

STRENCH CASE STUDIES

ANNEX 3 - DELIVERABLE D.T2.2.2

KOLIĆI

Version 1
05 2021



Name of PP(s): PP9 - MoD
Općina Dugopolje
Municipality of Dugopolje





KOLIĆI

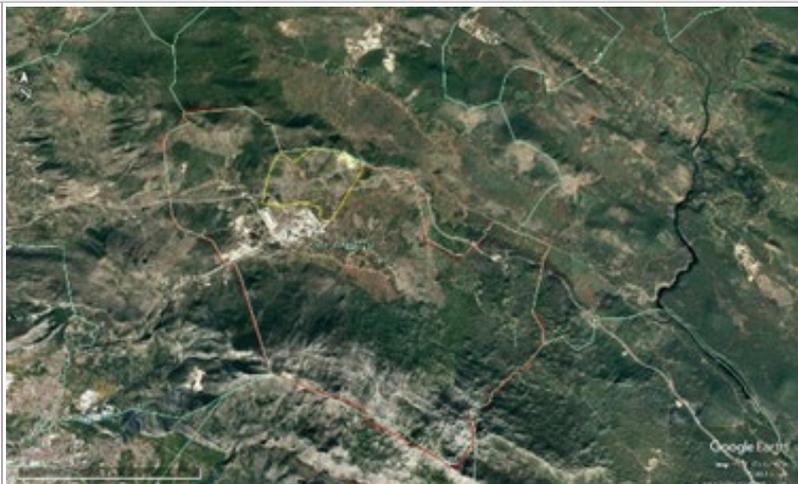
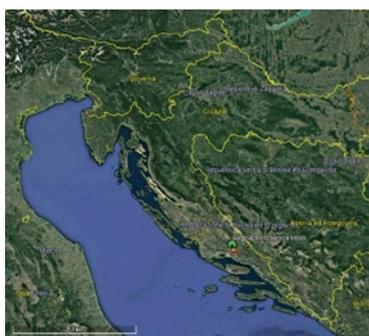
REGION	COUNTRY	EU ID	CITY	MUNICIPALITY
Split-Dalmatia	Croatia	HR		Dugopolje
CULTURAL HERITAGE CATEGORY				HAZARD TYPE
<ul style="list-style-type: none"> Hamlet in mountain area 				<ul style="list-style-type: none"> Fire  Landslides
SITE LOCATION				

Centroid geographical coordinates

Lat. 43.60301,

Long. 16.58136

Kolići is located on a hilly terrain in karst area on the northern side of the Mosor mountain. Vegetation is Mediterranean: maquis and garrigue. Geological structure is based on limestones and dolomites. Red soil and Mediterranean vegetation are the basis for agricultural production and livestock.



Geographical positioning of the site (left) with delimitation of the area extension (right): Opcina_Dugopolje (area delimited by red line) and Kolic Granica (area delimited by yellow line).

SITE DESCRIPTION

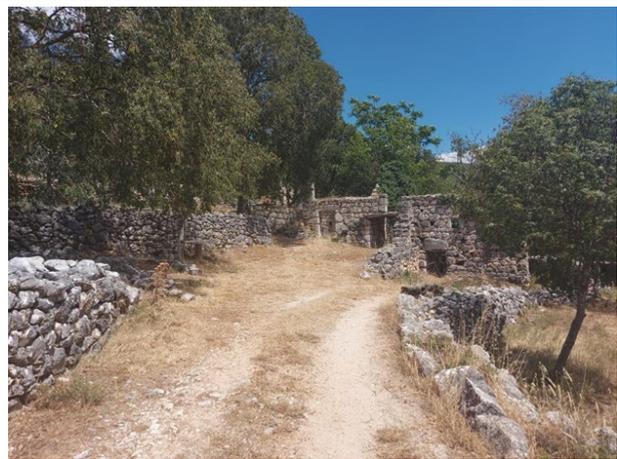
Kolići is a hamlet situated on the northeast side of the Mosor mountain, which represents a natural barrier to the Adriatic coast. There is evidence that proves that hamlet was populated in ancient Roman times, which is seen in Roman pathways and Roman gardens (Grubuša). There



is a great stagnation of population in Kolići recorded within the last century, following a tendency to reside in more developed areas, mostly in wider urban area of the city of Split. However, the traditional houses are still preserved and represent an excellent example of autochthonous Dalmatian architecture. Each summer the area is under a threat of devastating fires quick to get a great magnitude due to the impact of winds, droughts and vegetation that is easy to burn.

TPOLOGY OF CULTURAL HERITAGE ASSETS

Kolići is a hamlet in mountainous area with an example of preserved traditional Dalmatian village mostly made of stone material. In its surrounding, local cultural heritage (prehistoric mounds along the ancient road as well as a ruined medieval settlement) are present. There are two antique pathways dating to 1st century AD, out of which one (Kolići-Podi) is registered as protected cultural heritage of the Republic of Croatia.



The photo shows traditionally built residential and commercial buildings that were used to engage in agricultural and livestock activities common to this area.



The buildings are built of lime-bound stone, while the stone fences are built using the drywall technique, which has been recognized and protected by UNESCO on the World Intangible

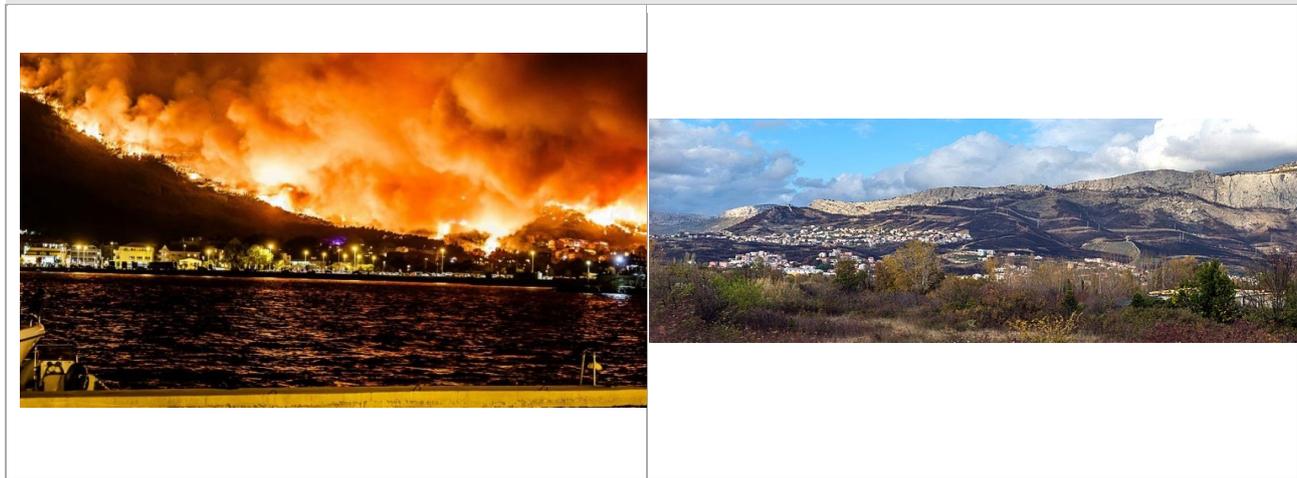


Heritage List. Due to poor housing conditions and underdevelopment, the environment around houses and outbuildings was often not paved.

