D2.1 End User needs and practices report

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[1] **R**=Document, report; **DEM**=Demonstrator, pilot, prototype; **DEC**=website, patent fillings, videos, etc.; **OTHER**=other

[2] **PU**=Public, **CO**=Confidential, only for members of the consortium (including the Commission Services), **CI**=Classified, as referred to in Commission Decision 2001/844/EC

Modifications Index	
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ACRONYMS AND ABBREVIATIONS

CH	Cultural Heritage
CP	Civil Protection
CC	Climate Change
HCAA	Hellenic Civil Aviation Authority
SAD	Seismic Alert Devices
UAV	Unmanned Aerial Vehicles

Table of Contents

List of Figures

Executive Summary

Deliverable D2.1 "End User needs and practices report" documents the work performed in Task 2.1 "End-users' needs and good practices analysis" during the first six months of the project's duration. This deliverable includes the description of the four study areas, Rhodes, Granada, Venice and Tønsberg and identifies specific Cultural Heritage buildings that are of great importance within those areas as well as buildings of great importance to the business continuity and financial sustainability of the areas.

For each study area, an overview of the infrastructure that will be modelled and monitored is provided, emphasizing details about building materials, already available infrastructure and hazards related with the geographical location of the cities as well as area specific topologies.

In addition, current practices and mitigation measures are described in detail. Gaps in the process, areas of improvement and needs of the areas are also identified and presented.

The deliverable is mainly intended for internal use, in particular by the partners involved in the specification of the system requirements, the use cases and the overall system architecture.

1. Introduction

1.1 Background

The deliverable D2.1 "End User Needs and Practices Report" is one of the initial milestones of the Hyperion project. It is an important document as the current user needs and current practices followed to date are being reported.

All the information gathered within the D2.1 deliverable document, will form a basis for the further Hyperion project implementation since its pre-requisite to collect all user needs as a reference point for the actions to be proposed and taken.

The organization of the document is being described in "Document Organisation" section, in the following page.

1.2 Scope and Objective

Our scope is to collect the information needed from the sites and their respective regions, from a technical, financial and regulatory point of view so as to summarize the risks related to the historic sites and their assets, as well as the practices that they were following to date and proven to be successful for their goals.

This deliverable "D2.1 – End user needs and practices report" is focusing on the infrastructure stakeholders, the analysis of their current practices they follow and their expectations from the HYPERION project.

Moreover, we are analysing separate user-cases per CH site, while describing the potential interactions between the users and HYPERION and collect their anticipated results.

1.3 Definitions

Cracking: probably due to weathering, flaws in the stone, several static problems, rusting dowels, too hard repointing mortar. Vibrations caused by earth tremors, fire, frost may also induce cracking. (ICOMOS, 2008)

Conflagration: an extensive fire which destroys a great deal of land or property.

Disintegration: detachment of single grains or aggregates of grains. (ICOMOS, 2008)

End-user: an end-user is defined as a person or group in a position to apply the information or tools being produced, evaluated or transferred through a project.

Erosion: loss of original surface, leading to smoothed shapes. (ICOMOS, 2008)

Stakeholder: is anyone who is affected by or has an interest or stake in an issue. Examples of stakeholders include members of national, regional, local agencies, governmental/state bodies, business leaders and industry representatives, representatives from non- profit groups or other citizen organizations. All end-users could also be considered stakeholders, but not all stakeholders are end-users.

Stiffness: The measure of the resistance offered by a construction to deformation.

Structural Capacity: Maximum loading that can be sustained without exceeding the allowable values for normal, extreme, or survival conditions and still maintain functional requirements.

Material degradation: deterioration of mechanical properties of the material when exposed to an environment resulting in the loss of that material.

Retrofitting and Structural rehabilitation: a process of reconstruction and renewal of a facility or its structural elements. This involves determining the origin of distress, removing damaged materials and causes of distress, as well as selecting and applying appropriate repair materials that extend a structure's life.

Eustatism: worldwide changes in sea level, caused by the melting of ice sheets, movements of the ocean floor, sedimentation, etc.

Exposure: the elements at risk (persons, buildings, infrastructure, goods, etc.) that, due to their location, are exposed to one or more perils (e.g. earthquakes, floods).

Fortification: a defensive wall or other reinforcement built to strengthen a place against attack.

Hazard: is anything associated with a peril that may affect the normal activities of people. This includes, for example, ground shaking for earthquakes or wind action for storms.

IOC/UNESCO: The Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO), established in 1960 as a body with functional autonomy within UNESCO, is the only competent organization for marine science within the UN system.

Landslide: a collapse of a mass of earth or rock from a mountain or cliff.

Thawing: the process of ice, snow, or another frozen substance becoming liquid or soft as a result of warming up.

Tornado: a mobile, destructive vortex of violently rotating winds having the appearance of a funnel-shaped cloud and advancing beneath a large storm system.

Vandalism: action involving deliberate destruction of or damage to public or private property.

VHF: is the International Telecommunication Union (ITU) designation for the range of radio frequency electromagnetic waves (radio waves) from 30 to 300 megahertz (MHz), with corresponding wavelengths of ten meters to one meter.

For any additional stone deterioration patterns, we refer to the Illustrated glossary produced in 2008 by the ICOMOS International Scientific Committee for Stone (ISCS).

(https://www.icomos.org/publications/monuments_and_sites/15/pdf/Monuments_and_Sites_15_ISCS_Glossary_Stone.pdf)

2. Description of the sites and the regions where they are located

In this Section a detailed description of the study areas is given. Each city describes in detail the specific area that is of interest, the Cultural Heritage (CH) buildings that are of importance to them, their availability for sensor installations as well as buildings that are of importance in regard to the Business Continuity.

In detail, the monitoring levels are defined in three tiers:

- **Tier 1**: A CH building of high importance for the area where there are already existing monitoring sensors or a permission can be obtained for the installation of sensors by the project. For this building detailed modelling will be provided. Each city can propose one or more building as Tier 1 buildings.
- **Tier 2:** Here, there are two types of buildings that can be included. The one type is a CH building of high importance for the area where it is not possible to install sensors, either due to permission issues or material degradation. The other type includes buildings that are no-CH buildings but very important for the Business Continuity of the area such as fire houses, hospitals and airports.
- **Tier 3**: The overall area that will be modeled/studied within the scope of the project. Given that no-CH buildings are expected to be in some distance from historical areas, it is not mandatory for tier 2 buildings to be inside the Tier 3 area.

Finally, a list with all the available infrastructure, both in local and national level, covering the study area is provided by each city. This list will be further defined and analysed by technical partners in order to identify external data sources that are of interest to the project objectives and should be incorporated to the overall system architecture.

2.1 Rhodes, Greece

The island of Rhodes/ Greece is situated at the South-East of the Aegean Sea. The island occupies an area of approximately 1,400 Km^2 and has an actual population of 116.000 people. Since the 2011 local government reform, Rhodes Municipality refers to the whole island.

The city of Rhodes has a history of 2400 years. The different people who settled in the island left their mark in all aspects of the island's culture: art, language, architecture. The Medieval city of Rhodes, built by the Knights of St. John, is one of the best preserved Medieval Cities in Europe and a UNESCO World Heritage Site since 1988. The cultural heritage of the island is one of its major comparative advantages with historic buildings -complexes and archaeological grounds located all over the island. Rhodes is a popular international tourist destination. The economy of the island is tourist-oriented. Almost 75% of the active population is engaged in the tertiary sector and tourism.

Rhodes’s strategy is primarily based on the promotion of the sustainable development of the area. Therefore, the municipality is actively engaged in the HABITAT Agenda as well as Local Agenda 21. Furthermore, the municipality became a signatory to the Covenant of Mayors in January 2010 making a commitment to achieve the EU target of 20% of reduction of CO2 emissions. Information and Communication Technology (ICT) is one of the most important challenges to implement for Rhodes. The municipality aims for improvement of services through the use of information technology in the public sectors.

General description of the historic area considered for the demonstration activities

The ancient city of Rhodes, as shown in Figure 1, was founded in 408 BC, in the place of the modern city of Rhodes. It was the capital of the federal Rhodian state, created after the unification of the three old city-states of the island, Ialyssos, Lindos and Kamiros. The new capital was meant to become one of the most important metropolises of the Hellenistic Word; it was planned according to the Hippodamian urban system, which provided straight continuous streets, oriented North to South and East to West, division of the city in zones of different functions and residential insulae of equal dimensions, arranged in successive terraces following the geological relief. The acropolis of the city, with the stadium, the gymnasium, temples and grotto sanctuaries, was lying on the hill to the west of the city. The agora was located to the east, close to the harbors, in the place of medieval town. South of the city, just outside the fortification walls, the necropolis was extending; it was one the biggest necropolises of the ancient world. Two streams divided the necropolis in three sectors. The stream of Makri Steno to the west, preserved until the Second World War, is today transformed into a roadway and buildings are constructed inside its bed. The eastern stream, the Rhodini stream, is preserved in all its length; along its banks the monuments that are going to be monitored by the Hyperion project are located.

Figure 1 Urban Plan of the ancient city of Rhodes

Both the tombs of the necropolis as well as the temples, the public buildings and private houses of the ancient city were built with the local sandy limestone, which is the virgin soil of the area. From the same stone the Medieval city is also built. Many ancient quarries have been uncovered in rescue excavations inside the perimeter of the ancient city as well as in the necropolis, while others are preserved in the countryside of the island.

In the early 12th century, the ancient city of Rhodes was limited in size and by 1309 it was occupied by the order of St John of Jerusalem Rhodes until 1523. It was a period of wealth and prosperity in all sectors. At the time the medieval city acquired its current size and structure. The **medieval city of Rhodes** (UNESCO world CH site) maintains the architectural character and the urban organization of a medieval city as well as its primary building materials, stone, wood and iron.

The stone used for building came from two types of rock: sandy limestone that is more prevalent and mountain limestone. Most of the sandy limestone is biogenic with low mechanical tolerance and great lack of homogeneity. It is quite porous that makes it low quality material due to its great water absorbency.

