. 23/2015). In particular, by implementing the Faro Convention Austria complements and redefines the concept of cultural heritage within the legal framework by highlighting the social value it represents for people.

Cultural Heritage and natural hazards

Responsibility for combating, eliminating or mitigating the effects of natural hazards or disasters lies mainly with the Federal Provinces of Austria. The legal basis are the disaster relief laws of the Provinces, which primarily define the declaration of a disaster, management and organizational structure in the municipalities, counties and Federal Provinces. The term cultural heritage or its protection is not mentioned in these laws.

The spatial planning laws of the Federal Provinces, in which the protection of the population against natural hazards is listed among others, are also not referring to cultural heritage explicitly except for the Federal Provinces Burgenland, Salzburg and Styria.

Only the Water Law Act (BGBl. 215/1959, §42a(1)) following the Flood Directive[45] refers to cultural heritage in connection with the mitigation of flooding disasters (establishment of flood risk management plans for "regions with a potentially significant flood risk").

[43] Österreichische Gesellschaft für Kulturgüterschutz, ÖGKGS;
https://kulturgueterschutz.wordpress.com/oesterreichische-gesellschaft-fuer-kulturgueterschutz-oegks/
44 https://whc.unesco.org/en/conventiontext/
[45] DIRECTIVE 2007/60/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 October 2007 on the assessment and management of flood risks

Switzerland - Policies and tools for the protection of cultural property in case of disaster

In relation to the protection of cultural heritage in case of natural hazard, the Canton Ticino regional law has defined clear policies and measures which need to be undertake.

Two main documents regulate the protection of cultural heritage: the Law on the Protection of Cultural Property (of 13 May 1997, reviewed in 2007) and the related Regulation on the protection of cultural goods (2004).

In particular, the article 41 of the Law on the Protection of Cultural Property (1997) specifically indicates the responsibility, tasks and measures to undertake in case of natural disaster:

Art. 41
In the field of the protection of cultural property in the event of armed conflict or disaster, the Council of State:
(a) designate the department competent to take the measures provided for by federal law and ordinance;
(b) have an inventory drawn up of the cultural property to be protected;
(c) have shelters prepared for cultural property owned or entrusted to the State and finance the construction of shelters for other cultural property inventoried;
d) subsidises the protection measures taken by municipalities and private individuals in the same percentages as those laid down by federal law;
e) gives notice of subsidy applications to the Swiss Confederation;
f) in the context of civil protection and in cooperation with the municipalities, it organises the protection of cultural property and supervises the training of personnel involved in this task;
g) to record on microfilm or other support the security documentation relating to the inventoried assets.

This Cantonal Law on the Protection of Cultural Property (1997) has led to:

1. The **census** of all the cultural assets present in the territory of Ticino, organized by the Ticino Grand Council. The 2002 census led to the identification and cataloguing of around 120,000 movable and immovable property by the civil protection authorities.
2. The creation of the **Cultural Heritage Information System (SIBC)**, the informatics management system of cultural property for the exclusive use of the Cultural Heritage Office, the civil protection and professionals: https://www4.ti.ch/dt/dstm/sst/ubc/temi/inventario-dei-beni-culturali/inventario-dei-beni-culturali/inventario/sibc/
3. The creation of an **inventory** of cantonal and local assets to be protected in the event of a disaster. The inventory is based on the census data and collects all information on movable and immovable assets, identifies those worthy of conservation and promotes their protection. The inventory of cultural property in Canton Ticino contains administrative, land, descriptive, typological, scientific and geo-referenced information on the cultural property to be protected.

Only a small part of the inventory can be consulted online at the link https://www4.ti.ch/dt/dstm/sst/ubc/temi/inventario-dei-beni-culturali/consultazione/consultazione/.
The public available online inventory contains about 5000 properties of cantonal and local interest whose protection has already been established within a Cantonal Use Plan or Municipal Regulatory Plans.

Laws

- Legge federale sulla geoinformazione. del 5 ottobre 2007 (Stato 1° ottobre 2009). https://www.admin.ch/opc/it/classified-compilation/20050726/index.html
- Legge cantonale sulla protezione dei beni culturali (1997) https://m3.ti.ch/CAN/RLeggi/public/index.php/raccolta-leggi/legge/num/556
- Regolamento sulla protezione dei beni culturali (2004): https://m3.ti.ch/CAN/RLeggi/public/index.php/raccolta-leggi/legge/num/557

France - Policies and tools for the protection of cultural property in case of disaster

The current policies and regulations framework in France aimed to the cultural heritage safeguard from natural disasters, is based on the preservation of accessible memories of past events. As example, for the flood risk, the so-called "Loi Bachelot", act n° 2003-699 – article 42 – approved on the July 2003 provides for the compulsory placement of marks of maximum water level reached in the cities affected by floods.

Concerning the planning and preparedness of emergency rescue and recovery actions to safeguard the cultural heritage facing a natural disaster:

- the article 8 of Decree of September 13, 2005 for the "Organisation de la réponse de sécurité civile" foresees several common safeguard practices for coping to different types of hazardous events, among which those intended for "[…] the protection of property, cultural heritage and the environment";
- the act for the establishment of the natural risk prevention plans (PPRN), of the 22 July 1987, modified by the law 2 February 1995, shall draw up the implementation of operational rules and devices, to be defined within the scope of the specific territorial risk prevention plans. According to this disposal, the PPRN for the Rhone and Saone flood risk for the Metropolitan Area of Lyon in force up to 2009, includes the cultural heritage buildings among the special provisions related to the exercise of the public service mission. It obliges the responsible of public cultural structures to provide a detailed vulnerability analysis concerning the flood risk and operate the measures to reduce it at acceptable residual level, which is the one allowing the safeguard of the threatened heritage. This disposal was requested within 5 year from the entry into force of the aforementioned act.

Within the scope of this review, no mention has been found about private property cultural heritage.

An exhaustive state of the art concerning the actual natural disaster risk management of cultural heritage has been published by the "Comité Français du Bouclier Bleu" in 2013. The dossier "Pour un plan Patrimoine culturel et risques majeurs" (http://www.bouclier-bleu.fr/blog/2014/01/13/pour-un-plan-patrimoine-culturel-et-risques-majeurs/) highlights critical aspects and gaps for an effective safeguard of the cultural asset and introduces national and international best practices to improve the preparedness. It identifies the professional training at different levels and roles, as the most valuable tool to address regulatory and operational improvement concerning this issue, providing a detailed and structured training plan for civil servants involved in the cultural heritage management, disaster managers and first responders, and art conservation and restoration professional.

Policy implications and main messages

Policy implications and main messages

Natural hazards are persistently putting the cultural heritage of Alpine Space under pressure, with a daily incremental frequency. Such disasters and catastrophes compound the conservation challenges and needs of the heritage assets.

Planning, implementation and evaluation of heritage areas and its exposure to natural hazards is getting some positive momentum due to various EU projects (**see Annex**) that, among others, deal with heritage management issues. Although many projects are dealing with wider geographical regions, not Alps solely, their knowledge can be transposed (in some cases) to Alpine regions. Of course, we must avoid mistakes made by this kind of generalizing.

Only few of the abovementioned projects dealt solely with situation in the Alps, which indicates that Alpine area, although a place of frequent natural disasters, is not receiving attention, which it obviously deserves. Few projects pilot areas were located in the Alps (SAMCO, PECO…), others had more EU perspective.

Legislation in EU level has some common points all over EU, but in view of Alps countries have different approaches and levels of understanding of complexity of occurrence natural hazards and vulnerability of cultural heritage.

Project countries do have homogeneities in both natural hazards and cultural heritage assets. The main differences between project countries are related to the existing rules/laws and governance during the lead time activities, which produce different procedures and practices in emergency and preparation in peace time.

The main messages we wish to pass to policy makers:

Some types of natural hazards are occurring more often in area of Alpine area (e.g. ice storms, landslides, hail and strong winds), which indicates where to put research and development focus in terms of either prevention or mitigation of damage on cultural heritage.

The scientific research on cultural heritage and natural hazards is not tightly connected issue in research process.

Environmental issues are considered, in general, something “detached” from historic buildings and urban components, so the interventions on this sort of goods can usually disregard the environmental prescriptions, in order to “don’t alter” the historic material substance of the building.

Annexes

List of annexes

A. guidelines for administering the survey,
B. list of research projects, policy documents, initiatives and studies.

ANNEX A - GUIDELINES FOR ADMINISTERING THE SURVEY

prepared by Anže Japelj | Slovenian Forestry Institute | October 2018

Relevant information from the Application Form

Description of the activity and deliverables (from AF, p. 44)

A capitalization process framing the state in the definition of the concept of Alpine cultural heritage, in relation to the specific environment where it developed and the natural hazards it is exposed to in the Alps. A review of previous project results, initiatives, strategic documents from the Alpine area and analogous regions, integrated with inputs from relevant sources at national and transnational level (e.g. expert interviews) (major contributions PP SFI, UCSC, BRGM, CUDHg Idrija, AIT, RCC).

Deliverable D.T1.1.1

Review and survey for a framework analysis on Alpine cultural identity and natural hazards

All PP will contribute to a preliminary analysis on versions and approaches to the theme of Alpine cultural heritage with initial evaluations, supported by analysis in past disaster occurrences, on its exposure to natural hazards.