MAIN RISKS IMPACTING THE SITE

Due to its position in the Mediterranean area, Kolići hamlet is threatened by a high risk of drought and forest fires also increased by climate change; moreover, the site is surrounded by a particularly vulnerable and easily burning vegetation.

Geomorphologically, the site is located in a sensitive karst area. Being on a slope, it is also endangered by the slope processes as landslides.



One of the largest fires in Croatian history broke out on July 17, 2017 and with the extraordinary efforts of firefighters, the army and volunteers was brought under control two days later. The fire front was 10 kilometres long and 2 kilometres wide, and stretched on the southern slope of Mosor and Perun Hills, while the Kolići location is on the northern slope of Mosor. The combination of high temperature, wind and easily flammable vegetation resulted in the rapid spread of the fire.





At the beginning of December 2020, heavy rain caused floods in the area of Dugopolje, but also in the rest of the Dalmatia region. There is a lot of groundwater in this area, so during heavy rains, springs are activated that flood the fields. The average rainfall in central Dalmatia, where the project site is located, for the month of December is 100.6 mm per square meter, while in 24 hours on December 9, 2020, 306 liters of rain per square meter fell in Dugopolje. Tests have shown that water from this area affects the source of "Jadro", which is a source of drinking water that supplies almost all of central Dalmatia and the islands.

RECORDED PAST EVENTS

Fire

- 17/07/2017, fire in Split-Dalmatia country that covered an area of 4,500 ha in the vicinity of the city of Split in 2017, great material damage was recorded in the Split area. It was one of the biggest fires in Croatian history. The fire destroyed small villages on the slopes of Mount Perun, as well as large areas of the cultural landscape that includes dry stone walls, olive groves and vineyards that form typical Dalmatian landscape.

Floods

- 08/12/2020, heavy rainfall was caused by a Mediterranean cyclone. Low air pressure caused sea levels to rise, and southerly winds brought plenty of rain that fell non-stop for three days in a row. This caused flooding and activated landslides throughout Dalmatia. In addition, there has been an increase in the level of rivers in the region, especially the Neretva river, whose mouth is located in a low delta in which there are several settlements, which were flooded.

ADOPTED MEASURES

- Since Kolići hamlet is mainly made of stone material, it has a certain resistance to natural and human disasters. Historical sites located near the hamlet are recognized and protected by the Spatial plan of the Municipality of Dugopolje which represents the strength of the site in terms of management and protection.

POINTS TO BE ADDRESSED AT LOCAL LEVEL

The issue of conservation and management of cultural heritage is endangered by the consequences of climate change that are particularly expressed in the Mediterranean area. For this reason, it must be emphasized the importance of:

- setting up of monitoring and evaluation methodology of the risk management,



- the coordination of stakeholders involved in the decision making for cultural heritage protection,
- mapping and management of the pilot site in conditions of natural risks,
- strengthen the capacity of the public and private sectors in mitigating the impact of climate change and natural risks on cultural heritage,
- raising the level of awareness and knowledge about the process of cultural heritage protection.

SUPPLEMENTARY MATERIAL

Regional/Local Strategies/Plans for the protection of Cultural Heritage

- Disaster and major accident risk assessments for the Split-Dalmatia County: the document refers to the organization of civil protection as a system of organizing participants, operational forces, and citizens to achieve the protection and rescue of people, material and cultural goods and the environment at risk and under the influence of disasters (windstorm, fire due to drought, flash flood).
<https://webcache.googleusercontent.com/search?q=cache:Rjce8HIF8KoJ:https://www.dalmacija.hr/DesktopModules/EasyDNNNews/DocumentDownload.ashx%3Fportalid%3D0%26moduleid%3D1766%26articleid%3D21131%26documentid%3D6670+&cd=1&hl=en&ct=clnk&gl=hr>
- Civil Protection Action Plan of the Municipality of Dugopolje: Civil Protection Action Plan of the Municipality of Dugopolje provides a description of the area of the Municipality of Dugopolje from the aspect of vulnerability to natural risks, as well as an action plan in a case of disasters.
<https://dugopolje.hr/dokumenti/sluzbeni-vjesnik-opcine-dugopolje-12-2019/>
- Master plan for tourism development of Split-Dalmatia County (2017-2027) with strategic and operational plan: the main goal of the Master plan is to define the strategic and operational concept of tourism development according to the principles of sustainable development. The emphasis is on the development of cultural tourism which is enabled by wealth and diversity cultural heritage in the County. The need for effective cultural management is also emphasized, however, the strategy does not define the approach and manner of the management.
<https://www.dalmatia.hr/hr/priopcenja/glavni-plan-razvoja-turizma-splitsko-dalmatinske-zupanije>
- Spatial plan of the municipality of Dugopolje: the spatial plan does not strictly define the cultural heritage management plan, but there are defined measures for the preservation, protection, arrangement and use of cultural property in the Municipality. It is stated that the cultural goods recorded in this plan must be included in a professionally acceptable manner in future development of the Municipality and the County. Although the cultural assets management plan itself is not defined by this document, the process of protection and preservation of cultural property is, as one



segment of management, in detail prescribed by the spatial plan.
https://dugopolje.hr/wp-content/uploads/2009/01/PPUO_-_Dugopolje_prosinac_2004.pdf

Regional/Local Web GIS Platforms for Hazard/Risk assessment

- Interactive map of fire risks and vulnerability, regional scale (Kvarner, North and South Dalmatia): the map contains layers of fire risk and vulnerability, impact on transport infrastructure, proposed measures to reduce fire risk and control, land and vegetation characteristics, transport infrastructure, information relevant to the civil protection system. Source project: Copernicus.
- Interactive map of fire risks and vulnerabilities: the map contains layers of fire risk and vulnerability, impact on transport infrastructure, proposed measures to reduce fire risk and control, land and vegetation characteristics, transport infrastructure, information relevant to the civil protection system.
<https://hukm.maps.arcgis.com/apps/View/index.html?appid=b8905fa20a2a454c8d66c70537d26ed4>

Regional/Local Maps for Hazard/Risk assessment including cultural/natural heritage

- Flood hazard map for low, medium, and high probability of occurrence, national scale: the maps show the possibility of developing three flood scenarios; they were prepared within the Flood Risk Management Plan in accordance with the provisions of Articles 111 and 112 of the Water Act of the Republic of Croatia. Paid service, source project: IPA 2010 Twinning.
- Preliminary erosion risk assessment: a preliminary erosion risk assessment was made in the framework of the Preliminary Flood Risk Assessment. The areas at risk of erosion are located in the Adriatic river basin district, to which the Municipality of Dugopolje belongs. About 40% of the territory of the Republic of Croatia is estimated to have a high and moderate risk of erosion, of which slightly more than 50% is located in the Adriatic river basin district. Paid service, source project: IPA 2010 Twinning.
- Extreme temperature, earthquake, forest fire, drought, landslide risk assessment: it was prepared in the framework of the Disaster Risk Assessment for the Republic of Croatia.
https://civilnazastita.gov.hr/UserDocsImages/CIVILNA%20ZA%C5%A0TITA/PDF_ZA%20WEB/Procjena_ri_zika%20od%20katastrofa_2019.pdf

3D Models for risk management

n.a.