Tier 1 buildings

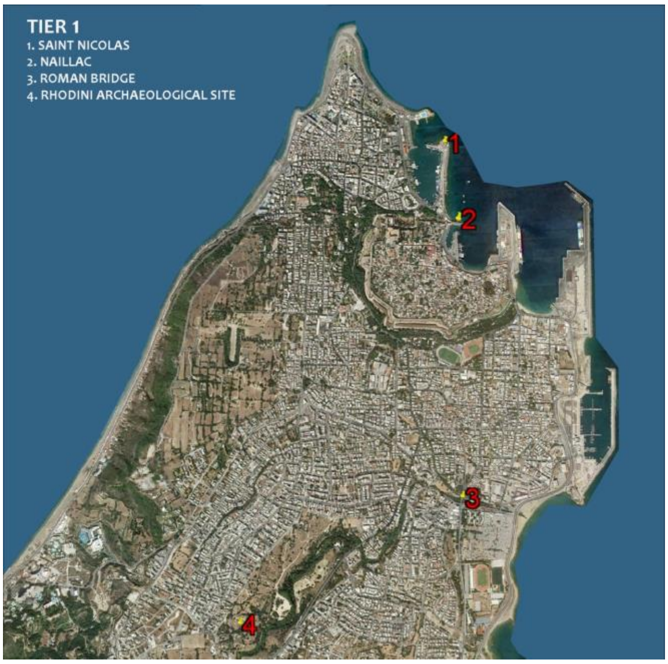

Figure 2 Tier 1 Buildings - Rhodes

1. Saint Nikolas lighthouse and fort at the entrance of the Mantraki port (part if the medieval fortifications with a waterfront location).

The fortress of Saint Nikolas is a single stronghold that occupies the northern tip of the homonymous pier. It includes consecutive reinforcements and expansions after the destructions it suffered from sieges, during which it acted as "a key to the defense of the city". It was built by the duke Philip of Burgundy in 1464-67. Previously, there was only a small chapel dedicated to Saint Nicolas at the same place, which was turned into a fort by the Egyptians when they invaded and was used to bomb the town. The walls around the fort of Saint Nicolas were built by Grand Master Pierre d' Aubusson, who also restored the damage suffered by the fort during the Turkish besiege in 1480. The fort was transformed into a lighthouse in 1863.

Figure 3 Saint Nikolas lighthouse and fort

2. **Nailac Pier** at Saint Paul's rampart. (part if the medieval fortifications with a waterfront location). Naillac pier and rampart was constructed around 1400 on the Hellenistic pier and it was part of the fortification of the "Great Port", the Commercial Harbour of Rhodes.

Figure 4 Nailac Pier

3. The Roman bridge. The bridge was built across the stream of Rhodini, a few meters before its outfall to the sea. It is a monument of particular archaeological importance, since it is one of the few ancient bridges surviving in Greece, being furthermore in use until today. The bridge belongs to an enclosed archaeological site, where part of the Hellenistic fortification wall of the city is preserved. The stream of Rhodini that flows along the fortification, served here as a natural defense motte. The bridge is built in isodomic masonry, without employment of connecting mortar; it has two arched openings, 6.50 m. wide and 8.20 m. high. Previously it was dated in the Hellenistic Period, however in more recent studies, specialized in bridge construction, is dated in Roman period. Later repairs are noticed at the piers of the arches.

A few meters east of the bridge there is a second bridge or dam of very different architectural form. It is built with rectangular sandstones and has three relatively narrow rectangular openings, which were closed and opened with movable slabs, regulating the flow of the water. The length of the structure is 10 m., the width of the passageway 2.50 m. The date of the monument is still under discussion; initially it was dated in classical or Hellenistic period, recently though it was discussed that it might be dated after the Roman times.

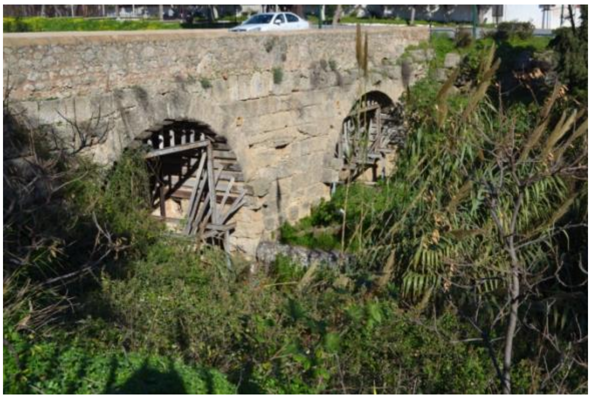

Figure 6 The Roman bridge east facade

Figure 5 The Roman bridge west facade

Figure 7 The dam east of the Roman bridge

The Roman bridge is in continuous use from Antiquity until today, since it is located in the main exit of the city towards the east coast of the island. The traffic, in particular the crossing of heavy vehicles, has deteriorated the static competence (efficiency) of the bridge and caused fissures in its masonry, widening of the joints between the stones and falling of stones. The wooden scaffolds, that temporarily sustain the arches, are partially destroyed and at risk to collapse. Although consolidations work has been carried out a few years ago on the banks of the torrent, the flow of the water is blocked impeded by the dense vegetation and the elevation of the initial riverbed by the modern one, made of reinforced concrete. Furthermore, the water passes only through the southern opening, while the north one is filled with alluvial debris.

4. ***Grave enclosures in Rhodini.***

Rhodini was in antiquity part of the central necropolis, therefore some of the most important monumental graves of the Rhodian necropolis are here preserved. At the same time, it is believed that the area served as a kind of suburban park, due to its picturesque landscape, partially preserved until today. With the ancient park manmade formations of the landscape are connected, such as retaining walls in rustic masonry, rocky small outcrops with narrow staircase functioning probably as belvedere, underground water-supply channels and sanctuary imitating natural grottoes. During the Italian occupation (1927) a park was created along the northeastern part of the stream, reviving in a way the function that the area had in antiquity. A few decades ago the park was one of the sightseeing attractions of the modern city, whereas today it is in state of abandonment.

The monumental graves preserved in Rhodini are dated in the Hellenistic period, in the 3rd- 2nd century BC. They are concentrated in the southern part of the Archaeological site, around the so called "Tomb of the Ptolemies", a maussoleion type tomb of big dimensions, cut into a rocky hillock. The other tombs are hewn on the high rocks faces framing the stream-bed. They are formed as enclosures, open towards the stream and their main characteristic are false facades cut above the graves. The false façade of the so called "Korinthian tomb", lying at a distance of few meters to the west of the "Tomb of the Ptolemies", consists of semicolumns and false doors. Another grave enclosure adjacent to the "Korinthian tomb" has pedestals and arched niches for the placement of funerary altars as well as relief stele sculptures; on the pedestals and under the niches circular shields are barely visible due to the erosion of the rock. To the opposite bank of the stream a sanctuary with two vaulted-roofed chambers, and another grave enclosure with two staircases on its corners, leading from the upper terrace into the stream bed, are also preserved. Another grotto complex, created after quarrying of the rock, it was probably a sanctuary dedicated to chthonic deities. A roadway passing through the grottoes in an Italian intervention.

Figure 8 Rhodini. 1. "Tomb of the Ptolemies". 2. Grave enclosure with shields (to be monitored by Hyperion project) and "Korinthian Tomb". 3. Sanctuary with vaulted-roofed chambers. 4. Grave enclosure. 5. Grotto sanctuary.

The environmental conditions and the microclimate of the area, in which critical role plays the stream of Rhodini, in combination probably with extreme natural disastrous events, such as earthquakes, have caused severe damages to the tombs ranging from the erosion of their stucco-coated facades, as at the "Korinthian tomb", to fissuring, detachment and collapse of the monuments. More severely affected are the **"Tomb**

of the Ptolemies", great parts of which have been detached from its back side, and the **grave enclosure with the shields,** whose south wall is crossed by numerous fissures, inside which an oak tree is grown. The conservation status of the wall is constantly deteriorating, there is a rapidly aggravating inclination from the vertical and the monument is thus in imminent danger to collapse in pieces.

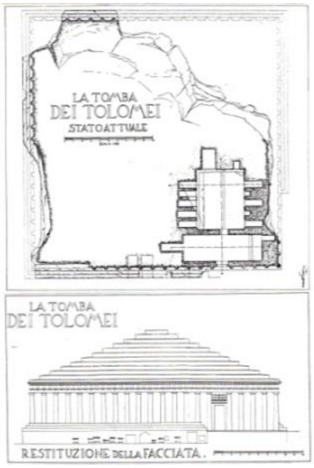

Figure 9 The tomb of the Ptolemies

Figure 11 Sanctuary with vaulted-roofed chambers (a)

Figure 10 Sanctuary with vaulted-roofed chambers (b)

Figure 12 Rhodini. Grave enclosure with pedestals, niches and relief shields

Figure 13 Rhodini. "Korinthian Tomb"

Tier 2 buildings

Buildings that are important for the Business Continuity and financial sustainability of the study area are included in the Tier 2. These building, presented in Figure 14, are:

1. Fire station. Operational as well as CH building
2. Police station. Operational as well as CH building
3. S. Aegean Regional building. Operational as well as CH building
4. Municipality of Rhodes (City Hall). Operational as well as CH building
5. Central offices of Ephorate of the Dodecanese islands. Operational as well as CH building
6. Electrical power substation. Operational building
7. Military Headquarters. Operational building
8. Public services building. Operational building
9. Regional Hospital. Operational building

Figure 14 Tier 2 buildings - Rhodes

Tier3 buildings

The overall area that will be modeled/studied will be the whole city of Rhodes an area of approximately 1400 Km^2, as presented in Figure 15.

Figure 15 Tier 3 study area in Rhodes

The assets, chosen for the Tier 1, have excellent visibility and are easily accessible from air and ground. Permission to assess the assets has to be granted by the ministry of culture.