The link between A.T1.1 and other project activities

Action T1 is heavily related to T2, especially in terms of setting a common empirical framework. Terminology and basic concept need to be harmonized in order to provide results relevant for all project activities, which can then be cross-linked and utilized consistently – e.g. activity A.T2.1 is to provide an overview of hazard mapping/assessment methodologies within the Alpine area, which will be already investigated within A.T1.1. The latter activity is also related to A.T1.2, which is to provide a conceptual tool for evaluation of cultural assets – this will also be addressed in this review by investigating previous research and projects.

Instructions for completing the A.T1.1 review

First, we set the empirical framework of the investigation, which defines the scope of the review and then we list all information sources, where data on CH and related NH in Alpine area are to be found.

The empirical framework

The review should relate to (also relates to definitions sent by AIT):

- tangible CH, which can be either mobile or immobile,
- the assets within the Alpine area,
- the asset actually/potentially subjected to one of NH,
- aspects of
  - assessing the likelihood of NH, or
  - assessing the vulnerability of CH, or

- mitigating the effects of NH, or
- rescue and evacuation, or
- safe storage of CH.

These are the aspects that set criteria, which limit the scope we are investigating within the review. Below, types of data sources needed to consider when gathering information on CH in Alpine area are defined.

Data sources

According to the AF, the review is partitioned into five sections (i.e. Excel sheets in the attachment you got with your e-mail), as one for:

- projects,
- research studies,
- strategies,
- initiatives, and
- showcase interventions.

Projects cover research or implementation activities funded by various sources and are commonly policy driven, meaning that they are related to implementation of either international (EU), regional (alpine area) or national policies. Partners are advised to investigate past or ongoing project from several different funding programmes like Interreg (Alpine Space, Danube, Central Europe, Bilateral projects …), Horizon 2020, IPA, LIFE, JPI, Euro. Investment Fund, Euro. Regional Development Fund, Euro. Social Fund, etc.

A preliminary list of projects has been provided (from a recent EC study), so please add if needed. Additional (complete) information will be input by SFI.

Research studies are commonly either very problem-focused and detailed or smaller than projects in terms of activities. Studies can be master/PhD thesis, specially-designated assignments from the ministries/government focusing only on a specific aspect of CH-NH relation, etc. Research studies are usually done by smaller groups – can be only one organisation/person.

Strategy is the approach you take to reach your objectives, while **initiatives** are action items guided by the strategy that you undertake to achieve your objectives.[46]

Showcase interventions are activities done specially to represent an event/drill on how to prevent a negative effect of NH on CH, how to act in case of NH, to show which institutions are responsible, and to transfer know-how among stakeholders.

[46] http://www.answers.com/Q/What_is_the_difference_between_initiative_and_strategy

ANNEX B - LIST OF RESEARCH PROJECTS, POLICY DOCUMENTS, INITIATIVES AND STUDIES

PROJECTS

Projects marked grey are not directly related to the topic of the project CHEERS, but they contain elements that are good for interpreting some content of project CHEERS.

Project name	Web site	CH types	Effective area	Aim	Means	Results	Evaluation methodology	NH
JPI-CH PROTection of European Cultural HEritage from GeO-hazards (2015-2018)	http://www.prothego.eu/	Tangible cultural heritage (various categories of monuments and sites, from cultural landscapes and sacred sites to archaeological complexes, individual architectural or artistic monuments and historic urban centers).	Italy, Spain, UK, Cyprus	Conservation/restoration. A new space technology based on radar interferometry, for the monitoring of vertical deformation of monuments and sites settled on natural hazards prone areas on 400 UNESCO sites.	Providing new information on novel space technology based on radar interferometry (InSAR) to monitor monuments and sites in Europe which are inscribed on UNESCO's World Heritage List.	Restoration of cultural heritage. Production of new tool and a new, low-cost methodological approach for the management of sites and world heritage monuments located throughout Europe, using specialized remote sensing techniques.	The role of satellite monitoring to detect geohazards and their impact on cultural heritage.	Landslides, sinkholes, settlement, subsidence, active tectonics as well as structural deformation.

Project name	Web site	CH types	Effective area	Aim	Means	Results	Evaluation methodology	NH
FP7 NEW INTEGRATED KNOWLEDGE BASED APPROACHES TO THE PROTECTION OF CULTURAL HERITAGE FROM EARTHQUAKE-INDUCED RISK (2010-2012)	http://www.niker.eu/	Built environment (buildings, townscapes, archeological remains) Artefacts (objects)	Europe and its neighboring countries LAU level 1, formerly NUTS level 4	Multidisciplinary approach for the development of innovative materials and systems for low-intrusiveness, compatible interventions. Developing and validating complete and diversified innovative technologies and tools for systemic improvement of seismic behavior of CH assets.	Providing new information Change in management system	Creation of a new structured database that links earthquake induced failure mechanisms, construction types and materials, interventions and assessment techniques; Experimental validation of the envisaged technological solutions for vertical and horizontal structural elements; Experimental quantitative characterization of the behavior of connections before and after strengthening; Development of test setups and testing strategies for sub-assemblies and experimental characterization of the seismic behavior of original substructures and substructures strengthened with integrated interventions by shaking table tests; Integration, validation and assessment of intervention techniques by experimental evaluation of overall seismic response of model buildings on shaking table; Development of advanced materials and improved techniques for intervention on vertical and horizontal structural elements; Development of innovative intervention techniques for connections and of strengthening elements able to dissipate seismic energy; Calibration of innovative measuring devices or systems, including embedded instruments in dissipative devices, on laboratory specimens and subsequent on-site application on real case studies; Implementation of the project results into guidelines for an integrated applicability of the proposed methodologies and subsequent transfer into codes of practice and standards		Earthquakes

Project name	Web site	CH types	Effective area	Aim	Means	Results	Evaluation methodology	NH
FP7 Climate for Culture Project (2009-2014)	https://www.climateforculture.eu/	Built environment (buildings, townscapes, archeological remains)		To identify the damage potential of our cultural heritage most at risk, so as to encourage the development of strategies to mitigate the effects of climate change, including through policy makers and the Intergovernmental Panel on Climate Change (IPCC) reports. Furthermore, the project provides insight into the possible socio-economic impact of climate change, given the importance of cultural heritage to Europe's economy.	Providing new information (climate change modelling a developing decision support software for managers); change in management system	The main innovation of the project is to use simulation and modelling tools to better predict the influence of the changing outdoor climate on the microclimate in historic buildings until 2100, and to assess the damage potential of these future microclimates on art collections in various climate zones. For the first time ever, regional climate models with a high resolution of 10x10 km are therefore being developed and coupled with whole building simulation tools to identify the most urgent risks for specific regions.	Various types of historic buildings located in different climate zones and from different time periods are investigated concerning the behavior due to weather changes and different utilization.	Climate change
FP7 European Cultural Heritage Identity Card (2009-2012)	https://cordis.europa.eu/result/rcn/159555_en.html	All	Europe and its neighboring countries LAU level 1, formerly NUTS level 4	To propose a strategy, and systems for the most efficient methods and tools of harmonizing criteria and indicators to track changes and interventions on the tangible cultural heritage across Europe and its neighboring countries	Providing new information, creates the capability to monitor, and systematically report on, various human and natural impacts on the physical state of that heritage, and assist in the provision of the most relevant and economic choices for effective preventive conservation	More effective stewardship; improving entrepreneurship potential; enforced participation from the public: development of indicators and criteria for assessing resilience of cultural heritage and for prioritization of preservation		All (but the focus is not really on natural hazards, as much as it is on identification and monitoring of CH)

Project name	Web site	CH types	Effective area	Aim	Means	Results	Evaluation methodology	NH
JRC Enlargement action within the FP6 "Management of Natural and Technological Risks" (2003)	https://minerva.jrc.ec.europa.eu/EN/content/minerva/e7876bf1-ed38-4611-a9d7-1dbbb2479c62/peco_report_2002	Technological Hazards: hazardous installations contaminated lands pipelines oil shale mining transboundary pollution transport of dangerous goods Natural Hazards: floods forest fires landslides earthquakes	JRC EU countries	Risk management of hazardous installations. Collection and Analysis of Existing Data and Information. Creation of Regional and National Information Systems. Development of Risk-Based Screening Tool for Prioritizing Intervention.	To establish information management tools that would reflect hazard identification and analysis priorities of the region, or common to a number of countries within the region.	Progress in Seveso Implementation for PECO countries and Further Technical Support Requirements, including Risk Assessment		Floods, forest fires, landslides, earthquakes
FP6 Risk Mitigation for Earthquakes and Landslides (2004-2007)	https://cordis.europa.eu/project/rcn/74272_en.html	Built environment (buildings, townscapes, archeological remains)	Many European Centers of excellence	(i) instrumentation and monitoring, (ii) methods and technologies to reduce vulnerability, (iii) innovative approaches for design/assessment and (iv) disaster scenarios and loss modelling.	Coordinated action that embraces a wide range of organizations and disciplines	New information	Development of innovative methods and approaches to design and assessment of structures and earth slopes for both short- and long-term implementation, the development of advanced monitoring techniques and devices, and the development, manufacturing and testing of innovative isolating and dissipating seismic devices.	Landslide, earthquake