Videos/Virtual tour

n.a.

Photographic archives



n.a.
<i>App</i>
n.a.
<i>Time Series</i>
n.a.
<i>Other</i>
n.a.

STRENCH CASE STUDIES

ANNEX 1 - DELIVERABLE D.T2.2.1

LAKE BALATON

Version 1
05 2021



Name of PP(s): PP6 - LBDCA
Balaton Integrációs Közhasznú Nonprofit Kft
Lake Balaton Development Coordination Agency





LAKE BALATON

REGION	COUNTRY	EU ID	CITY	MUNICIPALITY
Transdanubia	Hungary	HU		

CULTURAL HERITAGE CATEGORY	HAZARD TYPE
<ul style="list-style-type: none"> Cultural landscapes Natural heritage 	Flood/Flash flood  Landslide/Erosion Fire due to drought  Windstorm

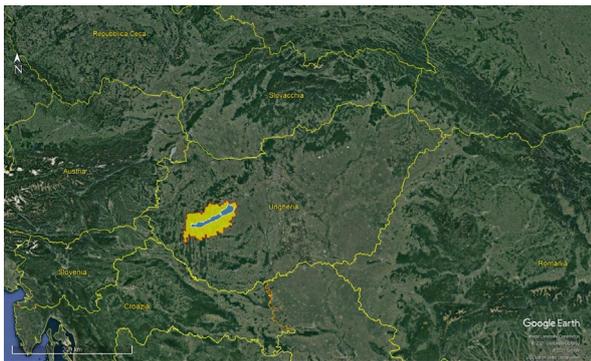
SITE LOCATION

Centroid geographical coordinates

Lat. 46.84819

Long. 17.73957

With a surface area of 594 sq. km, Lake Balaton is the largest freshwater body in central Europe, located in Transdanubian region of Hungary.



Geographical positioning of the site (left) with delimitation of the area extension (right).

SITE DESCRIPTION

The Lake Balaton catchment area is predominantly agricultural land. Elevation of the mildly rolling hilly landscape varies between 100 and 400 meters above sea level. The northern



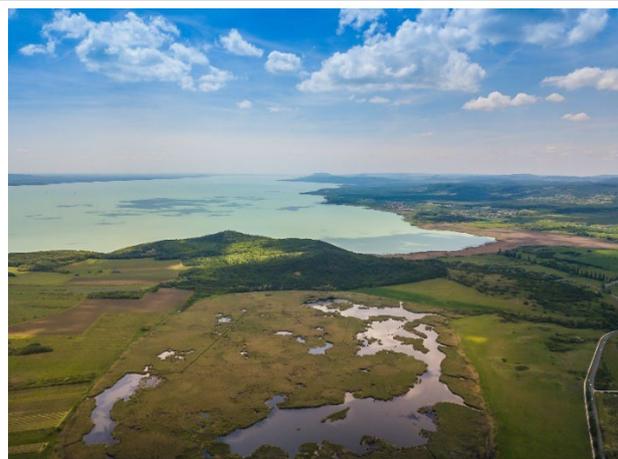
catchment follows the shoreline of the lake in a wide band and represents about one-fifth of the total area. The area of the southern catchment is 1450 km², about 1.5 times larger than the northern catchment. The western catchment area is nearly as large as the above two combined. The river Zala drains this catchment and carries about half of the total inflow and total sediment load of the lake. These loads impact directly on the Keszthely Basin, which represents hardly one-twentieth of the total volume of the lake. The area is hilly with the exception of the Kis-Balaton and the surrounding marshy area. Soils of the area are prone to erosion, a characteristic accentuated because this area receives the highest precipitation.

TYOLOGY OF CULTURAL HERITAGE ASSETS

The lake and its environment accommodate a rich and diverse flora and fauna: many rare and protected plant species can be found in the area, as well as strictly protected and rare animal species. Walk paths, educational trails and cultural landscapes introduce the rich nature of the area to visitors from all over the world. Since it is a highly frequented international tourist destination, a considerable stress is exerted on the sensitive ecosystem.

The importance of the geological, topological and aesthetic values of the area is shown by the fact that the Bakony-Balaton Unesco Global Geopark is a member of the European Geopark Network. 81 settlements of this area are involved in geoparks, which contain significant historical, cultural and ecological values. The volcanic formations of the Tihany Peninsula received an European Diploma in 2003.

A significant part of 29 Natura 2000 sites are located in the area south of the lake. In addition, municipalities have designated 116 locally protected nature areas, eg. forests, gardens, parks, etc. The area is also extremely rich in terms of cultural heritage. 2935 buildings, unique landscapes, historical gardens and sculptures enjoy national or local protection.



A bird’s eye view of Lake Balaton area with Szigliget castle (left) and the Bózsai-bay in the northern part of Lake Balaton.



MAIN RISKS IMPACTING THE SITE

Problems of anthropogenic origin include eutrophication and other water quality issues, introduction of foreign and potentially invasive species, loss of natural habitat in the littoral zone, erosion, and contamination.

The shore zone of Lake Balaton is mainly artificially built environment. Installations, unauthorized embankments, the exit of unlicensed boat and sailing, and tourism developments have contributed to the extinction of waterfront reeds, sedges, and grasslands that are important for both water quality and nature conservation.

Hilly terrain and the weak soil structure contributes to erosion.

Oscillations in the level of the water surface (seiches) and local variation of atmospheric pressure aided by currents in the water increase the erosion effect.

Droughts and decline in groundwater level, resulted by climate change, have a direct or indirect effect on the different forest types.

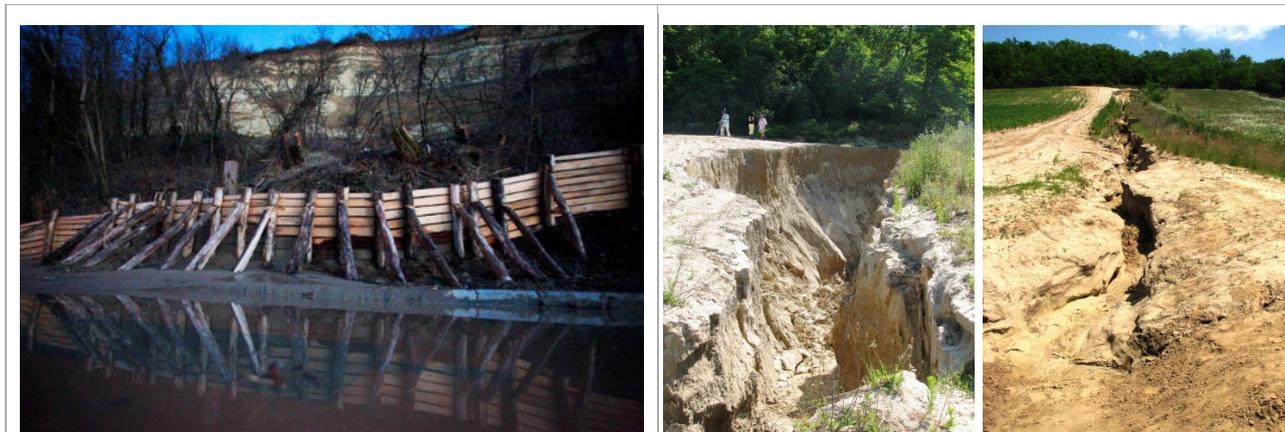
Significant conversion of wetlands: regulation, riverbed management, intensification affect many wetlands.