The civil protection department is equipped with two UAVs. Drone flights are allowed in Greece under specific rules. To begin with, permission must be obtained in advance if the drone is to fly more than 50 meters away from the operator from the Hellenic Civil Aviation Authority (HCAA). In the application, information about the operator, the aircraft and a detailed flight plan must be provided. Among other things, Pilot Training Certificate will be asked and a registration number of the drone. As long as there is not a registration number from a European country, additional registration with the HCAA is required. More info can be found at Regulation –General framework for flights of Unmanned Aircraft Systems - UAS (Published in Government Gazette B/3152/30.9.2016)

2.1.1 Current equipment/infrastructure available

- **Seismicity network:** One station (NOA National Observatory of Athens) to monitor seismicity and two mari-graphs (tide gauges at Kalathos and Plimiri), part of the seismic network of the Hellenic Seismic Network (HL), which provides in n-RT waveform data exchange with more than 150 stations. The HL webpage provides simple seismicity inspection, automatic earthquake location based on SeisComP3, manual revision of earthquake locations performed by a seismologist analyst, moment tensor solutions from waveform inversion, seismic noise and station quality control automated assessment.
- **Near-Field Tsunami Early Warning and Emergency Planning (NEARToWARN):** Four early warning devices (Gennadi, Kalithies, fire brigade station in Rhodes city, civil protection office -city hall) for warning in case of major local earthquakes. The main goal of NEARTOWARN is to promote technology with the aim to close the gap between the regional watch services scheduled to be provided by the North East Atlantic and Mediterranean Tsunami Warning System (NEAMTWS) coordinated by IOC/UNESCO and the need to warn for near-field tsunamis with travel times of the first wave to the closest shoreline being less than 30 min. The core component of the system is seismic alert devices (SED). SED's are activated and send alerting signals as soon as a P-phase of seismic wave is detected in the near-field but for a predetermined threshold of ground motion. Then, emergency starts while SED's activate remotely other devices, such as computers with data bases of pre-calculated tsunami simulations, surveillance cameras etc. The system is completed with tide-gauges, simulated tsunami scenarios and emergency planning supported by a Geographical Management System.
- **Accelerometer network** is installed along the island, part of the national network operated by the Institute of Engineering Seismology & Earthquake Engineering. The network communicates data in constant flow. This is equipped with wide range accelerometers, digitizers with a resolution of 24 bits and GPS.
- **Meteorological stations:** Five meteorological stations are installed throughout the island (Rhodes, Lindos, Empona, Katavia, Diagoras airport). The data is directed to

the National Observatory of Athens and are used for the weather forecast at http://www.meteo.gr/

- **PREMARPOL (Prevention and Combating of Marine Pollution in Ports and Marinas):** Two stations equipped with multi sensors are installed at the cruise port and "Akandia" commercial port within the city of Rhodes part of the PREMARPOL network. Sixteen environmental indicators are recorded and data is provided in RT.
- **Wireless communication network:** The municipality operates a wireless communication network with two VHF transmitters and another one for the prevention of natural disasters and protection of the environment of Rhodes.

2.2 Granada, Spain

In Granada there are around 2,000 monumental buildings with various preservation-related problems. Near Granada we can see what could be one of the first domes in the history of construction, Tholos de El Romeral, built around 3000 BC. Several tribes and cultures have been around in the area. Granada County has the first diocese (seat of the bishop) in Spain. Granada has been Islamic during the period 711-1492 AD. In Granada city few constructions before the Islamic occupation period remain, although several constructions from the time of the Islamic period are still standing, especially in the Albayzín.

Figure 17 Map of Spain showing the location of Granada

Figure 16 Granada

Several types of structural elements are present in the CH of Granada city: rammed earth, bricks, stone (limestone), wood, bricks and mortar. Rammed earth construction (locally named as "tapial") was widely used during the Islamic period of Granada. It is often reinforced with bricks so the rammed earth is used as an in-fill.

Figure 18 Rammed earth construction, locally named as "tapial".

In this case, the wall is built between brick masonry as wall reinforcing, and can also appear brick rows between successive walls. These reinforcements can remain outside or be hidden behind a scab that covers the entire wall. These brick reinforcements are arranged and displaced in each course, so that they constitute the lateral reinforcement of each rammed earth module and, in addition, each wall moves with respect to the lower one.

The main cause of deterioration of the rammed earth are water ingress, low dry capacity, salt transport, biological attack, and the different mechanical behavior among the different materials used. As possible hazards are identified the flooding, which will increase the presence of water in the rammed earth; the extreme heat, which may trigger the effect of expansion that produce the loss of cohesion in the material; and the long period of return earthquakes, which will increase the action over the structures that has to be considered, among others. In relation to the rehabilitation, the mechanical incompatibility has been by large the most relevant misused in restoration of rammed earth. Proper mortars, compatible with each type of rammed earth, is the main objective when restoring this type of materials.

Regarding to the porous lime stone, there are two main types of lime stones in Granada area used for construction material. One is the highly consolidated Elvira mountain range lime stone and the second is a characteristic porous lime stone used in walls in most of the main monuments built after the end of the muslin period (after XIV century). The *Saint Justo and Pastor Temple* is an example of both materials (**Error! Reference source not found.**). The main facade is the Elvira mountain range lime stone and the rest of the walls are the porous lime stone. This porous lime stone is very vulnerable to freeze thaw cycles as well as biological attack.

Figure 19 Saint Justo and Pastor Temple

Another important material in Granada is the quaternary conglomerate, composed by a clay matrix with boulders. It is very common in the hills where several CH structures are located, such as some of the most important towers of the Alhambra Palace. For example, *Sabika* is the hill of the Alhambra and *Valparaiso* is the hill of Sacromonte area. This quaternary agglomerate is very vulnerable to freeze-thaw cycles, where landslides are common, likely due to the climate change.

Figure 20 Sabika & Valparaiso hills

General description of the historic area considered for the demonstration activities

About the **Tier 3**, The *Albayzín* and *Realejo* will form the study area, as shown in Figure 21.

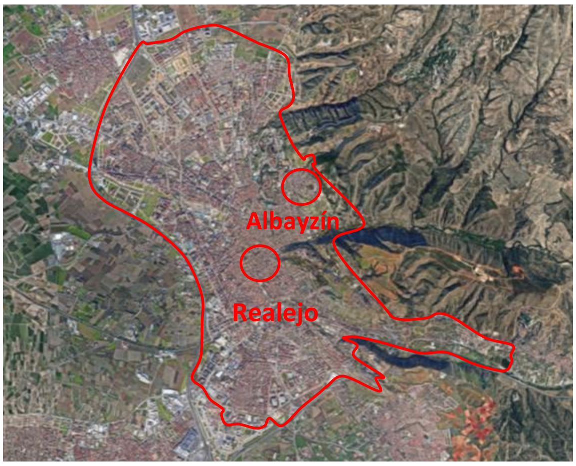

Figure 21 Map of Granada showing the Albayzín and Realejo areas (Tier 1).

The Albayzín area is the best-preserved illustration of a Hispano-Muslim city in Spain, enriched with the contributions of Christian Renaissance and Spanish Baroque culture. Until 1990, the lack of global policy provoked the inadequate use of materials and techniques for some restorations. Nowadays these defects are being rectified and reverted.

Regarding to the other historic area, Realejo was mainly a Christian expansion after Granada was reconquered. It owns many palaces and churches, mainly built with limestone and bricks, constantly being restored.

Inside Realejo area, the CH building named *The mill of the Marquis of Rivas* is selected to study it and classified as **Tier 1**. The main characteristic of this CH building is the rammed earth construction with bricks from XI century. This type of construction is highly vulnerable to the changes in the cycles of humidity. Consequently, it is more vulnerable than other constructions of the same period because it is a river mill. The most important variables, such as temperature and humidity, will be monitored by installing sensors around the building. For that, it is not necessary to get any special permissions since the CH building belongs to the Granada Council, who is a participant of Hyperion Project.

Figure 22 The mill of the Marquis of Rivas (Tier 1).

The other selected CH building is *Saint Jeronimo Monastery*. It is classified as **Tier 2** since it is a very important building but it is not possible to get permission for sensor installations. Its main characteristic is the construction material, the porous lime stone. This type of construction is very vulnerable to freeze thaw cycles as well as biological attack. Satellite imagery and the accelerometer located at the School of Architecture will be used to inspection it.

Figure 23 Saint Jeronimo Monastery (Tier 2).

Finally, the fire house of Granada is considered as the non-CH building defined in **Tier 2**. This building is located in Almanjayar area. It is selected as it is a critical building in case of disasters such as earthquakes, floods, landslides, or terrorism attacks, among others.

Figure 24 Fire House of Granada (Tier 2).

2.2.1 Current equipment/infrastructure available

- **Sensors for structural health, climate/weather, pollution:** Some of the buildings are monitored: inclinometers, crack widths control, temperature, humidity.
- **Seismicity and accelerometers' network:** There are several stations in the area and one accelerometer in the School of Architecture located in the center of El Realejo.
- **Weather/pollution stations** used for surveillance of weather and pollution parameters in town. There are 2 main stations (one in each of the pilot areas). They measure most of the available parameters, from temperature and humidity to quality of the air and radiation.

2.3 Venice, Italy

The City of Venice (capital of the Veneto Region) is located in the North-eastern Italy. Founded in the $5^{th°}$ century (in the year 421) and spread over 118 small islands, Venice was inscribed in the UNESCO World Heritage List in 1987, in recognition of its unique historical, archaeological, urban and artistic heritage and exceptional cultural traditions, integrated into an extraordinary natural landscape. It covers a surface of about 540 mi^2. According to the data referring to 2018, the City of Venice has a population of 261.321 inhabitants, distributed as follows:

- **53.799 inhabitants** of the historic centre
- **27.983 inhabitants** of the Lagoon's islands
- **179.539 inhabitants** in the mainland

Venice was built in an area where it was hard to find building materials; therefore, only two types of materials were available: the "spolia" (recycled) and the new materials. In the lagoon, between the end of the ancient world and the Middle Age, all the building materials were "spolia"/reused materials: foundation stones, decorated marbles, inscribed slabs, bricks, roof shingles, rubble. In fact, in ancient times, "spolia" materials were "bargaining chips" and their exchanges were governed by clear regulations. New materials arrived in the city only when Venice became an economic and military power. Both new and reused materials had to adapt to a climatic situation that was different from their places of origin, in particular to the high level of saltiness in the ground, in the water and in the air, that risks to break apart their structure. To guarantee that these materials are going to last long there is a need for an efficient methodology to protect them from aggressive chemical and physical agents and possible hazards.

General description of the historic area considered for the demonstration activities

The proposed sites have been identified for their different location in the city, in order to understand how the main building materials (stone and marble, brick, wood, metal, plaster) can be quantitatively and qualitatively subject to chemical variations and exogenous physicists.

The two selected study areas are: **1) the Marciana area**, **2) Ca' Pesaro Palace**. All of them are exposed to different pollutants from various sources. St. Mark square is mostly affected by the emissions of small boats and touristic large ships and Ca' Pesaro is mainly exposed to the intense traffic along the Canal Grande. The CH building in the Marciana area, Torre dell'Orologio (The Clock Tower) has been selected for the demonstration activities and it can be classified in **Tier 1 as** sensors can be installed on it. Currently there are none.

Infrastructures and buildings to be classified in **Tier 2**: the bridge connecting Venice historical centre to the mainland allowing both car and train transportation, the buildings along the Grand Canal, from piazzale Roma to the Accademia bridge, the Rialto bridge and the Mercerie, the Giudecca canal, the Civil Hospital. These buildings and infrastructures are fundamental for the city and Business Continuity.

The area to be classified in **Tier 3** includes the areas with infrastructures and important sites that border the lagoon and therefore the city of Venice, like the airport, the port mouths, the industrial site of Porto Marghera.