Project name	Web site	CH types	Effective area	Aim	Means	Results	Evaluation methodology	NH
FP5 Fire risk evaluation to European cultural heritage: quantification of priorities and optimization of fire protection strategies (2002-2005)	http://www.framemethod.net/indexen_20.html	Built environment (buildings, townscapes, archeological remains) Artefacts (books and documents, objects, pictures and paintings)	Belgium; United Kingdom; Portugal; The Netherlands; France; Germany; Aristotle University of Thessaloniki (AUTH), Greece	The financial resources available for the fire protection are limited and priorities need to set by authorities and owners of cultural heritage. Actually, no scientific tool is available to assist in the decision process. A quantitative decision method will be developed, able to prioritize between series of projects based on parameters such as value of cultural heritage, fire risk, the protection methods available - their cost and efficiency. As input to this decision method, a valuation method and risk analysis method based on statistical data on fire damage in cultural heritage will be developed. Fire protection methods will be examined on their efficiency, cost and applicability on cultural heritage.	Providing new information. FiRE-TECH was a thematic network of European fire protection experts and practitioners. The aim of the project was to evaluate the risk that fire poses to our cultural heritage and to suggest methods by which that risk can be quantified and managed using the systems and components that are currently available	Analysis of national fire event regulatory framework; Analysis of causes of past fires, Fire performance of ancient materials, Existing fire safety technologies and products, Development of a quantitative decision model/method (with a review of already existing approaches).	A mathematical method of optimization has been established. The advantages and limits of basic existing optimization methods of different kinds (functional optimization, multivariance analysis, hierarchy analysis...) have been examined and a hierarchy method chosen. Two programmes, ALADIN and IST-Cost/Efficiency sheet have been elaborated on 11 cases. A users guide provides the description of the retained methods and gives the information necessary for practical utilization of the computer programme. An overview of different methods for fire hazard quantification have been presented.	Fire

Project name	Web site	CH types	Effective area	Aim	Means	Results	Evaluation methodology	NH
Cultural heritage protection against Flood FP6 (2007-2009)	https://opus4.kobv.de/opus4-bam/frontdoor/index/index/docId/38546	Built environment (buildings, townscapes, archeological remains)	Very local (an object)	Objectives: -Classification of moveable and immovable cultural heritage e to their vulnerability to flood -Analysis of damage processes in different materials, structures and sites -Verification of methods and sensors for non-destructive testing and monitoring of material and structural parameters - Definition of threshold levels for exposure and damage -Analysis of preventive and temporary (emergency) measures -Assessment of restoration and repair techniques -Assessment of case studies -Definition of strategies	For avoiding or mitigating flood-related damage of cultural heritage, a multitude of aspects has to be considered, like historic significance and context of the object, building structure and its location in risk areas. But also, technical problems like lack of documentation, unspecified structural condition and assembly, unknown material characteristics and parameters of exposure require intense investigations.	A comprehensive analysis (and a book) of protective measures BEFORE, DURING and AFTER a flood has been carried out within the project, including technical and administrational measures. An overview of these measures is given, followed by recommendations on how to establish the most effective protective strategies.	Case studies	Flood

Project name	Web site	CH types	Effective area	Aim	Means	Results	Evaluation methodology	NH
Risk assessment and sustainable protection of cultural heritage in changing environment (2017-2020)	https://www.interreg-central.eu/Content.Node/ProteCHt2save.html	Cultural heritage sites, structures and artefacts; movable cultural heritage; material and immaterial cultural heritage	Very local	Raising awareness; preparation of evacuation plans, natural risks	Providing new information; change of legislation; change in management system	More effective stewardship. ICT solutions (web-based inventory and maps) and tools (decision support tool, best practices manual, handbook on transnational rescue procedures) for risk management and protection of cultural heritage in central Europe. Pilot actions will test the approach and tools in risk prone areas and areas with cultural heritage vulnerabilities to improve the existing disaster risk management plans and policies in municipalities. Input to adaptation policies of government organizations thereby promoting improved strategies and plans for the protection of cultural heritage will be ensured as major impact. By the achievement of the planned objectives, ProteCHt2save is expected to proactively target the needs and requirements of stakeholders and policy makers responsible for disaster mitigation and safeguarding of cultural heritage assets and to foster the active involvement of citizens and local communities in the decision-making process.	Project still running	Floods and heavy rain
Map of exposure to the seismic hazard of protected sites and monuments and the Museums of France in the PACA region (2010)	http://www.iitk.ac.in/nicee/wcee/article/0632.pdf http://www.paca.developpement-durable.gouv.fr/	Protected historical monuments and museums of France	Region PACA	Identify the regional cultural heritage exposed to seismic hazard	Cartography	Regional map	Mapping	Seismic events, earthquake

Project name	Web site	CH types	Effective area	Aim	Means	Results	Evaluation methodology	NH
Knowledge and Enhancement of Historical Centers and Cultural Landscapes in Alpine Space (2000-2006)	http://www.alpine-space.org/2000-2006/index-2.html	Movable and immovable cultural heritage	Pilot areas	The aims of the project are to protect and enhance that common heritage, improving the knowledge on characteristic features of historical alpine settlements and promoting integrated sustainable policies for interventions, taking into account different aspects of cultural, historical, social, economic and environmental identity, according to the spatial and economic context.	1) cataloguing and cartographic representation (data bases, Geographic Information Systems) of Alpine Cultural heritage components, based on harmonized methods; 2) defining harmonized analytical methods to evaluate strengths and weakness (SWOT analysis); 3) promoting pro-active policies to protect and enhance cultural heritage components (best practices, guidelines); 4) spreading out positive experiences and supporting integrated policies using information society technologies.	http://www.alpine-space.org/2000-2006/temp-results117.html#1353	1. STR model (State, Trend, Response Indicators - shared indicators) 2. SWOT Matrix 3. Suitable sustainable intervention policies. The operational tools aim to preserve, pass on and promote our heritage in its full diversity while respecting its authenticity.	All
Global Climate Change Impact on Built Heritage and Cultural Landscapes (2009-2011)	https://www.ucl.ac.uk/bartlett/heritage/research/projects/project-archive/noahs-ark-project	Built cultural heritage	EU	A strategic overview of the changing pressures on heritage rather than examining individual monuments. The results cover a wide geographical base and are presented as a vulnerability atlas for Europe and accompanying management guidelines.	Providing new information. Change in management system.	Atlas involves ('The Atlas of Climate Change Impact on European Cultural Heritage Scientific Analysis and Management Strategies'): Climate maps; Heritage climate maps; Damage maps; Risk maps and Thematic pages.	Atlas, which provides a number of climate damage and risk maps on various materials. atlas contains also guidelines which provide a management context to the scientific findings.	Climate change (rising sea levels, increased rain and floods)

Project name	Web site	CH types	Effective area	Aim	Means	Results	Evaluation methodology	NH
Built Heritage: Fire Loss to Historic Buildings (2002-2006)	https://www.cost.eu/actions/C17/#tabs|Name:overview	Built environment (buildings, townscapes, archeological remains)	EU	Proposal of remedial actions and recommendations to combat such loss, using minimal invasive techniques	Providing new information Change of legislation Change in management system	Optimizing fire detection methods and developing fire-fighting strategies. The final objective is to protect human health and life, to conserve cultural heritage and to prevent material loss in general. The second area of interest was method-oriented and aimed to develop or to improve the different scientific (engineering and physics) tools.	Definition (at European level) of the degree of loss to the Built Heritage to the effects of fire and for the proposal of remedial actions and recommendations to combat such loss, using minimal invasive techniques. The programme has served to promote the use of data, methodologies and management systems to assist a broader clientele achieve a necessary balance between fire engineering needs and conservation requirements to assist in the future preservation of the European built heritage.	Fire.
Society Adaptation for coping with Mountain risks in a global change Context (2013-2016)	http://www.agence-nationale-recherche.fr/Project-ANR-12-SENV-0004	Natural environment (rural landscapes, coasts and shorelines, agricultural heritage)	Local to regional, Alps	A conceptual and methodological approach to define how the resilience capacity of local mountain communities confronted with natural hazards and disasters can be characterized and measured, taking into account potential exacerbation of the hazards/risks due to global change	Providing new information Change in management system	Conceptual and methodological approach to define how the resilience capacity of local mountain communities confronted with natural hazards and disasters can be characterized and measured, taking into account potential exacerbation of the hazards/risks due to global change	Combine different techniques, methodologies and models (multi-hazard assessment, risk evolution in time, vulnerability functional analysis, and governance strategies) and gather various interdisciplinary expertises in earth sciences, environmental sciences, and social sciences.	Landslides, rockfalls, floods due to climate changes

Project name	Web site	CH types	Effective area	Aim	Means	Results	Evaluation methodology	NH
Flood Risk Assessment and mitigation for Masonry Arch Bridges (2015-2017)	https://cordis.europa.eu/result/rcn/219939_en.html	Artefacts (built bridges)	EU	Defining a flood risk assessment framework for masonry arch bridges combining a realistic description of the hazard (probability of exceeding a given flood discharge) with an accurate assessment of the structural vulnerability (probability of exceeding a given damage level in the bridge components for a flood with a given intensity).	Providing new information. Change in management system.	The modelling strategy proposed within the FRAMAB. The flood risk assessment framework developed within the FRAMAB.	A modelling strategy has been defined for simulating the effects of scour and of other flood-induced actions the proposed strategy employs the nonlinear structural analysis code ADAPTIC development of probabilistic framework for flood risk assessment analysis	Flood
UNDERWATER EXPLORER FOR FLOODED MINES (2016-2020)	https://www.unexmin.eu/	Built environment (flooded mines)	Very local on many pilot areas over EU and UK - flooded mines	Conservation/restoration, afterward tourism and raising awareness.	Money (investment) and providing new information.	Restoration of cultural heritage. To develop a submersible robotic system for non-invasive 3D mine mapping for gathering valuable geological, mineralogical and spatial information on flooded mines.		Floods