Lack of funds, lack of official action, change of institutional system (national park directorate only performs managerial role and has no official authority).

The population is aging who would cultivate the land.



Weather related hazards in Lake Balaton area: inundation (left) and reed fire (right)



Weather related hazards in Lake Balaton area: erosion of the so called loess soil

RECORDED PAST EVENTS

Flash flood

- September 2014, heavy rain caused a flash flood in Balatonfüred and Balatonalmádi (north side of Lake Balaton).
- June 2019, heavy rain caused a flash flood in Fonyód and Balatonboglár (south side of the Lake Balaton).

Fire

- September 2003, peat fire in Balatonfenyves, Fonyod (south side of the Lake Balaton).

Landslide

- 1910, the mountain (loess wall) in Balatonkenese (north shore of Lake Balaton) collapsed cutting the train passage.

Wind

- 1931, storm with 90-100 miles/h wind in Lake Balaton destroyed a hydroplane.

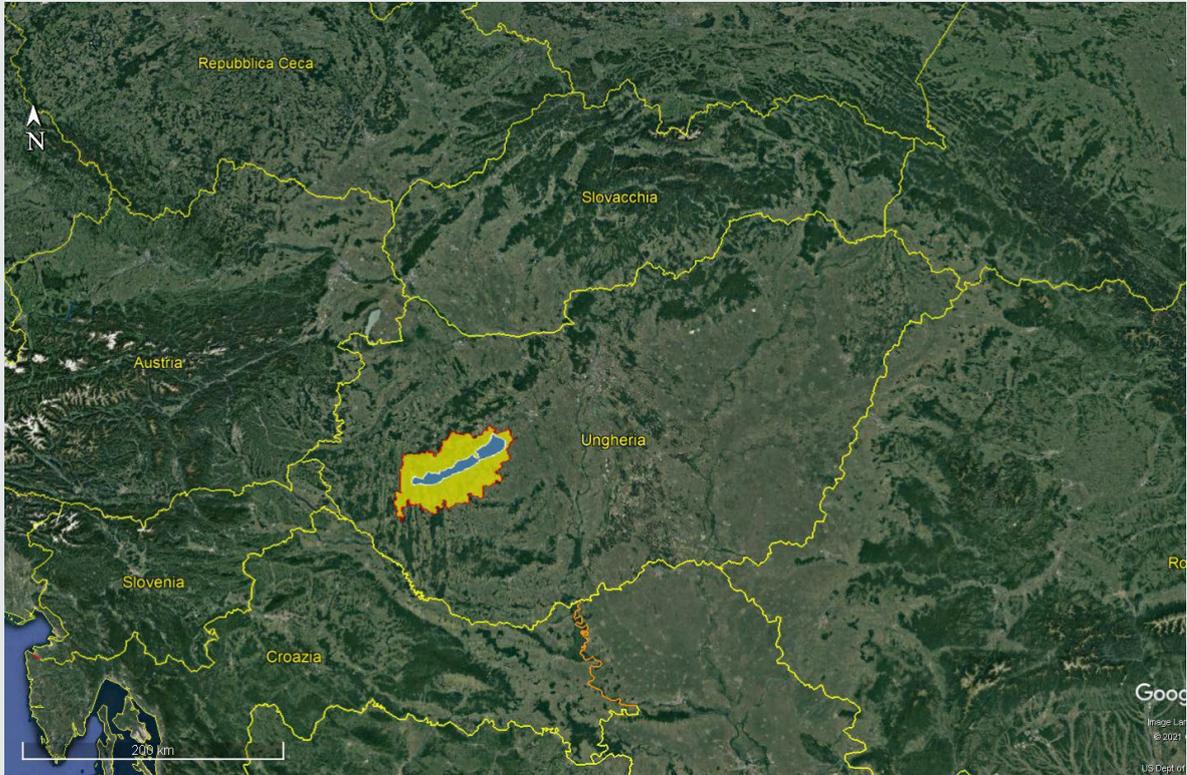
ADOPTED MEASURES

- Presence of active civil organizations (NGOs).
- Drainage systems have been developed to reduce soil erosion.
- A modern storm warning system operates in the Lake Balaton area.
- A plant protection forecasting system was installed at the vineyards in the Badacsony area.
- In the event of peat fires, the affected area is ditched around and flooded with water.



STRENCH

- Public security advisory board including the following bodies/organizations: county police headquarters, county disaster management directorates, water police, civil protection, ambulance service, water ambulance service



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POINTS TO BE ADDRESSED AT LOCAL LEVEL

- Updated database.
- Integrated tools of decision support.
- Simulation of various scenarios (natural events and management options).

SUPPLEMENTARY MATERIAL

Regional/Local Strategies/Plans for the protection of Cultural Heritage

- Act CXXVIII of 2011 Disaster Protection, national law that includes elemental disasters, natural hazards (floods, inland water, extreme weather, geological hazards), industrial misfortune, dangers of civilizational origin, etc.
<https://net.jogtar.hu/jogszabaly?docid=a1100128.tv>

Regional/Local Web GIS Platforms for Hazard/Risk assessment



Regional/Local Maps for Hazard/Risk assessment including cultural/natural heritage

3D Models for risk management

Videos/Virtual tour

Photographic archives

App

Time Series

Other

STRENCH CASE STUDIES

ANNEX 1 - DELIVERABLE D.T2.2.2

TROJA HAMLET & DISTRICT

Version 1
03 2021



Name of PP(s): PP2 - ITAM

Ústav teoretické a aplikované Mechaniky Akademie věd České republiky
Institute of Theoretical and Applied Mechanics CAS



TROJA HAMLET

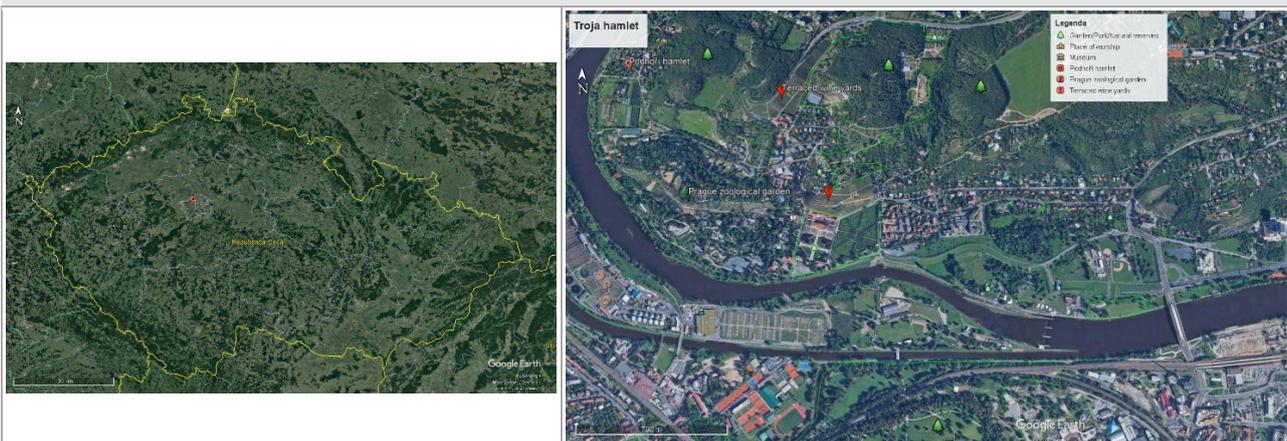
REGION	COUNTRY	EU ID	CITY	MUNICIPALITY
	Czech Republic	CZ	Prague	Troja