With regard to the buildings and infrastructures included in **Tier 1 and Tier 2**, a further problem arises from the fact that all buildings and artifacts are of high historical and artistic value and the materials with which they are made have suffered great stresses since their first use, which is it aggravates daily with the highest level of pollution and with the increasing variability and intensity of climate change in recent years. An example for all is the increase in high tide levels over the last fifty years.

Figure 25 Venice city and sites of interest

✳ The Marciana area, Torre dell'Orologio (The Clock Tower).

Figure 26 The clock tower

The Clock Tower, is one of the most famous architectural landmarks in Venice, standing over an arch that leads from St. Mark's square into what is the main shopping street of the city, the old Merceria. The tower with its large Astronomical Clock was designed by Mauro Codussi in the early 16th century, it was built with brick, stone and wood and covered with stone material. The monument that stands in the Marciana area, faces the city's waterfront and it is therefore exposed to the sun, rain, high water, wind with all the saline humidity coming from the sea. In addition, the foundation of St. Mark square is lower than the rest of the city, and frequently subjected to the high water phenomenon, which comes directly from the large San Marco basin by wave motion. The presence of erosive salty water is massive, almost constant, and salt affects the buildings' masonry. Its position makes it a perfect place where to position specific devices to detect the polluting agents responsible for the deterioration of the building materials.

✳ Ca' Pesaro Palace

Figure 27 Ca' Pesaro Palace

The grandiose palace of Ca 'Pesaro, now seat of the International Gallery of Modern Art, was built in the second half of the 17th century after a project by the Venetian baroque architect, Baldassarre Longhena.

Overlooking the Grand Canal, the city's main waterway, very busy with motor boats, the Palace was built using the traditional techniques and materials of the time and the two facades were coated with the Istrian stone. The building is exposed to the intense traffic of public and private transport and the pollution is acute. The building is to be classified in **Tier 2** as it might be difficult to obtain an authorisation for installing any sensor.

2.3.1 Current equipment/infrastructure available

- **The City of Venice instituted a "Centro Previsioni e Segnalazioni Maree"- ICPSM (Tidal forecasting and early warning center).** It has a dedicated service for the tide monitoring to constantly provide tide levels and weather conditions forecasts and manage the early warning systems. ICPSM has been collecting data on tide levels for the last 40 years. The ICPSM provides both near-real-time and historic meteorological data: sea level rises, air temperature, atmospheric pressure, relative humidity and precipitation, solar radiation and wind. The data are available also as spreadsheet on line at: https://www.comune.venezia.it/it/content/dati-e-statistiche-0.
- **The City operates a IT system (ARGOS) for the water traffic monitoring caused by the passage of large ships and private/commercial boats in the lagoon** and especially in the San Marco basin and the Grand Canal, which cause the increase of the hydrocarbon level and a strong wave motion, with the consequent erosion of the banks. Moreover, given the proximity of the industrial pole of Porto-Marghera and the international Marco Polo airport, the quality of the air and the presence of heavy metals transported by wind and rain, which affect both superficially and in depth the stone materials and the bricks, with the consequent deterioration of the components, are constantly controlled
- **The City developed a security monitoring system** an integrated system for controlling and managing mobility, land and road safety in the territory of the Municipality of Venice. The Smart Control Room (SCR) collects and manages the information received through the various local public transport networks, the video surveillance systems and the telecommunication networks. A camera is also installed on the Clock Tower, the Tier 1 building.
- **Stations used for meteorological observations** are located in the and on St. Mark's basin - Tidal Centre HQ, located in Palazzo Cavalli, records air temperature, atmospheric pressure, relative humidity and precipitation - in San Giorgio station,

located on homonymous island, records solar radiation and wind - in [Punta Salute station](), in St. Mark's basin, records water temperature Charts about precipitation and wind,

- **IWS The Common Data Sharing Web GiS Tool** (Integrated Web System - IWS) is an on line tool collecting observation datasets and forecasts from the existing operational forecast systems in the Ionian Adriatic basin. It has just developed within the European project Interreg Adrion I-STORMS. It is managed by the City of Venice and the CNR – ISMAR. Data can be downloaded from www.seastorms.eu

The combined analysis of the data obtained by these control systems provide information to monitor the deterioration of the city and of its lagoon area. Regarding the buildings in the identified areas, they have been measured and registered in a free municipal database. Some sensors and devices have been installed to monitor their structural condition.

2.4 Tønsberg, Norway

Tønsberg is a town and municipality in the Vestfold Region. It is located 100 km south-southwest of Oslo on the western coast of the Oslo fjord. The municipality covers an area of ca. 110 km^2 and has a population of 51 887 (2018).

Figure 28 Vestfold Region within Norway

Figure 29 Tønsberg within Vestfold

Figure 30 Tønsberg's coat of arms

According to the sagas, Tønsberg was founded during the Viking-period at the end of the 9th century, but no archaeological evidence exists that confirms this. Today it is commonly believed that Tønsberg was founded during the 10th century, which puts it among the oldest towns in Norway.

Natural conditions – such as the availability of fertile farmlands, a safe port and possibilities for fortifications and defence – laid the foundations for the city's development. The town is dominated by a cliff with steep sides (Slottsfjellet), which contained the Castrum Tunsbergis. Urban structures of long, narrow estates divided by streets and narrow alleys were established in the 12th century at the foot of the cliff and along the harbour. The settlement consisted mainly of wooden log houses with one and two storeys. More monumental buildings were also erected in masonry, such as churches and monasteries. This development made Tønsberg a clerical and political centre of power throughout the medieval period.

In the second half of the 13th century, the fortress (Castrum Tunsbergis) at Slottsfjellet was erected. At about the same time international trade and shipping developed. This led to further urban growth. In the 14th century, Hanseatic merchants received trade privileges in the city. Docks and warehouses characterized the cityscape and the harbour became the town's pulsating centrepiece.

The medieval town probably reached its greatest density in population just before the Black Death in 1349. The plague cut down the population dramatically. Tønsberg, however, quickly recovered because of its strategic function as the hub and centre for remote trade. Due to acts of war and plunder in 1503 the fortress was completely destroyed, and the town experienced a recession. A large fire in 1536 left large parts of the town deserted.

Today, the traces of Tønsberg's oldest history are primarily preserved underground, as meter-thick cultural layers. The ruins of some of the monumental masonry buildings are still visible today – including Castrum Tunsbergis fortress, The Kings Hall and St. Olav's Basilica. The urban structure with estate boundaries, streets and alleyways is preserved relatively unchanged, but most of the surviving architecture is from the 19th and 20th century.

Figure 31 Townscape of Tønsberg from 1740 with the harbour and "Slottsfjellet" in the background

Figure 32 A suggested reconstruction of the Castrum Tunsbergis at "Slottsfjellet"

General description and classification of the historic area considered for the demonstration activities

The selected site covers and includes the "Slottsfjellet-area" together with most of the accompanying medieval town. The area includes both commercial, and residential areas. The CH-buildings (Tier 1 and 2) are mainly wooden, built before 1900 and usually have 2-3 floors. The traditional building material in Norway is wood. Only public and major monumental buildings were erected in masonry – a tradition that is evident in Tønsberg up until the 20th century. The area classified as Tier 3, is less homogenous regarding age and CH-value, and with a mixture of commercial, public and residential use.

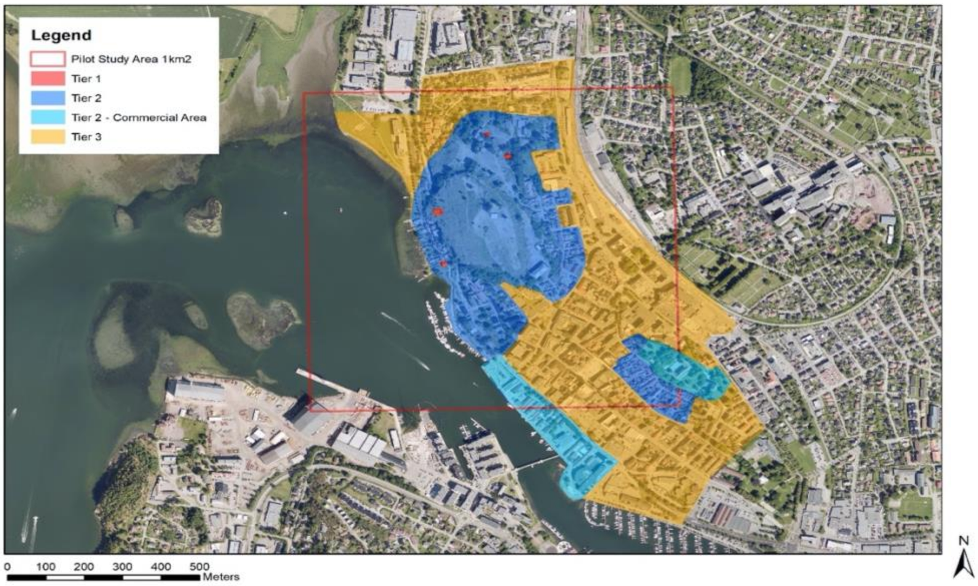

Figure 33 The Tønsberg pilot area with suggested Tier classification

Tier 1

The proposed monuments and buildings selected for sensor installation and detailed modelling (Tier 1) include different types of objects in which both masonry and wood constitute the main material.

Figure 34 Part of the selected site with a stone building (ruin) and three wooden buildings indicated for sensor installation and detailed modelling (Tier 1 buildings)

Only parts of the masonry monuments (the 13th century castle and the fortifications at the top of Slottsfjellet) are preserved today. The materials used are relatively uniform and consist mainly of local stone (granite and porphyry), lime mortar and some brick. In the first half of the 1900 century, the ruins were scientifically examined, uncovered and eventually restored.

The selected sites include many protected wood buildings, which vary greatly with regard to age, function and use. Essentially, they consist of a wood-made constructive core with panelled and painted surfaces. The roofing material varies slightly but is essentially brick tiles.

Western Tower

The western brick tower was originally part of the fortification and defence system. Located at the western edge of the cliff, overlooking the fjord and the harbour, it is believed to have had different functions connected to the docks and arriving ships.

The ruin has a rectangular plan measuring ca. 16x13m. Masonry thickness varies between 1.2-1.7 m. The building material consists mainly of local stone (granite and porphyry), laid in shifts in varying sizes with traces of bricks. The ruin has starting to decay with loose stones as well as cracks in mortar joints and the protective, concrete top layer. The most relevant degradation factors are: general weathering, freeze/thaw cycles, biological growth and man-made hazards.