Project name	Web site	CH types	Effective area	Aim	Means	Results	Evaluation methodology	NH
The Material Cultural Heritage as a Strategic Territorial Development Resource: Mapping Impacts Through a Set of Common European Socio-economic Indicators (2018-2019)	https://www.espon.eu/cultural-heritage	Material c.h.	EU	The main outcome should be a common theoretical framework, defining the most important economic sectors on which the material cultural heritage has an impact and developing the empirical evidence of such impact	Step-by-step plan on how to build a monitoring system in the stakeholder countries that includes all actions necessary to obtain and maintain data for the defined impact indicators in the future	A common theoretical framework defining the economic sectors on which material cultural heritage has an impact. A common methodological framework describing how to determine the impact material cultural heritage has on these economic sectors. Evidence (collected data and set of indicators) on the economic impact of cultural heritage in stakeholder territories / regions over the past 5 years (for example e.g. cultural heritage-related gross value added in tourism, construction, etc.). Step-by-step plan on how to develop a monitoring system (at the territorial level) to be used in the stakeholder countries, that includes all actions necessary to obtain data of the defined socio-economic impact indicators, building time series and checking and reporting the status of the indicators on a regular basis. It should also include an operational description of the data generating and reporting procedures,	See documentation	
INTEGRARTE (closed)	https://www.vallesusa-tesori.it/it/progetti/integrarte	Movable and immovable cultural heritage	Very local:	Improvement of fruition of museums and such, through the implementation of technologies and local economic strategies		Valle Susa Heritage mobile app, interacting with Bluetooth low-energy beacons which activate an information transfer for fruition (some dedicated to disabled people)	Possibly, as they have assessed the income generation potential of local collections	

Project name	Web site	CH types	Effective area	Aim	Means	Results	Evaluation methodology	NH
Prevention, Analysis and Tools for Cultural Heritage (2012)	http://www.promedhe.eu/2017/03/27/p-a-t-c-h-prevention-analysis-and-tools-for-cultural-heritage-guidelines-protocols-and-procedures-for-the-rescue-of-cultural-heritage-items-during-seismic-events/	Built environment (buildings, townscapes, archeological remains) Artefacts (books and documents, objects, pictures and paintings)	EU	Guidelines, protocols and procedures for the rescue of cultural heritage items during seismic events.	Providing new information	Guidelines, protocols and procedures for the rescue of cultural heritage items during seismic events	Guidelines for the creation of protocols and procedures on how to intervene on cultural heritages in case of earthquake events organization of training courses on the protection of cultural heritage during earthquakes, the web historical geomap of the earthquakes	Earthquake
Protecting Mediterranean Cultural Heritage During Disasters (2016-2018)	http://www.promedhe.eu/	Movable and immovable cultural heritage	Transnational effect	Entrepreneurship, common approach and methodology (a. reinforce collaboration among their national civil protection authorities; b. developing tools and assets to improve cultural heritage safeguard)	Change in management system (creating national pools of experts able to work jointly at both national and regional level, reinforcing capacities and procedures)	A pool of experts capable of operating during emergencies at regional and national level. Disaster management governance, vulnerabilities, capacities and needs assessment, assessment and technique of cultural heritage safeguard in early response, assets development, capacity development and training methodologies	Organization of training courses focused on the protection of cultural heritage during emergencies, elaboration of Standard Operating Procedures (SOPs) for civil protection assets, simulation/train the experts and test the SOPs developed in the previous phases at regional and international level	Earthquake, flood, landslide, fire

Project name	Web site	CH types	Effective area	Aim	Means	Results	Evaluation methodology	NH
Safeguarding Cultural Heritage through Technical and Organizational Resources Management (2016-2019)	http://www.storm-project.eu/	Immobile CH	Regional and Local Level (Italy, Greece, Portugal, UK, Germany, Austria, Turkey)	Critical decision-making tools to all European Cultural Heritage stakeholders charged to face climate change and natural hazards	New predictive models and improved non-invasive and non-destructive methods of survey and diagnosis, for effective prediction of environmental changes and for revealing threats and conditions that could damage cultural heritage sites.	STORM integrated platform delivers a set of applications and services for the protection by climate changes and extreme weather events	Use of 3D imaging system to improve damage restorations gamification techniques and crowd-sourcing for collecting information about cultural heritage decision making system using Deep Learning for earthquake prediction by means of electromagnetic precursors 3D computational model using the finite element method was created from the PC data and structural analyses were conducted to investigate the theatre vulnerability by using collected seismic data from the site a numerical simulation by generating the Finite Element Model of the structure (before the earthquake) /structural health monitoring system quick and effective method for structural identification and assessment of the current state of the structures (after an earthquake), collaboration and knowledge sharing platform	Natural or climate change-caused disasters (floods, earthquakes, storms, tornados, fires…)

Project name	Web site	CH types	Effective area	Aim	Means	Results	Evaluation methodology	NH
Seismic protection of historical buildings by reversible mixed technologies	https://cordis.europa.eu/result/rcn/51903_en.html	Built environment (buildings, townscapes, archeological remains)	Local objects, South European and Mediterranean area	Seismic protection of historical and monumental buildings. Develop sustainable methodologies for the use of reversible mixed technologies in the seismic protection of existing constructions, with particular emphasis to buildings of historical interest. Reversible mixed technologies exploit the peculiarities of innovative materials and special devices, allowing ease of removal if necessary. At the same time, the combined use of different materials and techniques yields an optimization of the global behavior under seismic actions. The endpoint of the research was a proposal of codification for the use of such technologies in the seismic protection of existing constructions.	Money (innovation, not investment) Providing new information on new materials.	Improvement of building seismic performance by means of 'reversible mixed technologies'. promoting the use at a wide scale of reversible and environmentally friendly technologies, in order to fit existing constructions with easily removable and modifiable seismic protection systems; Supporting the adoption of 'smart' materials and special techniques for the seismic protection of constructions as a cheap and effective alternative to traditional, highly intrusive strengthening methodologies, especially when historical constructions are faced; Advancing the state-of-the-art in the field of seismic protection of constructions, by adding new information about the behavior of structures fitted with special systems and/or using advanced materials or devices for improving the seismic performance; Allowing engineers to use simple and reliable tools for analyzing the behavior of constructions provided with advanced systems for seismic protection, as well as for detailing up-grading interventions; Developing advanced, PBD-complying guidelines for the practical application of innovative materials and technologies in the field of seismic restoration.	The individuation of innovative materials and devices on the basis of their mechanical features, in order to select suitable materials for creating both strengthening systems and special devices aimed at the optimization of the structural behavior. Providing the information necessary to the proper use of innovative materials and mixed technologies in strengthening interventions, as well as the definition of special systems for seismic protection to be applied to existing buildings.	Earthquake

Project name	Web site	CH types	Effective area	Aim	Means	Results	Evaluation methodology	NH
FP7 Performance-based approach to the earthquake protection of cultural heritage in European and Mediterranean countries (2010-2012)	https://cordis.europa.eu/project/rcn/93579/reporting/en	- Arsenal de Milly, Neoclassical School, Hassan Bey's Mansion (Rhodes, Greece); - Casbah of Algiers, Great Mosque of Algiers (Algiers, Algeria); - Ardinghelli Palace, Santa Maria Paganica Church (L'Aquila, Italy); - St. Pardo Cathedral (Larino, Italy); - Bovec Region - rural architecture, Old City Centre, Kolizeij Palace (Ljubljana, Slovenia);	Local level (building) or district level within a city	Natural risks	Provide new information	- typology classification of cultural heritage types (taxonomy) - damage classification matrix - vulnerability functions of some structures to seismic hazard - investigation of reinforcement measures	Seismic vulnerability analysis	Earthquakes
The European project ResCult ("Increasing the Resilience of Cultural Heritage: A Decision Support Tool for the Safeguarding of Cultural Property") (2017-2018)	https://www.rescult-project.eu/ https://www.sdis04.fr/projets-europeens/rescult/	Artefacts (books and documents, objects, pictures and paintings) of the museum	Very local: the museum	Conservation/restoration	Creation of an additional criterion based on FLORA	More effective stewardship, elements to priories collections dans to make an emergency plan	The drivers for evaluation: identity, historical value by SDIS 04 and Museum	Natural disasters (floods, earthquakes, fires…) man-made threats (terrorism, vandalism, armed conflicts…)