TYPOLOGY OF CULTURAL HERITAGE ASSETS	HAZARD TYPE
<ul style="list-style-type: none"> Cultural landscapes (mainly terraced ones) Hamlets in mountain areas Historic parks 	<p>Flood </p> <p>Fire </p> <p>Windstorm</p>

SITE LOCATION

Geographical coordinates Lat. 50.109666 Long. 14.408998

Troja hamlet is located in Prague's north-west borough and it lies in the proximity of the Vltava river.



Geographical positioning of the site (left) with delimitation of the area extension (right).

SITE DESCRIPTION

The Troja Valley features important natural and cultural heritage assets with millions of visitors yearly. One of the largest and oldest natural parks, “Stromovka” sprawls in the river meadow along with various Troja sport facilities mainly for wild water canoeing, football or softball fields, and with diverse public recreation amenities. The second largest historic complex in



Prague, the Baroque “Troja Château” with its gardens is situated in the vicinity of a protected hamlet of the historic fisherman village. The valley accommodates the Prague zoological and botanical gardens complemented with local art galleries. Steep slopes and cliffs skirt the valley. Some parts are cultivated with historic vineyards, some are covered with original herbs and plants and protected as natural reserves.

T TYPOLOGY OF CULTURAL HERITAGE ASSETS

Cultural heritage assets include one of the most significant examples of the 17th century Bohemian palace in Baroque style surrounded by an extensive French garden decorated with terracotta vases, stucco prospects and orangeries with busts of imperators. Protected Cultural Heritage Monuments include Troja Mill, Troja Brewery, wine-yard homesteads, chateau farm, Vernacular Heritage Zone (Fisherman village). Besides the architectural heritage - the historic buildings, structures, walls and sculptures - moveable heritage in galleries as well as in private collections or in homes are also endangered. In regard to the landscape, the biological cover - mainly isolated trees - and exposed slopes are at risk.



Troja Chateau garden façade (left) and during wine harvest festival in 2019 (right)



Troja Mill and Troja Brewery in 1940 (left). Chateau farm after reconstruction in 2020 (right)

MAIN RISKS IMPACTING THE SITE

Proximity to the Vltava river.

Frequent high water level situations with major flooding are the main natural risks threatening the cultural heritage of the site along with the large numbers of visitors. Minor risks include local flash floods intensified with insufficient capacity of the rain drainage system, harsh weather situations with drought, strong winds and temperature fluctuations.

Historical constructions and their contents are mostly made of porous material with is highly susceptible to floods; building components as well as natural heritage is vulnerable to dynamic and static forces, flowing objects, moisture degradation of materials and biological colonisation.

Lack of specific management plan for cultural heritage risks in particular maintenance schemes.

Structural and architectonic elements typical of the Baroque period, in particular roofs and spires, are particularly prone to vibration included during windstorm.



Flash flood in August 2020 - transported stones from terraced slopes -



River flood in the year 2002 in the Chateau Troja garden (left), in the year 2021 in the Vltava valey.



RECORDED PAST EVENTS

Flood

- August 2002, Vltava and Labe (Elbe) rivers flood in Prague. Erosion, hydrostatic and debris actions were identified as principal flood actions on structures; in most cases combinations of the flood actions occurred. Main causes of structural damage included geotechnical aspects, inadequate structural properties, and insufficient communication among responsible authorities.

ADOPTED MEASURES

- Presence of a mobile flood barrier which protects only specific areas along the river.
- Creation of a flood warning system and local crisis management unit.

POINTS TO BE ADDRESSED AT LOCAL LEVEL

- Managerial issues such as planning, communication and awareness raising for local community.
- Implementation of local maintenance schemes to increase the resilience of cultural heritage assets with respect to flood, fire and wind hazards.

SUPPLEMENTARY MATERIAL

Regional/Local Strategies/Plans for the protection of Cultural Heritage

- Strategies for adaptation to climate change in the conditions of the Czech Republic: the document presents the national adaptation strategy of the Czech Republic, which, in addition to assessing the likely impacts of climate change, contains proposals for specific adaptation measures, legislative and partial economic analysis, etc.
https://www.mzp.cz/cz/zmena_klimatu_adaptacni_strategie
- The concept of solving the problem of flood protection in the Czech Republic using technical and nature-friendly measures: the objective of the Concept is to assess and manage flood risks in accordance with Directive 2007/60 / EC and in accordance with the objectives of Directive 2000/60 / EC regarding the sustainable development of society and the interests of nature and landscape protection.
<http://eagri.cz/public/web/mze/ministerstvo-zemedelstvi/koncepce-a-strategie/koncepce-reseni-problematiky-ochrany.html>
- Methodical instruction of the Ministry of Culture on fire risk assessment of monuments and determination of the minimum standard of fire protection for immovable monuments.
https://www.mkcr.cz/doc/cms_library/metodicky-pokyn-ochrana-pamatek-4971.docx



Regional/Local Web GIS Platforms for Hazard/Risk assessment

- Flood risk map: map of flood danger and flood risks for the 2nd planning period 2021 - 2027 according to the European directive on the assessment and management of flood risks
<https://cds.mzp.cz/>
- ELECTRONIC DIGITAL FLOOD PORTAL: focused on flood prevention, management and instructions for processing digital flood plans of individual municipalities, cities, ORP and regions, as well as a catalog of products and services focused on flood protection, expert articles and discussions about the issue.
<https://www.edpp.cz/online-povodnova-mapa-cr/>

Regional/Local Maps for Hazard/Risk assessment including cultural/natural heritage

Online maps of inundation during various flood situations are available on the portal <https://www.edpp.cz/online-povodnova-mapa-cr/> . The maps have layers for the flood danger of Q5, Q20 and Q100 equivalents. The map is related to the orthophoto maps in which the architectural heritage objects are presented. No specific hazard/risk map with cultural heritage description is available.

3D Models for risk management

Physical 3D model was elaborated to assess the flow of flood waters in the Troja basin.



3D model of the capital City of Prague - terrain and buildings is available at

<http://en.iprpraha.cz/clanek/1437/explore-prague-with-a-new-3d-model-application>



Videos/Virtual tour

n.a.