The ruin is located in a remote part of the Slottsfjellet, which receives few visitors and thus minimizes the chance for vandalism. The area is suited to house relevant surveillance equipment such as a meteorological/atmospheric monitoring station etc. During the project period, the area could be fenced in and secured, if necessary.

Figure 35 Aerial view of the Western Tower ruin

Figure 36 Detail taken inside the ruin

The Heierstad Loft

The Heierstad Loft is a storage building, that was moved from its original location at the Heierstad farm 50km north of Tønsberg to the Slottsfjell Museum, where it was re-erected in 1957. The ground floor is preserved and was dated to 1407 using dendrochronology, while the attic floor is partly reconstructed.

The building has a rectangular plan measuring ca. 8x9m, and a height of ca. 9 meters. It is built (logged) of large pine or spruce logs, with a simple gable roof construction. The roofing material is traditional, consisting of coarse wooden boards, a layer of birch bark and turf. The exterior is surface treated with tar. The building is generally in good condition but requires continuous maintenance. The most relevant degradation factors are: General weathering, high humidity levels, biological growth and destabilization caused by settings in the ground.

Figure 37 The Fadum Store House

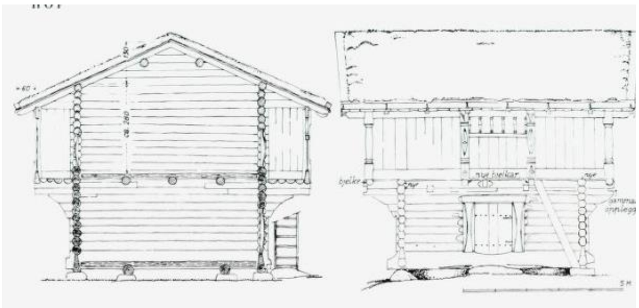

Figure 38 The Fadum Store House

The Fadum Store house

The *Fadum store house* is a building dating from ca. 1820, that was moved from its original location at *Sem*, 5 km north-west of Tønsberg to the Slottsfjell Museum, where it was re-erected in 1952. The building has a rectangular plan measuring ca. 7,5x9m, and a height of ca. 5 meters. It is built (logged) of pine or spruce logs, with a simple gable roof construction. The roofing material is brick tiles. The exterior is surface treated with tar. The building is generally in good condition but requires continuous maintenance. The most relevant degradation factors are: General weathering, high humidity levels, biological growth and destabilization caused by settings in the ground.

Figure 39 The Fadum Store House dated from 1820. To the right on its original location before its movement to the museum in 1952.

Figure 40 The Fadum Store House dated from 1820. To the right on its original location before its movement to the museum in 1952.

Bentegården

Bentegården is located in the northern part of Tønsberg, at the western foot of Slottsfjellet, close to the sea. It is part of an old building environment consisting of densely built wooden houses with 1-2 floors, dated to the 18th and 19th centuries. Bentegården consists of a main building dated ca. 1700, which today is used as a private home. Its constructive parts consist of a logged timber core standing on a low foundation wall of local stone and mortar. The exterior is panelled with vertical coarse wooden boards painted with linseed oil paint. The roof is covered with brick tiles. The building is generally in good condition but needs continuous maintenance. The most relevant degradation factors are: General weathering, high humidity levels, biological growth, destabilization caused by settings in the ground, flooding and storm surges, rock slide/landslide.

Figure 41 Bentegården is the red house to the left, here seen from Slottsfjellet surrounded by buildings from the same period.

Figure 42 Bentegården seen from the fjord with Slottsfjellet in the back

2.4.1 Current equipment/infrastructure available

- **Meteorological stations:** Several meteorological stations are installed throughout Vestfold County. The data are send to The Norwegian Meteorological Institute in Oslo and used in research and for weather forecasts. The Norwegian Meteorological Institute has a free and open data policy. (https://www.met.no/en)
- **Air quality/air pollution monitoring:** Several monitoring stations are installed throughout Vestfold County. The data are send to The Norwegian Meteorological Institute in Oslo and used in research, and for public forecasts and warnings. The Norwegian Meteorological Institute has a free and open data policy. (https://www.met.no/en)
- **Ground water and pore water pressure (PWP)**: The Directorate for Cultural Heritage has an ongoing monitoring program within the pilot area in Tønsberg, where groundwater levels and pore pressure are logged. (https://www.riksantikvaren.no/en/)
- **LIDAR-data/Terrain model**: Lidar data of the current topography as well as historical images for the generation of historical DTM's and/or the target buildings for comparison purposes. (https://www.kartverket.no/en/ & https://hoydedata.no/LaserInnsyn/)
- **TLS -data:** Terrestrial laser scan data from the upper part of Slottsfjellet are available as unfiltered point-cloud data

Due to its location in an urban area, the Slottsfjellet can provide electricity, internet/GSM coverage (4G) and all areas are accessible by asphalt roads via car. The vicinity of the Slottsfjellet museum means that on-site management (surveillance, contact), office rooms and storage facilities are available. Vestfold County Administration is located 1 km from the site and can contribute with human resources and site-specific background data to the investigations, including geographical, historical and archaeological information.

3. Demonstration City related Hazards

The HYPERION platform will be designed to offer multiple hazard assessment and optimized operational and strategic decisions for management and maintenance of the historic areas. The hazards will include specific vulnerabilities of the study areas, such as the materials used and the local topology as well as other hazards relevant for the city, such as seismic activity and man-made hazards.

A detailed representation of the hazards related to the location, local weather conditions and topology of each demonstration city is provided below. The importance of each hazard for the area is supported by historic events and their consequences or with the description of recent changes mostly related with the Climate Change.

3.1 Rhodes, Greece

The main hazards for the city of Rhodes are related to its location and local topography. To begin with, Rhodes is one of the highest seismic risk areas of Greece, with many earthquakes recorded regularly. The study area has suffered great damaged twice for large earthquakes. In 1856, an earthquake estimated up to 8 Richter destroyed the Palace of the Grand Master within the Medieval city of Rhodes while one hundred years later, in 1957, an earthquake of 7.2 Richter caused widespread damage in housing areas of the Medieval city.

In addition, the northern part of the city, which is the selected study area is almost at sea level, making the surrounding area vulnerable to flooding. Especially the recent years, due to the consequences of the Climate Change, there were two major flooding incidents in 2011 and 2013.

The island of Rhodes, is greatly affected by intense winds and the saline humidity coming from the sea. Especially the fortification walls and Saint Nikolas lighthouse, which is a Tier 1 building for this study.

Focusing to the study area, the main hazards are related to the building materials used and their response to the local climate conditions. The main building materials used in the Medieval city are highly affected by the weather conditions and the extreme weather phenomena associated with the Climate Change as they are highly vulnerable to the presence of water. In detail, the stone used for building came from two types of rock: in the northern part of the island, sandy limestone is more prevalent, while in the central and southern part of the island there is a profusion of mountain limestone from the massifs of Attavyros and Akramytis. This rock is considered older.

Most of the sandy limestone is biogenic in origin, with low mechanical tolerance and generally a great lack of homogeneity. It is particularly porous, which makes it a poor quality building material because of its great water absorbency. The porous of the stone, in combination of the local climate conditions, are to a great extend responsible for the deterioration suffered by the historic building of Rhodes especially in the city.

Wood was also used mostly for load-bearing beams of floors and for window frames. During the Hospitaliers period, timber mostly came from cypress forests of Asia Minor, known in the Dodecanese as «katrani». It is a kind of cedar relatively hard, with a few knots. When dry it is durable even in unfavorable climatic conditions.

3.2 Granada, Spain

The location of the city of Granada, at the foot of Sierra Nevada, the highest peak in Spain, is responsible for a unique climate characterized by extreme cold and increased freeze thaw cycles. Granada experiences temperatures below zero in winter and above 40^{oC} in summer, having frequent freezing /thawing cycles. Due to the Climate Change the frequency of these cycles increases, intensifying the problems of some CH buildings.

Granada is also suffering from many earthquakes as it is the region of highest seismic risk in Spain. The intense seismic activity along with the type of rocks of the mountains of Granada, create a problem with landslides. This problem is present in the hill of La Sabika, where the Alhambra is located. Recent studies show that the pit of San Pedro at the north side of La Sabika is advancing at a rate of few millimeters per year

Focusing to the study area, the main hazards are related to the adaptation of the building materials to changes to the weather phenomena, intensified by the Climate Change. The three main materials at the Granada site, rammed earth, limestone and quaternary conglomerate, are highly vulnerable to the presence of water. As an example, see the lateral wall of *Saint Ana's Church* corresponds with a rammed construction. It can be observed the humidity reaches half of the height of the Church.

Figure 43 Saint Ana's Church

According to *Gonçalves et al. (2007)* cycles of drying/hydration of the salts of the rammed earth material produce tensions which induces loss of cohesion in the material. In addition, *Afanador et al. (2013)* analysed the behaviour of rammed earth in Colombia, having a linear behaviour with almost no incursion into the plastic range. The compression strength was 0.17 MPa, the Elastic modulus between 40 and 70 MPa and a Poisson modulus of 0.26.

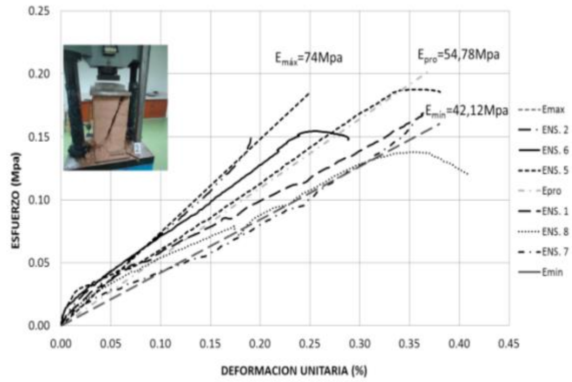

Figure 44 . Stress versus deformation. Afanador et al. (2013)

3.3 Venice, Italy

The City of Venice is in a unique and very complex territory made of water and land in which many different realities coexist and bring both valuable resources and critical issues: an extraordinary cultural heritage, a very precious and delicate natural environment (the Venice Lagoon). Venice has unique features: it was built on wooden poles planted in a compact layer of clay called «caranto», undergoing a mineralization process that makes it more and more resistant. The stone part of the buildings is in direct contact with saltwater and with the air.