Project name	Web site	CH types	Effective area	Aim	Means	Results	Evaluation methodology	NH
L'eredità culturale nelle collezioni fra Alpi e Carso (2012-2015)	http://zborzbirk.zrc-sazu.si/it-it/home.aspx	Material and immaterial	Val Canale, Resia, Valli del Natisone e Torre on the italian side; Gornjesavska dolina, Tolminsko, Kambreško, Lig in Brda on the slovenian side	Valorization of local cultural heritage and languages	On-field assessment, survey, cataloguing, recording, set-up of collections, valorization through communication		Not clear, probably only catalogues and recordings, plus local exhibitions	
TRASMETTERE RICERCA ARCHEOLOGICA NELLE ALPI DEL SUD (2017-2018)	http://www.interreg-alcotra.eu/it/decouvrir-alcotra/les-projets-finances/traces-trasmettere-ricerca-archeologica-nelle-alpi-del-sud	Immovable cultural heritage object	Pilot areas: ALPI DELL'ALTA PROVENZA, ALPI MARITTIME, CUNEO	Integration of the most relevant archeological sites from prehistory to middle-age in the trans-boundary area			No	

Project name	Web site	CH types	Effective area	Aim	Means	Results	Evaluation methodology	NH
P.A.T.C.H. – Prevention, Analysis and Tools for Cultural Heritage	http://www.montesca.it/patch/index.asp?lang=EN	Mobile, immobile CH	Provincia di Perugia, Municipality of Heraklion, Crete	Development of Guidelines on Earthquake risk management and Tools for increase of the effectiveness of CH rescue operations	Creation of a cooperative network	Geomap (web) Best practices report cards	Not aailable	Earthquake

STUDIES

Author	Title	Reference	CH types	Effective area	Aim of the study	Type of study	Methodol-ogy	Results	NH
Adamič, Tatjana	Ocena poplavnega škodnega potenciala nepremične kulturne dediščine	link	All types	Whole country	Natural risk	Qualitative	GIS risk analysis	Potential risk assessment	Floods
Erhartič, Bojan Jelenko, Ida	Vpliv naravnih nesreč na naravno in kulturno dediščino	link	Bolnica Franja	Local	Natural risk, conservation/restoration	Qualitative	Damage assessment	narrative description of the disaster event	Torrential flows
Peršolja, Igor	Obnova, rekonstrukcija in zaščita objektov Partizanske bolnišnice Franja po katastrofalnih poplavah leta 2007	link	Bolnica Franja	Local	Conservation/restoration	Qualitative		narrative description of reconstruction	Torrential flows
ICCROM and the Prince Claus Fund	First Aid to Cultural Heritage in Times of Crisis	link	Mobile and immobile CH	Very local and regional scale	Developed to answer to the increasing need for cultural heritage professionals and humanitarians alike to have a reliable and user-friendly reference that integrates heritage safeguarding into emergency and recovery activities, offering standard operating procedures that are applicable in almost any crisis context.		Handbook and Toolkit is the outcome of nearly a decade of field experience.	Step-by-step instructions and real-life case examples. It walks readers through the three phases of cultural heritage First Aid – (1) situation analysis; (2) post event, on-site damage and risk assessment; (3) security and stabilization, which collectively lead to early recovery.	

Author	Title	Reference	CH types	Effective area	Aim of the study	Type of study	Methodology	Results	NH
Charline Lamarche	Cartography of cultural heritage and risks in Rhone-Alpes	http://www.bouclier-bleu.fr/ comité français du Boulcier Bleu - Blue shield	Built environment (building-s), artefacts (books and documents, objects, pictures and paintings)	Rhône-Alpes	conservation/restoration and natural risks	Quantitative	GIS risk analysis, study internship, request of the CFBB, financing Ministry of environment	Cartography and statistics	Flood, earthquake
Bevölkerungsschutz Bundesamt für Bevölkerungsschutz	Bevölkerungsschutz: Risikomanagement	https://www.bbk.bund.de/SharedDocs/Kurzmeldungen/BBK/DE/2012/Neue_Ausgabe_BevSch_Magazin_4_12.html		DE	raising awareness; natural risks	qualitative and quantitative	expert assessment; multi-criteria analysis	integration of multiple players is needed	climate change and floodings
World Bank	Promoting Disaster Resilient Cultural Heritage	http://documents.worldbank.org/curated/en/696061511882383371/Promoting-disaster-resilient-cultural-heritage	built environment	Global	disaster resilience; strengthen risk management	quantitative	multi-criteria analysis, expert assessment	Disaster Preparedness	every NH
Will, Thomas; Lieske, Heiko	Flood Protection for Historic Sites Integrating Heritage Conservation into Flood Control Concepts	https://katalogbeta.slub-dresden.de/id/0017273847/	built environment	DE, DEE0, DED5, GDEG0	flood protection	qualitative and quantitative	expert assessment, gis modelling	integration of flood security in CH	flooding
European Parliament's committee on Culture and Education: Policy Department Structural and Cohesion Policies	PROTECTING THE CULTURAL HERITAGE FROM NATURAL DISASTERS	http://www.europarl.europa.eu/thinktank/en/document.html?reference=IPOL-CULT_ET(2007)369029	built environment	EU	coordination and effective protection		economic valuation, multi-criteria analysis	Disaster Preparedness	every NH

Author	Title	Reference	CH types	Effective area	Aim of the study	Type of study	Methodology	Results	NH
Vereinigung der Landesdenkmalpfl eger in der Bundesrepublik Deutschland	Prevention, care, maintenance. Recommendations for the repair of monuments and their equipment	https://www.vdl-denkmalpflege.de/veroeffentlichungen.html	Artefacts	_	Raising awareness, solution against NH in the object itself	_	Multi-criteria analysis	Prevention	Fire, heavy rain
Wagner, Klaus; Suda, Michael	NATURAL HAZARDS IN THE PERSPECTIVE OF THE POPULATION - A BIG BLACK BOX	http://www.interpraevent.at/?start=1300&tpl=publikation_detail.php&id=1&menu=&search_text=&search_art=&order_by=	Built environment	DE21	Communication strategy and awareness	Qualitative	Expert assessment, multi-criteria analysis		Mainly flooding
Konferenz nationaler Kultureinrichtungen	Culture! Good! Protect! Security and civil protection for museums	http://www.konferenz-kultur.de/projekte/Publikationen.php	Built environment	DE91, DE21	Communication strategy and awareness; minimal forms for security	Qualitative	Expert assessment, multi-criteria analysis	Prevention	General
Matija Zorn, Blaž Komac, Massimiliano Moscatelli	Enhancement of Cultural Heritage through Environmental Planning and Management: CHERPLAN	http://www.southeast-europe.net/en/downloads_section/programme_related_documents/ https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=2ahUKEwiK3fb--JzfAhXCzqQKHUFTD00QFjAAegQIExAC&url=http%3A%2F%2Fwww.southeast-europe.net%2Fdocument.cmt%3Fid%3D809&usg=AOvVaw2TpFR5gkk-vTR9yAeBSfAEChapter 5.12	Artefacts, built environment	SI, EL, ….	Coordination and disaster resilience	_	GIS, expert assessment	Disaster Preparedness	General
José Luiz Pedersoli Jr., Catherine Antomarchi, Stefan Michalsk	Guide to Risk Management	https://www.iccrom.org/publication/guide-risk-management	Artefacts, built environment	Global	Coordination and disaster resilience	Quantitative	Multi-criteria analysis	Risk management	General
Stovel, Herb	Risk Preparedness: A Management Manual for World Cultural Heritage	https://www.iccrom.org/publication/risk-preparedness-management-manual-world-cultural-heritage	Built environment	Global	Conservation/restoration		Multi-criteria analysis	Risk management	Flooding, earthquake, fire

Author	Title	Reference	CH types	Effective area	Aim of the study	Type of study	Methodol-ogy	Results	NH
VMS	Emergency in the museum. A guidebook	https://wissenschaftliche-sammlungen.de/de/service-material/materialien/notfall-im-museum-ratgeber-2012	Artefacts	CH	Conservation/restoration		Expert assessment	Risk management	Fire, water
Sesana, Elena; Gagnon, Alexandre S.; Bertolin, Chiara; Hughes, John	Adapting Cultural Heritage to Climate Change Risks: Perspectives of Cultural Heritage Experts in Europe	https://www.mdpi.com/2076-3263/8/8/305	Built environment	EU	Conservation/restoration	Quantitative	Multi-criteria analysis	Disaster Preparedness	Climate change
Rönnau, Christina	Risk assessment of gravitational natural hazards in the alpine area. Application to the working area Hallstatt / Plassen in the UNESCO World Heritage Site	https://publikationen.bibliothek.kit.edu/1000003773	Built environment	AT32	Raising awareness, natural risks, tourism	Quantitative	GIS, multi-criteria analysis	Disaster Preparedness	Rockfall, landslide, floodings
Viktoria, Lukas-Krohm	Heritage protection and heritage reservation from 1975 to 2005 with emphasis Bavaria	https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=2ahUKEwiprrXHg53fAhXLEVAKHfXbB0cQFjAAegQIGhAC&url=https%3A%2F%2Fopus4.kobv.de%2Fopus4-bamberg%2Ffiles%2F25158%2FSGUK19LukasKrohmopusseA2.pdf&usg=AOvVaw2H4QId8sMEsJUiZrq4lKtJ	Built environment	DE21-DE27	Conservation/restoration	Qualitative	Expert assessment	General overview of cultural heritages in Bavaria	
Waentig, Friederike. International Council of Museums / Deutsches Nationalkomitee	Preventive conservation: a guide	https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&ved=2ahUKEwjx5abRnJ3fAhWRDuwKHYvGC7AQFjADegQIDhAC&url=http%3A%2F%2Fwww.gbv.de%2Fdms%2Fweimar%2Ftoc%2F812795350_toc.pdf&usg=AOvVaw3DsTA_0cRFNK0bNyhVitwI	Artefacts, built environment	DE	Conservation/restoration		Multi-criteria analysis	Disaster Preparedness	Fire, water
Jeberien, Alexandra	Principles of Emergency Planning and Disaster Prevention: Approach, content and structure	https://www.htw-berlin.de/forschung/online-forschungskatalog/publikationen/publikation/?eid=3193	Artefacts, built environment	DE	Conservation/restoration		Multi-criteria analysis	Disaster Preparedness	General