Photographic archives

Prague geographic data including for example Archive of Prague's Orthophotomaps available on <https://www.geoportalpraha.cz/en>

More photographs of Troja District and from flood events available on the web site of the Municipal District Praha-Troja, www.mctroja.cz and in the Digital Archive at the Municipal District office

App

n.a.

Time Series

n.a.

Other

n.a.

STRENCH CASE STUDIES

FRANCONIAN SWITZERLAND

Version 1
05 2021



Name of PP(s): PP8 - LRA FO
Landkreis Forchheim
District Council Forchheim





FRANCONIAN SWITZERLAND

REGION	COUNTRY	EU ID	CITY	MUNICIPALITY
Bavaria	Germany	DE		

CULTURAL HERITAGE CATEGORY	HAZARD TYPE
<ul style="list-style-type: none"> Cultural landscapes (fruit growing) Hamlets 	Flood  Drought Temperature variation due to climate change

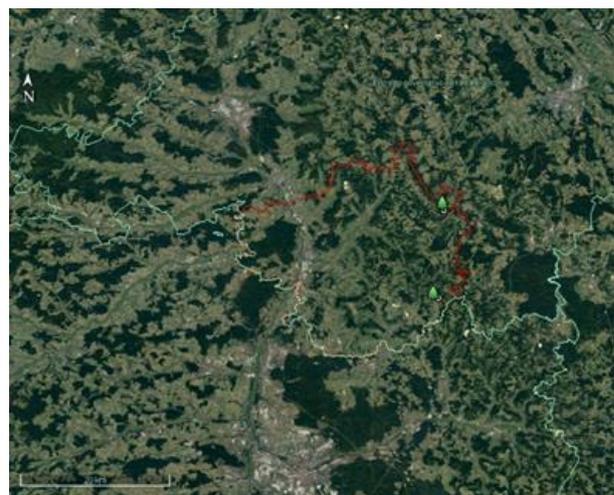
SITE LOCATION

Centroid geographical coordinates (WGS84)

Lat. 49.719722

Long. 11.058056

The District of Forchheim (DoF) is located at the northern part of Bavaria, Germany, and is part of the Nuremberg metropolitan region. The DoF comprises parts of the scenic nature park “Fränkische Schweiz” (Franconian Switzerland) and has a long settlement history.



Geographical positioning of the site (left) with delimitation of the area extension (right).

SITE DESCRIPTION



The Forchheim district (northern Bavaria) comprises parts of the natural park Fränkische Schweiz (Franconian Switzerland), which is part of the low mountain range Fränkische Alp (Franconian Alp) and has a long settlement history. Franconian Switzerland is an upland in Upper Franconia, Bavaria and it comprises almost 30 municipalities with several hamlets and touristic areas. Consequently, the Franconian Switzerland covers cultural heritage and natural heritages such as a characteristic mountain and hilly cultural landscape with a high density of castles and ruins, striking rock formations and caves, deep valleys formed by rivers and old architectures. The cultural heritage assets include hamlets with half-timbered houses or mills at rural areas and natural, typical cultural landscapes with fruit growing areas in particular cherry plants.

TYPOLGY OF CULTURAL HERITAGE ASSETS

Within the STRENCH project the DoF aims to strengthen the resilience of its unique cultural landscape with a special focus on fruit growing and hamlets in mountain areas. Thereby, the competences of the DoF lie in the regional planning and development.



Elements of the unique cultural landscape in the Forchheim district are for example ruins in mountainous areas (left) and fruit growing areas (right)



The “Walberla”, a characteristic mountain in the DoF, is a well-known cultural and natural heritage site with a settlement history from the Stone Age to the Middle Ages.

MAIN RISKS IMPACTING THE SITE

Natural and climate related hazards, particularly drought, heat, pluvial and flash floods, storm events, late frost events, fire and pests strongly affect the unique cultural landscape covering the District of Forchheim.

The cultural landscapes are facing more frequent and more unpredictable water floods especially in the valleys (river systems e.g., river Wiesent, Trubach, Leinleiter, Ehrenbach etc.) at mountain areas.

Agriculture, especially cherry cultivation, is facing water drought damage and temperature fluctuations.



Next to heat and drought, floods pose a major risk to the valleys in the district of Forchheim. The scenic valleys (left) can turn into severely damaged floodplains (right).

RECORDED PAST EVENTS

Flood

- 1920s to 1960s, local flooding in Forchheim district with infrastructure and agriculture damages.
- 2007, heavy rain, thunder, flash flood in Forchheim district with infrastructure damages.

Drought

- 1930s to 1950s, drought in Forchheim district with harvest damages.

Low temperature

- 2000s, frost temperature in Forchheim district with harvest damages.

ADOPTED MEASURES

- Possible rivers re-naturalisation – building costs at reservoir pools.



- Physical resilience e.g., temperature at cherry growing plants: frost control, new water reservoir and distribution systems.

POINTS TO BE ADDRESSED AT LOCAL LEVEL

- Managerial weakness: NIMBY problem (not in my backyard/municipality).
- Better forecast and control system, better coordination of building and construction.

SUPPLEMENTARY MATERIAL

Regional/Local Strategies/Plans for the protection of Cultural Heritage

- Katastrophenschutzplan: management plan and coordination in case of natural or cultural catastrophe/emergency at the Forchheim district.

Regional/Local Web GIS Platforms for Hazard/Risk assessment

- FIN-Web: The Bavarian State Environmental Office provides various spatial environmental data. For certain user groups such as authorities, municipalities, landscape and nature conservation associations additional topics can be activated.
https://www.lfu.bayern.de/natur/fis_natur/fin_web/index.htm
- CEDIM Risk Explorer Germany: maps that present the results of the CEDIM project “Riskmap Germany” including natural (winter storm, earthquake, flood) and man-made hazards, vulnerability, and risk as well as assets.
<http://cedim.gfz-potsdam.de/riskexplorer/#>
- GIS ImmoRisk Naturgefahren: online GIS tool provided by the Federal Institute for Research on Building, Urban Affairs and Spatial Development. The map shows natural hazards at national level such as heavy rainfall, winter storms, forest fires, earthquakes, and heat as well as - depending on the availability of databases - a qualitative or quantitative assessment of climate risks.
<https://www.gisimmorisknaturgefahren.de/immorisk.html>
- UmweltAtlas Bayern: the Bavarian State Environmental Office provides various spatial environmental data concerning different thematic areas (geological hazards, hydrology, protected areas, floods, past events etc.).
<https://www.lfu.bayern.de/umweltdaten/kartendienste/umweltatlas/index.htm>
- BayernAtlas: maps concerning different thematic areas as environmental data and natural hazards.
https://geoportal.bayern.de/bayernatlas/mobile.html?lang=de&topic=nage&bgLayer=atkis&catalogNodes=1&layers=5d4af972-fa72-48e0-a8c1-55d0782e540a,1ccf59af-de93-481b-ba48-f09a5f140fca&layers_visibility=false,false
- Hochwassernachrichtendienst Bayern: measure of river water for the prevention of floods.
<https://www.hnd.bayern.de/pegel/meldestufen>
- Drought monitoring: map of drought index in Germany.
<https://www.ufz.de/index.php?de=37937>
- Deutscher Wetterdienst: measure of climate indicators
https://www.dwd.de/DE/wetter/warnungen_gemeinden/warnWetter_node.html