Venice was built in an area where it was hard to find building materials; therefore, only two types of materials were available: the "spolia" (recycled) and the new materials. In the lagoon, between the end of the ancient world and the Middle Age, all the building materials were “spolia”/reused materials: foundation stones, decorated marbles, inscribed slabs, bricks, roof shingles, rubble. In fact, in ancient times, “spolia” materials were “bargaining chips” and their exchanges were governed by clear regulations. New materials arrived in the city only when Venice became an economic and military power. Both new and reused materials had to adapt to a climatic situation that was different from their places of origin, to the high level of saltiness in the ground, in the water and in the air, that risks to break apart their structure. To guarantee that these CH materials could still last long there is a need for an efficient methodology to protect them from aggressive chemical and physical agents and possible hazards. The main building materials used in Venice are stone, marble, brick, wood, metal, plaster.

Here too, the main hazards of the study area are associated to the building materials used and their response to the recent changes of the climate conditions. The materials used in Venice for the buildings construction had not been previously tested for such an aggressive environment from the point of view of climatic variations such as temperature changes, atmospheric agents, the presence of brackish water, tidal fluctuations, high salty water, humidity and salinity, etc. Hence, it is important to constantly monitor and examine the main buildings and monuments of Venice to verify how CC as well as air and water pollution affect the materials life and analyse their components in order to efficiently intervene for their conservation.

In the period 2000-2017 the average sea level increased about 30 cm due to the phenomena of subsidence and eustatism. Main effects are the sinking of the land (subsidence) and erosion of the lagoon bed. The impact of the salty water on the monuments and on the building materials during the high tide phases is remarkable as the salt contributes to the erosion of the buildings. Climate changes generates new strains of algae sticking to the foundations of the buildings and involves more and more heavy and intense rainfall concentrated in a short period of time with consequent problems of water overflow and drainage. Heavy rains and high water are responsible for the erosion of the walkable areas, the quay walls and the foundations of the buildings.

In addition, Venice is very vulnerable to the extreme cold and increased freeze thaw cycles. In winter, there is a damp cold with the frequent presence of fog and slight frosts. When the bora blows, the wind sharpens the feeling of cold. During the most intense cold spells, the temperature can drop below -5 ° C. During the coldest winters the lagoon can freeze.

3.4 Tønsberg, Norway

Extreme weather conditions effect greatly the city of Tønsberg. To begin with, strong winds affect the overall structural stability of the buildings in both *Nordbyen* and the area around the *Heierstad-loft*. The archaeological remains on the *Slottsfjellet* are located on the highest spot in all of Tønsberg, and therefore especially exposed to storm and strong winds. In addition, freeze and thaw cycles are already affecting the stone structures on the Slottsfjellet, leading to erosion of the original surfaces. On a large scale, freeze and thawing cycles affect the structure of the cliffs and could cause landslides.

At the study area the local materials can be divided into two main groups, stone/masonry and wood.

Stone and masonry are mainly related to the ruins of the Middle Ages. Wood is associated with standing buildings. The stone used in the current monuments is local and basically very robust (granite and porphyry). In addition, lime mortars and brick are used. These materials are very prone to degradation and damage.

The main problem, however, is related to degradation and damage to wooden buildings. Change in climate and increased stresses has already a visible and accelerating effect. The damage is mainly related to biological degradation and rot on all types of wooden building parts.

Moreover, the deep cultural layers under the ground in parts of the pilot area are very susceptible to climatic changes. Good conservation conditions require stable groundwater levels and prevention of drying out. In connection with ongoing plans for the restoration and reconstruction of parts of the medieval fortress, it is vital that all new elements are constructed and built to withstand future stresses while the materials and the design are within accepted standards.

4. Local Legislations and Financial Recourses

Cultural Heritage buildings are protected by European Union and national regulations and recommendations. Local municipalities and Cultural Heritage sites managing authorities are also involved in national or European initiatives for the establishment of proper guidelines, restoration processes and the acquisition of financial recourses for the protection and restoration of monuments of Cultural Heritage. The details regarding the legislations related with the study areas as well as the initiatives that they are currently involved are presented below.

4.1 Rhodes, Greece

- The Greek national adaptation strategy adopted in 2016 has a 10-year time horizon and outlines broad policy directions and adaptation actions in vulnerable sectors. These include natural ecosystems and biodiversity, agriculture and food security, forestry, fisheries and aquaculture, water resources, coastal zones, tourism, human health, energy and industry (including mining), transport, the built environment, cultural heritage, the insurance industry and the banking sector. The core objectives of the strategy are to improve decision-making for climate change adaptation; link adaptation with a sustainable development model through regional and local action plans; promote adaptation policies in actions in sectors identified as vulnerable; establish a system of monitoring the effectiveness of adaptation policies and actions; and make Greek society more resilient to climate change impacts through increased awareness. The 13 regional authorities of Greece are obliged to develop regional adaptation action plans and are able to make use of European Structural and Investment Funds (ESIF) to implement the national strategy. It should be noted that although more than 40 Greek cities have already committed to the Covenant of Mayors for Climate & Energy-2030, interventions to address climate-related risks are poorly integrated due to the limited capacity of some local authorities involved. (Law 4414/2016 in line with European Directive 2014/91/EE/ L 257)
- Greece is currently implementing the LIFE-IP AdaptInGR project, “Boosting the implementation of adaptation policy across Greece”. The overall goal of the project is to support the implementation of the national adaptation strategy in Greece. To this end it will build national and regional capacity for coordinating, prioritising, monitoring and mainstreaming adaptation policy actions. Pilot projects will be developed in priority sectors for 3 regions and 5 municipalities. The municipality of Rhodes is one of the beneficiaries of the project at local level. The total budget of the project is 14,2 million euro, meanwhile European contribution amounts to 8.3 million euro. The duration of the project is 8 years.
- Greece compiles and supports the proposal for climatic neutrality in Europe, by 2050.

- A joint Agreement between the Ministry of Culture and Sports, the Ministry of Shipping and Island policies, the Municipality of Rhodes, the Fund of Archaeological proceeds, the Municipal Water and Sewerage company and the Municipal Port Fund of South Dodecanese, is composed and about to be signed. The objective of the agreement is the protection, promotion, management and sustainable development of the medieval city of Rhodes meanwhile appropriate strategies and procedures and technical works will be developed and funded.
- Law 3028/2002 (ΦΕΚ 153/Α/28.6.2002) «For the protection of Antiquities and Cultural Heritage in general»
- Ministry of Culture decision ΥΑ 94262/5720/28-12-1959 - ΦΕΚ 24/Β/22-1-1960 declaring the Medieval city a historic monumental complex (ΦΕΚ 24/Β/22-1-1960) and the Ministry of Culture decision ΥΠΠΟ/ΓΔΑΠΚ/ΑΡΧ/Β1/Φ29/48764/2052 Delimitation of the Medieval City of Rhodes as an archaeological site.
- Declaration of the Medieval city as a UNESCO WORLD HERITAGE SITE since 1988.

4.2 Granada, Spain

Although lime mortars and lime paints have been investigated, earth-based mortars are not well developed yet. The influence of climate change on both materials must be investigated. Furthermore, the behaviour of the materials chosen for the Granada case change with the moisture, temperature and thaw freeze cycles. Models of these materials under these changing conditions must be investigated.

Appendix A contains the legislation applicable to Heritage Constructions in Granada. Actions that depend on return periods must be reconsidered for extremely durable structures, such as heritage constructions.

The notion of preserving the heritage constructions first appeared in the 70s. Before that, people were not aware of the need of maintaining the cultural heritage. Abandons monuments were something common. One of the main problem in Granada area in relation to the cultural heritage is the lack of vocations to celibacy in the catholic church. Monasteries, abbeys and churches were preserved by monks, nuns, voluntaries and workers, people that are not available anymore. Monasteries are abandoned or their dwellers only use part of the property. New ways to use these facilities are needed.

Citizens are worried about these monuments and any change of use must be well explained to them. The ways of information to the general public is one of the main problems in cultural heritage. People need to know what is happening to their heritage and they need to be informed.

Most heritage constructions are not properly maintained. Few of the monuments, like Alhambra city can be hold by the tourist visits. Places like Granada have too many cultural heritage constructions and they need to know what the options are to preserve, use and repair their heritage.

Often, regulations of maintenance and reconstruction are a burden that owners can hardly afford. Heritage are not attractive, and they are often abandoned. Population moves towards areas without heritage, where housing can be constructed with no major problems.

4.3 Venice, Italy

Venice benefits from a Special National Law for Venice and its Lagoon which regulates most of the policies and interventions in the historic city centre and in the lagoon. This law allocates also national funds for the protection and maintenance of the environmental and cultural heritage. In addition, all the buildings in the historical centre are bound and subjected to the regulations by the National Authority for the Architectural and cultural Heritage.

The City of Venice takes part in the “Covenant of Mayors” (2011), developed its SAEP (2012, constantly monitored) and actively participates in the international network “C40 cites” as an innovator City, addressing climate change issues. On Summer 2018 the City signed the “Deadline 2020” strategy promoted by C40 and It is committed to draft a Climate Action Plan by 2020 developing mitigation and adaptation actions to increase the resilience of the Venetian territory.

In terms of finance, the maintenance of the buildings in the Venice historical centre, both public and private requires consistent allocation of budget. The restoration of some of the public monuments has been recently carried out by the City administration with the support of private investors, sometime large companies (as in the case of the Rialto Bridge recently restored) according specific PPP agreements. Often, regulations of maintenance and reconstruction are a burden that private owners can hardly afford.

4.4 Tønsberg, Norway

Cultural heritage issues within the pilot area are managed by state, regional and local authorities. The cultural heritage interests are principally safeguarded through the Cultural Heritage Act and the Plan and Building Act (see Appendix A). The Norwegian Directorate of Cultural Heritage (RA) and Vestfold County Council (VFK) has the authority regarding the Cultural Heritage Act, while Tønsberg Municipality is responsible for the Plan and Building Act. The oldest measures of formal protection in the area were adopted already in 1924. Since then, there have been several expansions and additions. Most recently with a proposal for a new site plan for the development and use of the Slottsfjellet area (see Appendix A).

There are currently several different financing schemes for the preservation, conservation and restoration of cultural heritage in the area. These are both public and private. Smaller and medium-sized conservation projects directly related to listed monuments and buildings are mainly funded by government schemes managed by the Directorate of Cultural Heritage (RA) and Vestfold County Council (VFK). Projects related to larger development and new use, are mainly to be funded by the municipality in cooperation with private funds.

5. Current Practices & Needs

Cultural Heritage sites operators are using well established guidelines and commonly accepted practices and solutions for the operational and strategic management, risk analysis and decision-making for their sites. These procedures, followed by the study areas, are presented below. In addition, Cultural Heritage sites operators have identified and presented the gaps in these procedures and needs that the HYPERION platform can eliminate.