Author	Title	Reference	CH types	Effective area	Aim of the study	Type of study	Methodol-ogy	Results	NH
OECD Reviews of Risk Management Policies (2017)	Boosting Disaster Prevention through Innovative Risk Governance Insights from Austria, France and Switzerland: Insights from Austria, France and Switzerland, OECD Publishing, 19 dic 2017 - 252 pagine. Organisation for Economic Co-operation and Development.	http://www.oecd.org/regreform/boosting-disaster-prevention-through-innovative-risk-governance-9789264281370-en.htm	None		Natural risks	Qualitative	Study about the governance		
Laupper H. et al. (2004)	Expert report: earthquakes and cultural property, Federal Office for Civil Protection, 2004, Bern.	https://www.babs.admin.ch/it/aufgabenbabs/kgs/prints.html#ui-collapse-589	Built environment	National (Switzerland)	Documenter les dégâts occasionnés en Suisse par des séismes et de proposer, sur cette base, des mesures concrètes pour une meilleure protection des biens culturels.	Qualitative	Expert assessments:	Proposals for seismic sanitation and protection of cultural property in case of earthquake	Earthquake

Author	Title	Reference	CH types	Effective area	Aim of the study	Type of study	Methodol-ogy	Results	NH
M. Devaux & P. Lestuzzi Applied Computing and Mechanics Laboratory, Department of Civil Engineering, Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland. (2008)	Seismic vulnerability of monumental buildings in Switzerland. Structural Studies, Repairs and Maintenance of Heritage Architecture IX 215. (PhD Thesis, Lausanne, EPFL)	https://infoscience.epfl.ch/record/125150/files/EPFL_TH4167.pdf	Built environment	Larger size of pilot areas (Switzerland and Italy)	Creating a methodology for assessing the seismic vulnerability of historical edifices	Quantitative and qualitative	Methodology for the assessment of the seismic vulnerability of cultural heritage buildings (multi-level analysis); seismic vulnerability ; old masonry ; structural behavior ; Romanesque churches ; theory of plasticity ; preservation of the building heritage	Results of the study (p.249) define the vulnerability of cultural heritage buildings depending on their peculiar structure which differs from common buildings. the study propose a methodology for assessment of the seismic vulnerability composed of four steps: 1. determine the seismic vulnerability of a given building 2. obtained the vulnerability curves for each structural element 3. refine the accuracy of step 2, applying most sophisticated methods in case of building which presents irregularities 4. diagnosis phase.	Earthquake
A. Brignola, C. Luchini, S. Parodi & S. Podestà (2012)	The Swiss procedure for the evaluation of seismic vulnerability of existing buildings A. Brignola, C. Luchini, S. Parodi & S. Podestà University of Genova, Italy, 2012	http://www.iitk.ac.in/nicee/wcee/article/WCEE2012_5831.pdf	Built environment	Larger size of pilot areas (Molise region, Italy)	To rectify, evaluate and apply the codified procedure for the seismic risk evaluation of public structures put into place by the Swiss authorities to Italian structures damaged by the 2002 Molise earthquake.	Quantitative and qualitative	Revision and adaptation of the Swiss procedure to Italian case studies	Provide a priority lists for a limited number of structures definition of damage scenarios on a territorial scale	Earthquake

Author	Title	Reference	CH types	Effective area	Aim of the study	Type of study	Methodol-ogy	Results	NH
Cristian Scapozza, Christian Tognacca, Christian Ambrosi e Silvio Seno (2015)	20 maggio 1515: la "Buzza" che impressionò l'Europa, Bollettino della Società ticinese di scienze naturali - 103, 2015, pp. 79-88 (ISSN 0379-1254)	http://repository.supsi.ch/7111/	Built environment	Very local	Raising awareness	Qualitative	Historical reconstruction of a natural event: the Buzza di Biasca of 1515 resulting from the Monte Crenone rockslide occurred the 30th September 1513 on the western slope of Pizzo Magn, upslope of Biasca	Historical reconstruction (research, essays, exhibition)	Landslide
Giorgia Fasola	L'analisi del rischio in ambiente museale Valutazione di applicabilità presso il Museo delle Culture di Lugano, Bachelor Thesis, SUPSI		Artefacts (books and do - cuments, objects, pictures and paintings)	Very local	Conservation/restoration	Qualitative			
Pierino Lestuzzi	Earthquake-Protection. Historic Masonry in Switzerland	https://infoscience.epfl.ch/record/213636/files/Postprint_KGS_Forum25_PLestuzzi_2015.pdf	Built environment	Larger site of pilot areas	Raising awareness	Quantitative			Earthquake

Author	Title	Reference	CH types	Effective area	Aim of the study	Type of study	Methodol-ogy	Results	NH
Pierino Lestuzzi	Evaluation sismique des monuments du XXe siècle. In Law and the Conservation of 20th Century Architecture, Edited by R. Grignolo, Mendrisio Academy Press, SilvanaEditoriale, Ita- ly, 2014.		Built environment			Quantitative			Earthquake
Berenika Drawzewska	The Cultural Heritage of Mankind and its Preservation in International Law of Armed Conflicts	http://p3.snf.ch/Publication-8a7dda04-678c-414e-8de7-17b2b677021b	All				Value of cultural heritage		
Agrawala, S.	The European Alps: Location, economy and climate. In Climate Change in the Alps: Adapting Winter Tourism and Natural Hazard Management; Agrawala, S., Ed.; Organization for Economic and Co-Operation and Development: Paris, France, 2007.	http://www.orobievive.net/conoscere/Climate%20Change%20in%20the%20European%20Alps.pdf	Natural environment						Climate change

Author	Title	Reference	CH types	Effective area	Aim of the study	Type of study	Methodol-ogy	Results	NH
Veronika Röthlisberger, Andreas P. Zischg and Margreth Keiler (2018)	A comparison of building value models for flood risk analysis	https://boris.unibe.ch/120561/3/nhess-18-2431-2018.pdf	Built environment	Large sites pilot areas (Switzerland)	Natural risks	Quantitative	They compare five different models that estimate the values of flood-exposed buildings.	Estimating exposed-building values should be based on individual buildings rather than on areas of land use types	Flood
Brönnimann, S., C. Rohr, P. Stucki, S. Summermatter, M. Bandhauer, Y. Barton, A. Fischer, P. Froidevaux, U. Germann, M. Grosjean, F. Hupfer, K. Ingold, F. Isotta, M. Keiler, O. Martius, M. Messmer, R. Mülchi, L. Panziera, L. Pfister, C. C. Raible, T. Reist, O. Rössler, V. Röthlisberger, S. Scherrer, R.	1868 – the flood that changed Switzerland: Causes, consequences and lessons for the future	https://boris.unibe.ch/120976/1/hochwasser1868eA4_en.pdf	Natural and built environment	Large sites pilot areas (Switzerland)	Natural risks	Qualitative and quantitative	Collective report	Description of the causes, consequences and lessons learnt from the flood catastrophe happened in 1868 in Switzerland	Flood

Author	Title	Reference	CH types	Effective area	Aim of the study	Type of study	Methodol-ogy	Results	NH
Weingartner, M. Zappa, M. Zimmermann, A. P. Zischg (2018)									
Agapiou,A.; Lysandroua, V.; Alexakis, D.D.; Themistocleous, K.; Cuca, B.; Argyriou,A.; Sarris, A.; Hadjimitsis, D.G. (2015)	Cultural heritage management and monitoring using remote sensing data and GIS: The case study of Paphos area, Cyprus	Computers, Environment and Urban Systems 54 (2015) 230–239	Archaeological sites and monuments	Paphos area, Cyprus	Cost effective tools for systematic monitoring of landscapes and CH sites	Qualitative	Remote Sensing for risk assessment	Roadmap for taking specific actions regarding the protection and/or consequent restoration of the archaeological monuments.	Landslides
Andretta,M.; Coppola, F.; Modelli, A.; Snatopuoli, N.; Seccia, L. (	Proposal for a new environmental risk assessment methodology in cultural heritage protection	Journal of Cultural Heritage 23 (2017) 22–32	General	n.a.	Innovative methodology for relative environmental risk assessment in cultural heritage	Qualitative		New approach on risk assessment for environmental risks to CH by microclimatic events	Future extensions intended for earthquakes, floods, storms, ertc.