- Map of erosivity of rain events.
<https://hess.copernicus.org/articles/23/1819/2019/>

Regional/Local Maps for Hazard/Risk assessment including cultural/natural heritage

- Denkmal-Atlas: The Bavarian Monument Atlas is the online version of the Bavarian Monument List - always up-to-date and accessible to everyone. Based on official maps and aerial photographs from the Bavarian survey authority, the atlas provides information on the current status of monuments, sites and ensembles throughout Bavaria. In combination with the above-mentioned Web-GIS platforms a hazard/risk assessment can be conducted.
<https://geoportal.bayern.de/denkmalatlas/>

3D Models for risk management

Videos/Virtual tour

Photographic archives

App

Time Series

Other

STRENCH CASE STUDIES

VIPAVALLEY

Version 1
05 2021



Name of PP(s): PP7 - UIRS

Urbanistični inštitut Republike Slovenije

Urban Planning Institute of the Republic of Slovenia





VIPAVA VALLEY

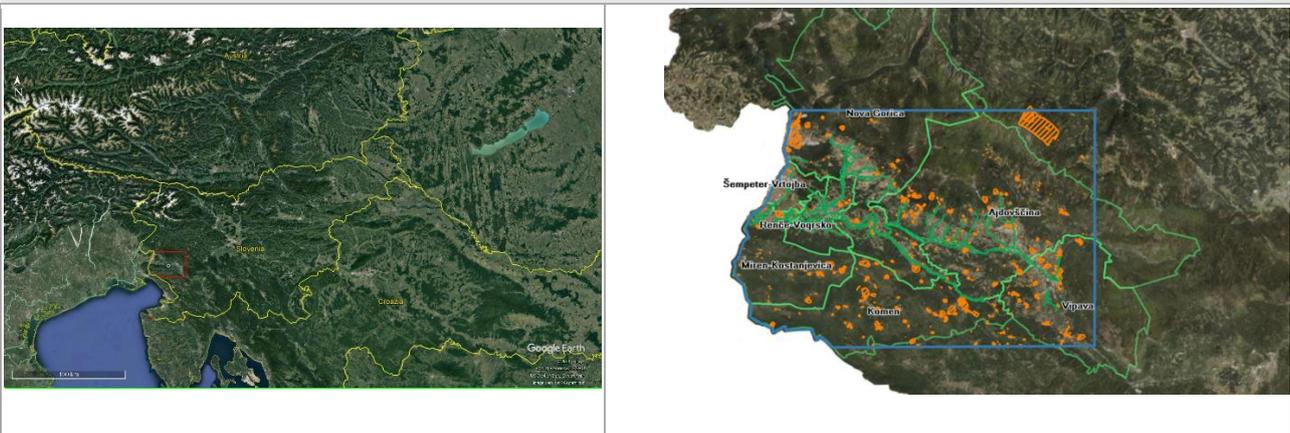
REGION	COUNTRY	EU ID	CITY	MUNICIPALITY
The Gorizia Statistical Region	Slovenia	SI		

CULTURAL HERITAGE CATEGORY	HAZARD TYPE
<ul style="list-style-type: none"> Cultural landscapes 	Flood  Windstorm

SITE LOCATION

Geographical coordinates Lat. 45.876147 Long. 13.907319

The Vipava Valley is located in the southwestern part of Slovenia. The area has been a passageway between Italy and the Danube region for millennia. The valley is surrounded by the mountains Trnovski gozd, Hrušica and Nanos and by the Vipava Hills merging with the Karst.



Geographical positioning of the site (left) with delimitation of the area extension (right).

SITE DESCRIPTION

Vipava Valley is surrounded by the mountains Trnovski gozd, Hrušica and Nanos and by the Vipava Hills merging with the Karst. For millennia, the area has been a passageway between Italy and the Danube region, but it keeps intact its natural features. The valley is rich in cultural landscape and cultural heritage: sacred monuments, mostly churches from the Gothic period, and castles constitute an important national heritage from Roman period to the 17th century. These include the Zemono (hunting manor, 17th century), the Lanthieri (manor house, 17th century), Vipavski Križ (village with castle walls and the Capuchin convent, 13th century),



Roman fortification and baths (Ajdovščina, roman period), Roman tower (Vrtovin, roman period). The area has also several other monuments from the 19th century such as Coronini manor, Miren castle with the Church of our Lady of Sorrows, Vogrsko manor, Dobrovo castle and Vipolže manor.

TPOLOGY OF CULTURAL HERITAGE ASSETS

Through the Vipava Valley, there are more than 1200 cultural heritage sites with a status of national or local importance. There are different types of cultural heritage from prehistorical archaeological sites, monuments from the Antique, Gothic, Baroque periods, and other objects from the 19th century. In the STRENCH project only selected cultural heritage at potential risk are taken into consideration.



Vipava Valley landscape



Lanthieri Manor, Vipava (left). Renče dam with mill (right).

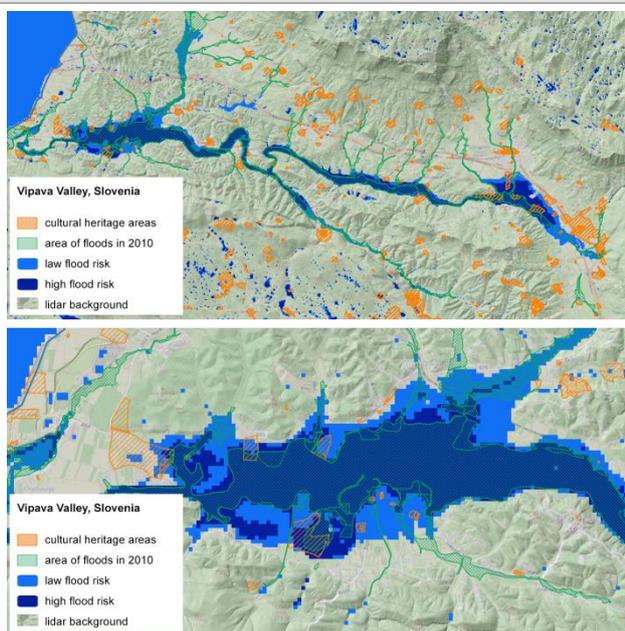
MAIN RISKS IMPACTING THE SITE

The Vipava valley and its cultural heritage are affected by natural disasters due to geographical, hydrological, and climatic characteristics. Locals are tackling bora wind, floods, and landslides for centuries. Floods, landslides, and the bora wind affected architecture, agriculture, economic



activities, and the population. Landslides are common on the steep slopes during heavy rainfall events in the north of the Vipava Valley.

A simple cellular automata fast flood evaluation model (CA-ffé) using LIDAR relief (1x1m) has been implemented to determine potential flood risk areas (50x50m) in Vipava Valley. The goal of this modelling is to predict long-term flood risk areas including anticipated scenarios of climate changes. The input of the model is the highest 5-day precipitation amount (yearly maximum of cumulated precipitation over consecutive 5 day periods). The value of the Strench WebGIS tool variable “rx5day_ensmax_2071-2100_rcp85” for Vipava Valley is used as the input parameter of the model. The output map (50x50m) of the model was “downscaled” from Strench WebGIS data (12x12km) and can now be used for Vipava Valley.