5.1 Rhodes, Greece

Municipality of Rhodes

Several scientific conference and workshops are held in national level to elaborate on the issue e.g. on 21 -22 of June, the international Conference for the impact of climatic change on world cultural heritage «Impacts of Climate Change on Cultural Heritage: Facing the Challenge» was held at Zappeion, Greece.

Locally, the "Department of the protection of the Medieval City and Archaeological Sites" was founded in 1985 under the Joint Agreement between the Ministry of Culture, Archaeological Receipts Fund and the Municipality of Rhodes.

The work carried out from 1984 to 2004 in the Medieval city within the framework of the Agreement, had to do with:

- Reversing the neglect and decline that was dominant until then.
- Implementing housing policy to reverse the trend of relocation of residents in the new residential areas of the city
- Restoration of significant monuments.
- Improving living conditions, social benefits and facilities.
- Implementation of underground networks applied at about 50% of the Old Town.
- Organizing conferences, publishing books, educating children on heritage, partnerships with other World Heritage cities of Europe and the world.
- Regulating the movement of vehicles “intra muros”.
- Organizing various actions in order to bring the citizen closer to the monuments.

One of the most important actions was the organization of the 7th International Symposium of World Heritage Cities that was held in Rhodes in 2003, just before the expiration of the Joint Agreement. At that time, the department emphasized on the necessity of renewal and redefinition of the cooperation between the Ministry of Culture, the Municipality of Rhodes and other stakeholders in order to confront the problems that were apparent by then. Unfortunately, these efforts were unsuccessful.

Therefore, after 2004, the Department is directed towards:

- restoration of “extra muros” buildings in the city of Rhodes.
- re-evaluation and redesign of open public space.

- restoration projects all around the island of Rhodes,
- other (mainly regulatory) studies,
- completion of the urban plan of the Medieval Town, which was considered to be an important tool for the proper function of city.

The civil protection office of the municipality takes action and initializes all necessary procedures in case of an incident.

Ephorate of Antiquities of the Dodecanese

The current activity of the Ephorate comprises archaeological research and excavations, protection, safekeeping and promotion of ancient and medieval archaeological sites and monuments in all islands of the Dodecanese, organization of new Museums and exhibitions, restorations works, conservation of immobile and mobile monuments and finds, publications of scientific studies, organization of congresses e.t.c.

In the city of Rhodes, the numerous salvage excavations, conducted from the period of the incorporation of the Dodecanese to Greece (1948) until today, have gradually brought to light the urban plan of the city, as well as sanctuaries, public buildings, private houses and thousands of graves, among them many of monumental architectural form.

For the protection of the antiquities that have already been uncovered, but also of those expected to be found, the Ephorate has designated Archaeological sites in all Dodecanese islands. The whole modern city of Rhodes and its suburbs is one of these. Furthermore, areas of particular archaeological significance or areas having outstanding visible antiquities are either expropriated or characterized as Protection Zone A, where building activities are totally prohibited; this is the cases of the ancient acropolis of Rhodes (Monte Smith hill) and of Rhodini. Both sites are today not only two attractive archaeological sites, but also the only open green spaces in the modern city.

The Ephorate, applying the Archaeological Legislation, supervises constantly all Archaeological sites and all the works executed in their limits must have its approval, after being examined by the responsible advisory bodies, the Local Archaeological Council of the Dodecanese or the Central Archaeological Council.

In 1988, after a proposition of the Ephorate, the Medieval City of Rhodes was declared an UNESCO Word Heritage Site. To the initiative of the Ephorate we also owe the foundation in 1985 of the "Department of the Protection of the Medieval City and Archaeological Sites" according a Joint Agreement signed by the Ministry of Culture and the Municipality of Rhodes. The Department undertook and implemented restoration works on many significant historical buildings in the Medieval City of Rhodes and improved its infrastructures and living facilities.

The same Department designed and carried out in the years 2006-2008 a project for the enhancement of the Hellenistic fortification wall adjacent to the Roman Bridge and for the consolidation of the banks of the Rhodini stream, flowing through the bridge. Due to technical difficulties, the repair of the masonry of the bridge, also provided by the project, could not be accomplished.

Aiming at the protection and enhancement of the many archaeological sites and independent monuments, the Ephorate has implemented the last two decades numerous major projects, partially funded by the European Community. New Museums have been founded in Rhodes and in other islands of the Dodecanese, and many projects for the restoration, rehabilitation and enhancement of archaeological sites and individual Byzantine, Medieval and Muslim monuments have been executed. Currently, a project for the restoration of the Apollo temple on the acropolis of Rhodes, as well as for the enhancement of the wider Archaeological site of the ancient acropolis is in progress.

The implementation of all these projects was accomplished according to current directives, by self-supervision and ex-post evaluation.

In Rhodini in 2002 a study was conducted by the Municipality of Rhodes, in close collaboration with the Ephorate of Antiquities, for the rehabilitation and enhancement both of the Italian park and of the antiquities surrounding the “Tomb of the Ptolemies”. However, due to the expiry of the provided deadline, the submission of the project for funding by the Community Support Framework 2000-2006 was not succeeded.

Among the current activities of the Ephorate is also the handling of emergency situations and extreme natural events, such as the earthquake in Kos two years ago, and the conflagration in the visited Archaeological site of Kamiros (Rhodes) in 2008. In these cases, the Ephorate after an autopsy (inspection) on the site, takes immediate measures employing its own scientific staff and skilful technicians, in order to protect and consolidate in the shortest time-span the affected monuments and prevent further damages.

5.2 Granada, Spain

Granada is the third most polluted city in Spain, and historical traffic regulation actions have been carried out to protect CH buildings from the air pollution. In this sense, the greatest intervention was the traffic regulation of Alhambra Palace, the most important CH building in Granada. For example, the access to the Alhambra from “Cuesta de Gomérez” was partial pedestrianised, and a new access from the Granada ring road was opened. In addition, the capacity of the reception site was improved with the development of other infrastructures such as parking.

Subsequently, “Puertas de las Granadas”, other CH monument, was restored and the transport was removed since its deterioration was generated by the pollution of the vehicles. Nowadays, touristic buses with hybrid-drive are the only vehicles that are passing through this monument.

Figure 45 "Puertas de las Granadas" before the restoration.

Figure 46 "Puertas de las Granadas" after the restoration.

Regarding to the historic centre of Granada, the Strategic Plan of Granada 2007 presented in the Sustainable Urban Mobility Plan, proposed the following actions:

- Pedestrianisation and improvement of the mobility of pedestrians.

- Improve the connection between the Alhambra and the City.

- Facilitate the access to the Albayzin area.

- Promote transport by cycling.

- Reduce the use of private vehicles.

Finally, the new Strategic Plan of Granada approved in 2015 incorporated actions to achieve a "Sustainable City" such as improve the air quality, CC adaptation plan, or conservation criteria compatible with the socio-economic and environmental development of the CH area Alabayzin-Sacromonte-Alhambra, among others.

Climate change is nowadays more evident than ever, and its adverse effects over the cultural heritage is a complex but important task that we need to address as a society.

The moisture, extreme temperatures, air pollutants, wind gusts, rainfalls or earthquakes are climate-related agents that certainly affect the deterioration of the materials and structures. The in-depth comprehension of these agents and their effect on the cultural heritage infrastructure opens a novel line of research with promising scientific, technological, and societal implications. This research line comprises a multidisciplinary approach where researchers, academics, citizens, policy makers, and heritage infrastructure owners/managers must work together to define the best protocols and guides for restoration based on multidisciplinary scientific knowledge. Therefore, the user needs and expectations of this project is a new generation of knowledge-based maintenance and inspection protocols and guides for restoration that aims at supporting decision-making for the optimal conservation of an ancient and historical city such as Granada.

5.3 Venice, Italy

The City of Venice has gained a significant experience in the management of a such a delicate and unique territory made of water and land where an extraordinary and unique cultural heritage is *combined with* a very delicate natural environment (the Venice Lagoon). The City works constantly to protect its Cultural Heritage by designing and implementing integrated policies and methodologies able to deal with different concomitant critical issues (such as for instance flooding risks, pollution of water and land and to adopt resilient strategies to mitigate the effects of climate change on its tangible CH. The City:

- benefits from a Special National Law for Venice and its Lagoon, allocating funds for environmental and cultural heritage;
- set up the Tidal Forecasting and early warning Centre to monitor tide and alert citizens in case of high tide level;
- realised the portal www.ramses.it providing a 3-D representation of the pavement of the city centre to support the management of public works;
- coordinates the monitoring committee of the 21 bodies responsible for the UNESCO site Venice and its lagoon;
- produced several studies and publications on the Venice urban maintenance and related topics

To protect the monuments from the phenomenon of the exceptional high water, Venice's main threat, the are two levels of interventions:

- the wider level: which can be represented by the MO.S.E. (Electromechanical Experimental Modul), a work of civil, environmental and hydraulic engineering, still under construction, aimed at the defence of Venice and its lagoon from the high water. It consists in the construction of rows of retractable movable barriers placed at the port inlets able of temporarily isolating the Venice lagoon from the Adriatic Sea during the high tide events.

- Ordinary level: works generally carried out in city as the raising of the banks and the pavements or, when intervening in the restoration of a building, the creation of reinforced concrete containment tanks to prevent the in-flow of the brackish water into the buildings.

The restoration of the buildings requires careful planning of the activities. Each intervention on the buildings and monuments needs also a preliminary historical and specialist analysis. Depending on the type of the problem specific solutions or techniques are applied also keeping in considerations the bounds posed by Authority for the Architectural and Cultural Heritage

Figure 47 Removable Barriers

The most common intervention to prevent the damage from the flooding of the buildings is to place removable barriers or inserting a pool by the exterior walls of the buildings.

Against the resurgence of the salty water, microporous plasters are applied to the walls to facilitate the expulsion of moisture and minerals. Even if they deteriorate quickly, the lower part of the walls (3-4 m from the road level) is always visible avoiding sudden collapses of plasters or brickworks.

Against the soil erosion underneath the walkable areas, the trachyte stones of the pavements are compacted with sand, instead of concrete, that facilitates the absorption of rainwater.

Against the erosion of the quay walls and foundations of the buildings it is necessary to temporary dry out the canal and repair the holes on the wall facing to prevent the detachment of the materials.

Figure 48 Absorbents and Protectors

Absorbents and protectors are periodically applied to the marble and brick surfaces to protect them from the erosion.