Author	Title	Reference	CH types	Effective area	Aim of the study	Type of study	Methodol-ogy	Results	NH
Directorate General Internal Policies of the Union	Protecting the Cultural Heritage from Natural Disasters	http://www.europarl.europa.eu/activities/expert/eStudies.do?language=EN	General	Europe	Support to EU legislation	Qualitative	Questionnaire; Team's personal experience; Literature review	Priorities of Action	various

STRATEGIES

Strategy name	Responsible body	Full reference	Scope	CH types	Spatial level	Effective area	Type strategy	Aim	Means	Results	Text of relevant caluses
Alpine Conveti-on (1995)	The Alpine Conference (ministers of the contracting parties)	The Alpine Convention / Framework Convention / Declaration 'Population and Culture'; II. Cultural Diversity - Tangible and Intangible Cultural Heritage	International	CH in general	Multiple CH objects of different types	Area of the Alpine conventi on	Other (general strategy)	Sustainable development	Providing new information, cooperation, investment	More effective stewardship / increase in touristic potential / enforced participation from the public	Establishment and development of local and regional documentation resource centers for cross-referencing purposes and for the dissemination of information about tangible and intangible natural and cultural heritage
Europea n Agenda for Culture (2007)	Council of the European Union	European Agenda for Culture	International	CH in general	Multiple CH objects of different types	EU	Other (general strategy)	Strengthenin g the role of culture	Providing new information, cooperation, investment, change in legislation	More effective stewardship / increase in touristic potential / enforced participation from the public	Promotion of cultural diversity and intercultural dialogue / promotion of culture as a catalyst for creativity in the framework of the Lisbon Strategy for growth, employment, innovation and competitiveness / promotion of culture as a vital element in the Union's international relations;
NEW Europea n Agenda for Culture (2019)	European Commission	A New European Agenda for Culture COM (2018) 267 final	international	CH in general	Multiple CH objects of different types	EU	Other (general strategy)	Strengthenin g the role of culture	Providing new information, cooperation, investment, change in legislation	More effective stewardship / increase in touristic potential / enforced participation from the public	Protect and promote Europe's cultural heritage as a shared resource, to raise awareness of our common history and values and reinforce a sense of common European identity

Strategy name	Responsible body	Full reference	Scope	CH types	Spatial level	Effective area	Type strategy	Aim	Means	Results	Text of relevant caluses
Work Plan for Culture (2015-2019)	Council of the European Union	Work Plan for Culture / B. cultural heritage / B3 Risk assessment and prevention by safeguarding cultural heritage from the effects of natural disasters and threats caused by human action	International	CH in general	Multiple CH objects of different types	EU	Action plan upon the Agenda	Natural risks	Providing new information (outsourcing a study by Commission)	More effective stewardship	Mapping existing strategies and practices at national level. Over-exploitation, pollution, unsustainable development, conflict area sand natural catastrophes (fire, floods, earthquake) are among factors to be considered.
Sendai Framework for Disaster Risk Reduction 2015-2030 (2015)	UN office for disaster risk reduction	Sendai Framework for Disaster Risk Reduction 2015-2030 / Sendai Priority 4 "Enhancing disaster preparedness for effective response and to 'Build Back Better' in recovery, rehabilitation and reconstruction."	Global	CH in general	Multiple CH objects of different types	World	Other (general strategy)	Raising awareness and natural risks (many per 4 priorities)	Investments, providing new information, change in legislation, change in management system	More effective stewardship	Expected substantial reduction of disaster risk and losses in lives, livelihoods and health and in economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries.
Action Plan on the Sendai Framework (2016)	European Commission	Action Plan on the Sendai Framework / Key area 4 - Supporting the development of a holistic disaster risk management approach	Global	CH in general	Multiple CH objects of different types	World	Action plan upon Sendai Framework	Raising awareness, conservation/ restoration and natural risks	Investments, providing new information, change in legislation, change in management system	More effective stewardship	Activity 17.1 (annex 2) Ensure exchange of information among member states on existing strategies and practices for risk assessment and prevention for safeguarding cultural heritage from natural and man-made disasters in the framework of the European Agenda for

Strategy name	Responsible body	Full reference	Scope	CH types	Spatial level	Effective area	Type strategy	Aim	Means	Results	Text of relevant caluses
											Culture, also drawing on EU-funded research projects; Sendai targets e, g.
Nacionalni program za kulturo 2018-2025	Ministry of culture RS	Resolucija o nacionalnem programu za kulturo 2015-2025	National	CH in general	Multiple CH objects of different types	Slovenia	Recovery measures, other	Raising awareness	Investment, change in management system	More effective stewardship	
Forest management plan of unit Idrija II; Gozdnogospodarski načrt GGE Idrija II (2018-2027) (2015)	Ministry of Agriculture, Forestry and Food (government)	Gozdnogospodarski načrt gozdnogospodarske enote Idrija I 2018- 2027. 2018. Idrija, Zavod za gozdove Slovenije, Območna enota Tolmin: 181 str.	Regional to local	Tangible culture (such as buildings, monuments and infrastructure from world war, forest management infrastructure and work artifacts and "Antonijev rov")	Single object (can be long linear object)	Local to regional	Conservation and restoration, protection against natural risks	Change in management system, coordination between landscape planners	-more effective stewardship - restoration of cultural heritage - increase in touristic potential - improving entrepreneurship potential - enforced participation from the public	Avoiding interventions on railway lines and in the vicinity of buildings, reconstruction of trees and paths damaged by natural disasters, providing safe access to visitors, tracking the guidelines laid down from the Expert Concepts of the Natural heritage, obtaining consents for	

Strategy name	Responsible body	Full reference	Scope	CH types	Spatial level	Effective area	Type strategy	Aim	Means	Results	Text of relevant caluses
										interventions in the soil or facilities	
Working Group Unesco World Heritage (2006)	Alpine Convention			All	Alps						
Linee guida per la protezione del patrimonio archivistico e librario trentino	Superintendence - Autonomous Province Trento			Document Archive & Books	Province	Province of Trento					Guidelines for protection and safeguarding archival and book heritage in the Province of Trento

Strategy name	Responsible body	Full reference	Scope	CH types	Spatial level	Effective area	Type strategy	Aim	Means	Results	Text of relevant caluses
Procedure per la gestione delle attivita' di messa in sicurezza e salvaguardia del patrimonio culturale in caso di emergenze derivanti da calamita' naturali	MiBACT			All	National						Procedures for managing activities of securing and safeguarding cultural heritage in case of emergencies due to natural hazards
Piano di Conoscenza per la Sicurezza di Archivi e Biblioteche	Soprintendenza Archivistica e Bibliografica della Lombardia			Document Archive & Books	(Regional)						Knowledge base for Security of Archives and Libraries

Strategy name	Responsible body	Full reference	Scope	CH types	Spatial level	Effective area	Type strategy	Aim	Means	Results	Text of relevant caluses
Conoscenza, prevenzione e metodologie per la salvaguardia dei Beni Culturali e del patrimonio diffuso sul territorio regionale. Caso studio: i 57 comuni lombardi in zona sismica 2	Regione Lombardia				Regional	Cluster of municipalities around the Garda Lake					Knowledge, prevention and methodologies for safeguarding of Cultural Assets and of Heritage located on the regional territory. A Case Study: 57 municipalities of Lombardy in seismic zone 3
Linee Guida per la Prevenzione dei Rischi e la Reazione alle Emergenze negli Archivi (2014)	MiBACT			Document Archive & Books	National						Guidelines for the Prevention of Risks and Reaction to Emergencies in Archives

Strategy name	Responsible body	Full reference	Scope	CH types	Spatial level	Effective area	Type strategy	Aim	Means	Results	Text of relevant caluses
Dissesto idrogeologico in Italia: pericolosità e indicatori di rischio - Rapporto Annuale (last 2018)	ISPRA			All	National	Italy					Hydro-geologic instability in Italy: hazard levels and risk indicators – Annual Report
Law of State n. 112 - 15 June 2002	Republic of Italy	-	national	real estate	multiple c.h. objects of similar types	national territory	assess the consistency and value of heritage belonging to the State to be put on sale	monetary assessment	a catalogue of real estate assets, assessed for their monetary value		
The protection of Cultural Property in Switzerland (2004)	Federal Office for Civil Protection FOCP Civil Protection Policy Protection of Cultural Property Monbijoustrasse 51A CH-3003 Bern		national	Built environment		Switzerland	preparedness measures				
Guidelines for the preparation of a Disaster plan	Federal Office for Civil Protection FOCP Civil Protection Policy Protection of Cultural		National			Switzerland	Preparedness measures				

Strategy name	Responsible body	Full reference	Scope	CH types	Spatial level	Effective area	Type strategy	Aim	Means	Results	Text of relevant caluses
	Property										
Disaster Plan	Federal Office for Civil Protection FOCP Civil Protection Policy Protection of Cultural Property		National			Switzerland	Emergency plan				
Checklist for a Disaster plan	Federal Office for Civil Protection FOCP Civil Protection Policy Protection of Cultural Property		National			Switzerland					
Immediate action in case of a disaster	Federal Office for Civil Protection FOCP Civil Protection Policy Protection of Cultural Property		National			Switzerland	Emergency plan				

Strategy name	Responsible body	Full reference	Scope	CH types	Spatial level	Effective area	Type strategy	Aim	Means	Results	Text of relevant caluses
Catasto degli eventi naturali StorMe (2006)	Ufficio Federale dell'ambiente		National	Natural environement		Switzerland	Preparedness measures	Documentation, evaluation and monitoring of disaster	Database StorMe		La banca dati StorMe (catasto degli eventi naturali) è lo strumento informatico che l'UFAM mette a disposizione dei servizi cantonali preposti ai pericoli naturali per la documentazione sugli eventi naturali.La documentazione sugli eventi naturali quale parte di un sistema di informazione sui pericoli svolge una funzione centrale nel quadro della valutazione dei pericoli. Nel catasto degli eventi naturali sono registrati gli eventi verificatisi e sono descritte le cause e le ripercussioni provocate dal loro decorso. Queste informazioni consentono di rimuovere settori potenzialmente pericolosi e di stimare la periodicità dei processi pericolosi.

Strategy name	Responsible body	Full reference	Scope	CH types	Spatial level	Effective area	Type strategy	Aim	Means	Results	Text of relevant caluses
Carte dei pericoli, carte d'intensità e carte indicative dei pericoli	Confederazione Svizzera, Ufficio Federale dell'Ambiente		National	Natural environment		Switzerland	Emergency plan	Natural risks	Providing new information	Most effective stewardship	Le carte dei pericoli mostrano le zone della Svizzera dove gli insediamenti e le vie di comunicazione sono minacciati da piene, scivolamenti, processi di crollo e valanghe. Inoltre forniscono informazioni sull'intensità (portata) prevista e sulla probabilità che un certo evento si verifichi. Al di fuori delle aree urbane le carte indicative dei pericoli evidenziano, con un grado di precisione inferiore, le possibili zone a rischio.
Guidelines No. 1/2003: Danni causati dall'acqua agli archivi - che fare?	Federal Office for Civil Protection FOCP Civil Protection Policy Protection of Cultural Property		National	Built environment		Switzerland	Recovery measures				Le inondazioni causano spesso danni alle collezioni delle istituzioni culturali (musei, archivi o biblioteche). Oltre che prevenire, si tratta di reagire rapidamente e correttamente in caso di sinistro. L'UFPP ha quindi elaborato, in collaborazione con l'esperto Guido Voser, una guida su come procedere in caso di danni causati dall'acqua al materiale d'archivio.

Strategy name	Responsible body	Full reference	Scope	CH types	Spatial level	Effective area	Type strategy	Aim	Means	Results	Text of relevant caluses
Earthquakes and cultural property (2004)	Federal Office for Civil Protection (FOCP)		National	Built environment	Multiple ch objects of different types	Switzerland	Preparedness measures	Optimize the protection of the population in terms of effective risk management, as well as improve the coordination of preventive measures			

INITIATIVES

Initiative name	Responsib-le body	Web site	Scope	CH types	Spatial level	Effective area	Aim	Means	Results	Text of relevant caluses
ARCCHIP (2000-2004)	FP5 Advanced Research Centre for CH Interdisciplinary Projects	http://www.itam.cas.cz/sd/novinky/hlavni-stranka/news-7.html				Enhanced reflection of social and economic issues in the research of cultural heritage problems, increased intensity of co-operation among European countries, new network arrangements; lines for concerted or joint a special programmes for young researchers, economic and social stability of small regional units and for integration of cultural heritage message into development of appropriate (eco-) technologies; ARCCHIP Centre operating a virtual international information center	A modern interdisciplinary approach + a new department of the Institute.		The ARCCHIP Centre mainly: summarizes state-of-the-art in selected areas of research in the problems of European cultural heritage study, safeguarding and integration into social and economic sustainability measures, especially in the countries which joined the EU in 2004 and later; continuously improves up-to-date mutual information about scientific achievements and capacity of research facilities and supports transition of this information among the EU countries as well as to the countries of Community's external policy interests; helps to select themes for medium term joint or concerted research in the field of cultural heritage and to inform about relevant national and international funding possibilities; helps to support cultural heritage research orientation and training of teachers necessary for a sound economic and social local or regional development; helps to establish networking and twinning arrangements and links among the EU countries in the area of cultural heritage research; helps to materialize national attempts in restructuring of the science and technology sector in the CEEC, e.g. acting as a National Research Centre	INSTITUTE OF THEORETICAL AND APPLIED MECHANICS - ACADEMY OF SCIENCES OF THE CZECH REPUBLIC Prosecka 76 19000 PRAHA 9 Czech Republic
Carta del Rischio	MiBACT	http://www.cartadelrischio.it/	National	Mainly non-movable asset	Multiple c.h. objects of different types	National territory	To map cultural heritage assets and overlay them with danger and risk maps	Geoportal	Geoportal and catalogue	Risk Map

Initiative name	Responsib-le body	Web site	Scope	CH types	Spatial level	Effective area	Aim	Means	Results	Text of relevant caluses
Proteggere Insieme ONLUS (1995)	(self)	http://www.protoggereinsieme.org/	National	All	Multiple c.h. objects of different types		Association for the training and deployment of Civil Protection operators, specialized in Rescuing and Securing Cultural Heritage assets	Training and setting up of local groups/associations		Protect Together non-profit association
SOS Archivi (2009)	(self)	https://www.sosarchivi.it/	National and internationl	Archives, books, documents	Multiple c.h. objects of similar types		Development and transfer of knowledge and techniques on rescuing and securing archives, books, documents and such from catastrophes and risks	Training and knowledge brokerage		Non-profit association
"Declaration on Population and Culture"	Alpine Convention - WORKING GROUP UNESCO WORLD HERITAGE	http://www.alpconv.org/en/convention/protocols/Documents/PopCult_en.pdf	Internationl	All, both material and immaterial	Multiple c.h. objects of different types			-		
Corso salvaguardia patrimonio culturale dai rischi naturali	Istituto Nazionale Superiore Formazione Operativa di Protezione Civile	https://www.insfo.it/corsi-di-formazione/corso-salvaguardia-patrim	National	Unknown	Multiple c.h. objects of different types			Training		Course on Safeguarding Cultural Heritage from Natural Risks

Initiative name	Responsib-le body	Web site	Scope	CH types	Spatial level	Effective area	Aim	Means	Results	Text of relevant caluses
		onio-cultura le-dai-rischi-natural i/								
Corso di Formazione "Il Volontariato nella Salvaguardia del Patrimonio Culturale dai Rischi Naturali-Beni Mobili"	Legambient e	NA	National	Unknown	Multiple c.h. objects of different types			Training		Training Course on "Volunteering on Safeguarding and Protection of Cultural Heritage from Natural Risks – Movable Assets"
Bando "Beni Culturali a Rischio" (2017 (last))	Fondazione CARIPLO	http:// www.f ondazi onecari plo.it/s tatic/u pload/ ban/00 00/ban do-beni-cultura li-a-rischio. pdf	Regional (Lombard y)	Non-movable	Multiple c.h. objects of similar types	Larger size of pilot areas	Identifying and implement interventions of structural improvement to increase the security levels of buildings and constructions compared to initial conditions	Knowledge acquisition and diagnostics		Call on "Cultural Heritage at Risk" by a private philanthropic fund

Initiative name	Responsib-le body	Web site	Scope	CH types	Spatial level	Effective area	Aim	Means	Results	Text of relevant caluses
Patrimonio dello Stato s.p.a. (2002)	Public society - Republic of Italy	NA	National	Real estate	Multiple c.h. objects of similar types	National territory	The ownership of the State Property is passed on to the Public Society, in order to rearrange and make more efficient the management of the property (and to be able to sell it)	Monetary evaluation (methodology not publicly available)	Registry of real estate assets	
PatrimonioSOS (2002)	Association "PatrimonioSOS"	http://www.patrimoniosos.it/index.php	National	All	Multiple c.h. objects of different types	National territory	PatrimonioSOS is a free association of experts and citizen concerned after the approval of the Law n.112 - 15/6/2002, that intends to promote awareness about the risk of dispose of national cultural heritage assets to convert it into money for the State; the founders are University Professors and the website is also a valuable source of information, also beyond the original mission of the association; particularly they publish a methodology for monetary evaluation of Cultural Heritage assets			

Initiative name	Responsib-le body	Web site	Scope	CH types	Spatial level	Effective area	Aim	Means	Results	Text of relevant caluses
Mobiliar Lab for Natural Risks (2013)	Swiss Mobiliar Insurance & Pensions and the Oeschger Centre for Climate Change Research at the University of Bern	http:// www. mobiliarlab.unibe.ch/	National				Investigates and quantifies climate risks, natural hazards			
Journal PCP Forum (about Protection of Cultural Property)	Federal Office for Civil Protection (FOCP)		National							
Politica della Confederazione per le aree rurali e le regioni montane										

SHOWCASES OF INTERVENTIONS

Date	Location	Organizers	Time scale	CH	NH
11.12.2006	Lorgues, Var, PACA	Claude-Marie Monneron-Crastre, LC2R	?	Chapel	Fire
June 2018	Quinson, PACA	SDIS 04, Musée de la préhistoire des gorges du Verdon	?	Museum	Fire
31.10.2017	Cannes	Cannes City	Actions during emergency: 1 day	All the city	Tsunami, earthquake

Project Partners

ITALY

Lombardy Foudation for the Environment (Lead Partner)
Catholic University of the Sacred Heart
Touring Club of Italy

FRANCE

National research institute of science and technology for environment and agriculture
French Geological Survey
Valabre Consortium

SLOVENIA

Slovenian Forestry Institute
Idrija Mercury Heritage Management Centre

AUSTRIA

Austrian Research Center for Forests
Austrian Institute of Technology

GERMANY

Rachel Carson Center for Environment and Society

SWITZERLAND

University of Applied Sciences and Arts of Southern Switzerland

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Lead Partner

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