In history, Venetians were able to select the best materials suited to these peculiar characteristics (like Istrian Stone). But an aggressive environment from the point of view of climatic variations such as temperature changes, atmospheric agents, the presence of brackish water, tidal fluctuations is threatening the Venice cultural heritage. To understand how the main building materials (stone, marble, brick, wood, metal, plaster) can be quantitatively and qualitatively subject to chemical variations and exogenous agents is important to counteract these effects. Venice needs to develop advanced integrated policies and innovative methodologies to protect its historical centre with special reference to its historic buildings.

5.4 Tønsberg, Norway

In recent years there have been several processes and activities related to the site:

- A proposal for a new site plan for the Slottsfjellet area. The plan aims to secure the Slottsfjellet area as a cultural environment, landscape formation, and landmark to give the public access to great experiences of culture, outdoor life, and history. The plan will improve the facilitation for tourism and festival use and ensure that the use and development of the site is done on the premises of cultural heritage. The plan should also improve the availability of the area and resolve the traffic and access structure limited to the purpose (see 8. Selected Sources and Documents). HYPERION can provide direct input to this new site plan that ensures sustainable solutions related to hazards and future climate change
- The Annual Nordic Ruin Seminar was held in September 2018 in Tønsberg. The conference aimed to gather the Nordic environment and scholars working with research and preservation of Nordic ruins. Excursions and visits to Slottsfjellet were a part of the program.
- In June 2019 the Directorate for Cultural Heritage (RA) organized a course for craftsmen in traditional roofing techniques with the use of birch-bark and turf. The Heirstad Loft was used as a course venue.
- In the summer of 2018, extensive restoration work was carried out on the exterior of the Bentegården with financing from Vestfold County Council. The work was mainly related to the exterior and the wooden paneling together with new surface treatment with linseed oil paint.
- An ongoing monitoring programme of cultural layers in the area with logging of data related to groundwater and pore pressure. Directorate for Cultural Heritage.
- Tønsberg Municipality and the regional fire department have an ongoing work with fire protection of the areas with dense wooden architecture within the pilot area. Hyperion can be a valuable tool into this work.

Vestfold County Council as an authority and management institution needs tools that enable us to make good priorities and wise choices so that the cultural heritage and cultural environments we are set to manage are preserved for the future.

There is therefore a need for more knowledge about how changes in climate affect cultural heritage sites and cultural environments, both on a micro and macro level. Climate change is a complex phenomenon that will increase the need for cross-sectoral research. There are many different research environments with competence that is relevant for climate impact on cultural heritage. This can be anything from meteorological research to environments developing new building materials or paint products.

There is also a need for research on how traditional techniques and materials can contribute to solutions to future challenges arising from climate change.

- We need to know what climatic factors will affect our cultural heritage most in the future and what materials and cultural heritage groups are most at risk
- We need to know what events and hazards are likely to happen in the future and at what interval they will occur
- Identification, mapping and documentation of cultural heritage and cultural environments that are particularly vulnerable as a result of climate change
- We need good contingency plans for securing cultural heritage in conjunction with future extreme weather events
- We need clear guidelines and recommendations regarding material use for conservation, restoration and reconstruction projects.

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The website of Norwegian Institute for Cultural heritage Research (NIKU) Contains information on climate change and the impact on cultural heritage.

ANNEXES

Annex 1: Legislation for Heritage Construction

Rhodes, Greece

- Ν. 3028/2002 (ΦΕΚ Α 153/28-06-2002) «Για την προστασία των Αρχαιοτήτων και εν γένει της Πολιτιστικής Κληρονομιάς»
- ΥΑ 94262/5720/28-12-1959 - ΦΕΚ 24/Β/22-1-1960 «Περί κηρύξως ιστορικών διατηρητέων μνημειακών συγκροτημάτων». "Χαρακτηρίζομεν ως ιστορικά διατηρητέα μνημειακά συγκροτήματα: α) Απασαν την μεσαιωνικήν πόλιν της Ρόδου ως καθορίζεται διά των τειχών αυτής και της παρ' αυτά εξωτερικής μνημειακής ζώνης, β) άπασαν την κωμόπολιν της Λίνδου, ως καθορίζεται από την υφισταμένην πολεοδομικήν της κατάστασιν, γ) άπασαν την κωμόπολιν της Χώρας Πάτμου ως καθορίζεται από την υφισταμένην πολεοδομικήν της κατάστασιν".
- ΥΑ ΥΠΠΟ/ΓΔΑΠΚ/ΑΡΧ/Β1/Φ29/48764/2052/28-5-2009 - ΦΕΚ 277/ΑΑΠ/15-6-2009. «Οριοθέτηση της Μεσαιωνικής Πόλης της Ρόδου ως αρχαιολογικού χώρου». Εγκρίνουμε την οριοθέτηση της Μεσαιωνικής Πόλης της Ρόδου ως αρχαιολογικού χώρου, σύμφωνα με τις συντεταγμένες αρ. 1-137, όπως αυτές αποτυπώνονται στον χάρτη Α1 που υποβλήθηκε από την 4η Εφορεία Βυζαντινών Αρχαιοτήτων, κλίμακας 1:3.000 του Νοεμβρίου 2007, που υπογράφεται από τον Προεδρεύοντα του Συμβουλίου.

Granada, Spain

LEGISLACIÓN AUTORIZACIÓN OBRAS E INTERVENCIONES EN BIENES MUEBLES E INMUEBLES PERTENECIENTES AL PATRIMONIO HISTÓRICO DE ANDALUCÍA

(LEGISLATION AUTHORIZATION WORKS AND INTERVENTIONS IN MOVABLE AND REAL ESTATE PROPERTY BELONGING TO THE HISTORICAL HERITAGE OF ANDALUSIA)

A.- NORMATIVA GENERAL DEL PATRIMONIO HISTÓRICO DE ANDALUCÍA (GENERAL REGULATIONS OF THE HISTORICAL HERITAGE OF ANDALUSIA)

1.- LEY 14/2007, DE 26 DE NOVIEMBRE, DE PATRIMONIO HISTÓRICO DE ANDALUCÍA

2.- DECRETO-LEY 1/2009, DE 24 DE FEBRERO, por el que se adoptan medidas urgentes de carácter administrativo. El Decreto-ley incluye, asimismo, la modificación de la Ley 14/2007, de 26 de noviembre, del Patrimonio Histórico de Andalucía, con el fin de agilizar el procedimiento de emisión de informes en las autorizaciones para la realización de intervenciones en determinados bienes afectados por la declaración de interés cultural

3.- DECRETO 379/2009, de 1 de diciembre, por el que se modifican el Decreto 4/1993, de 26 de enero, por el que se aprueba el Reglamento de Organización Administrativa del Patrimonio Histórico de Andalucía, y el Decreto 168/2003, de 17 de junio, por el que se aprueba el Reglamento de Actividades Arqueológicas.

4.- RESOLUCIÓN de 15 de julio de 2008, de la Dirección General de Bienes Culturales, por la que se delegan en las personas titulares de las Delegaciones Provinciales de la Consejería determinadas competencias en materia de Patrimonio Histórico.

5.- DECRETO 19/1995, de 7 de febrero, por el que se aprueba el Reglamento de Protección y Fomento del Patrimonio Histórico de Andalucía. Este Decreto ha sido derogado parcialmente por la legislación y las restantes normas posteriores.

6.- DECRETO 4/1993, DE 26 DE ENERO, por el que se aprueba el Reglamento de Organización Administrativa del Patrimonio Histórico de Andalucía. Este Decreto ha sido derogado parcialmente por la legislación y las restantes normas posteriores.

B.- NORMATIVA COMPLEMENTARIA PARA LA TRAMITACIÓN DE OBRAS QUE CONTRATA LA CONSEJERÍA DE CULTURA Y PATRIMONIO HISTÓRICO (COMPLEMENTARY REGULATIONS FOR THE PROCESSING OF WORKS CONTRACTED BY THE COUNCIL OF CULTURE AND HISTORICAL HERITAGE)

1.- LEY 9/2017, DE 8 DE NOVIEMBRE, DE CONTRATOS DEL SECTOR PÚBLICO, POR LA QUE SE TRANSPONEN AL ORDENAMIENTO JURÍDICO ESPAÑOL LAS DIRECTIVAS DEL PARLAMENTO EUROPEO Y DEL CONSEJO 2014/23/UE Y 2014/24/UE, DE 26 DE FEBRERO DE 2014.

2.- REAL DECRETO 1098/2001, DE 12 DE OCTUBRE, POR EL QUE SE APRUEBA EL REGLAMENTO GENERAL DE LA LEY DE CONTRATOS DE LAS ADMINISTRACIONES PÚBLICAS

3.- ORDEN DE 4 DE NOVIEMBRE DE 2016, por la que se delegan competencias en diversas materias en órganos de la Consejería. Existen unas Instrucciones vigentes sobre redacción de proyectos y documentación técnica para obras de la Consejería de Cultura y Patrimonio Histórico. Hay una actualización a la nueva Ley de Contratos de 9/2017 pero no se han publicado aunque están sirviendo de referencia actualizada para los redactores de proyectos y la oficina de supervisión.

C.- NORMATIVA ESTATAL DE PROTECCIÓN DEL PATRIMONIO HISTÓRICO (STATE STANDARD FOR PROTECTION OF HISTORICAL HERITAGE)

1. LEY 16/1985, DE 25 DE JUNIO DE PATRIMONIO HISTÓRICO ESPAÑOL.

2. REAL DECRETO 111/1986, DE 10 DE ENERO, POR EL QUE SE DESARROLLA PARCIALMENTE LA LEY 16/1985.

Venice, Italy

Main legislations and regulations for the restoration and protection of the Cultural Heritage

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- Legge n. 352 del 8.10.1997, – Testo unico delle disposizioni legislative in materia di Beni Culturali e Ambientali
- Decreto Legislativo n. 490 del 29.10.1999 – Testo unico delle disposizioni legislative in materia di Beni Culturali e Ambientali
- Decreto Legislativo n. 42 del 22.01.2004, - Codice dei Beni Culturali e del Paesaggio
- Linee Guida per la valutazione e riduzione del rischio sismico del patrimonio culturale con riferimento alle norme tecniche per le costruzioni – Luglio 2006
- Circolare del Ministero per i Beni e le Attività Culturali dell'8 novembre 2002 - Istruzioni generali per la redazione di progetti di restauro dei beni architettonici di valore storico-artistico in zona sismica
- Norme Tecniche per le Costruzioni (NTC) di cui al decreto del Ministero delle infrastrutture e dei trasporti 17 gennaio 2018
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Tønsberg, Norway

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