Vipava Valley. Cultural heritage under flood risk. The downscaled map presents predictions of long term flood risk areas including anticipated scenarios of climate changes.



Vipava, linden avenue, floods in June 2020 (left). Velike žablje, Vipava flooding in June 2020 (right).



RECORDED PAST EVENTS

Flood

- October 1898, in the 2nd half of October, Vipava was flooded (water up to half a meter high).
- 16-19/10/1992, floods in Vipava lower stream.
- 3-7/12/1992, Vipava near Ajdovščina flooded.
- 28/10/1994, Vipava near Žablje overflowed due to heavy rainfall.
- December 1995, Vipava lower stream flooded at the end of December.
- 2/04/1996, Heavy rainfall caused minor flooding of the Vipava river.
- 29-31/03/2009, the water caused the most damage in the Vipava and Goriška regions. Extensive agricultural areas, fields, vineyards, orchards, as well as dozens of residential and other buildings were flooded.
- 23-27/12/2009, the warning flows on the Vipava in Dolenja and its tributaries, especially the Hubelj flood of the Vipava upstream, were exceeded.
- 17-21/09/2010, extensive floods covered the Vipava.
- 06-10/12/2010, the river Vipava flooded harder. Vipava upper and lower part of the Vipava valley heavier floods.
- 23-27/12/2010, Vipava floods to a lesser extent.
- 27/10/2012, Vipava started flooding to a lesser extent in the morning.
- 05-20/11/2014, three more intense flood events occurred: 6 -11 November, 11-13 November, 18-20 November.
- 14/10/2015, Vipava floods in usual places in the lower part, increased flows in Hubelj, Branica and Lijak floods.
- 01/10/2016, Vipava was the first to rise and spilled to a lesser extent in the areas of frequent floods.
- 08-16/02/2017, with the onset of precipitation, flows began to increase.
- 27-28/04/2017, the first river overflows began on the morning of the 28 of April and in the central flood Vipava spilled along the watercourse.

Windstorm

- 03-07/02/2015, very strong bora wind: the highest half-hour average wind speed was 54 km/h caused road closures.
- 19-23/05/2015, very strong bora wind: the highest half-hour average wind speed was 78 km/h.
- 11/01/2016, bora wind: the highest half-hour average wind speed was 10,5 km/h.
- 05-07/11/2016, bora wind: the highest half-hour average wind speed was 9,2 km/h.
- 16-19/01/2017, strong bora wind: the highest half-hour average wind speed was 17,7 km/h.
- 14-20/09/2017, strong bora wind: the highest half-hour average wind speed was 19,1 km/h.
- 22-23/10/2017, bora wind: the highest half-hour average wind speed was 10 km/h.
- 12-15/11/2017, bora wind: the highest half-hour average wind speed was 13,9 km/h.
- 03/02/2018, bora wind: the highest half-hour average wind speed was 14,5 km/h.



- 22/02/2017, bora wind: the highest half-hour average wind speed was 13,9 km/h.
- 27-30/10/2018, strong bora wind: the highest half-hour average wind speed was 18,7 km/h.
- 02/01/2019, bora wind: the highest half-hour average wind speed was 12,55 km/h.
- 02/02/2019, bora wind: the highest half-hour average wind speed was 9,1 km/h.
- 03/11/2019, bora wind: the highest half-hour average wind speed was 7,6 km/h.
- 21/10/2019, bora wind: the highest half-hour average wind speed was 10,5 km/h.

ADOPTED MEASURES

Since natural disasters as floods and wind are present in Vipava Valley for centuries, they are well tackled in national and local documents (see the list below).

POINTS TO BE ADDRESSED AT LOCAL LEVEL

Demography (natural disasters affect various activities and the population).

Flood safety arrangements of area along the Vipava River.

Issue of windbreaks in the Vipava Valley.

SUPPLEMENTARY MATERIAL

Regional/Local Strategies/Plans for the protection of Cultural Heritage

- Ordinance on protection against natural and other disasters in the area of the Municipality of Vipava: responsibilities and tasks regarding protection against natural and other disasters.
- Protection program against natural and other disasters and fire protection for the period 2015-2020, Vipava.
- Municipal spatial plan: spatial components for protection of CH against natural hazards.
- SPRS-50: national spatial development strategy.
- Act on the protection against natural and other disasters: organization and duties of the civil protection system.
- Act on the protection of the environment: legislation regarding environmental hazards.
- Regulation on the organization and functioning of the system of observation, notification, and alarm: responsibilities of national authorities and regional centers during disasters.
- Cultural Heritage protection Act: responsibilities of public cultural heritage authorities regarding natural disasters and armed conflict.



- Resolution on the national security strategy of the Republic of Slovenia: strategy for national security.
- Regulation on the content and the drafting of protection and rescue plans: contents of plans and responsibilities.
- Risk assessment of the Republic of Slovenia due to flooding.
- Resolution on the national program of protection against natural and other disasters in the years from 2016 to 2022: priorities and tasks according to the national security strategy.

Regional/Local Web GIS Platforms for Hazard/Risk assessment

- iSlovenia: national scale GIS platform with detail of flood risk areas.
<https://gis.iobcina.si/gisapp/Default.aspx?a=vipava>
- Environmental Atlas of the Republic of Slovenia: national scale GIS platform with detail of flood risk areas and other relevant environmental contents.
http://gis.arso.gov.si/atlasokolja/profile.aspx?id=Atlas_Okolja_AXL@Arso
- "eWater": national portal and GIS platform about detail areas of flood risk.
<https://gisportal.gov.si/portal/apps/webappviewer/index.html?id=11785b60acdf4f599157f33aac8556a6>

Regional/Local Maps for Hazard/Risk assessment including cultural/natural heritage

iSlovenia

Coverage: Slovenia, national

Hazards for STRENCH: floods

Type of CH considered: all types of cultural heritage

Open access

Source: layers are regularly updated as maintained by different national agencies

<https://gis.iobcina.si/gisapp/Default.aspx?a=vipava>

The platform was developed mainly for small municipalities (smallest administrative unit in Slovenia that prepare spatial / urban plans). The platform enables basic GIS work and more sophisticated uses in the fields of spatial planning (documents, acts, land use, protection regimes for cultural and national heritage, housing, cadaster, etc), transport (routes, parking, school paths, road signalization, maintenance of roads, etc.), communal infrastructure (cemetery, public and green area, etc), energetics (lightning), and some other functionalities e.g. public participation.

Environmental Atlas of the Republic of Slovenia

Coverage: Slovenia, national

Hazards for STRENCH: floods

Type of CH considered: all types of cultural heritage

Open access

Source: layers are regularly updated and maintained by national agencies

http://gis.arso.gov.si/atlasokolja/profile.aspx?id=Atlas_Okolja_AXL@Arso

Environmental Atlas is a web portal that allows users to view spatial data via the Internet using a web browser. It provides insight into environmental spatial content to the widest circle of



users. The Environmental Atlas presents spatial data that are in the official records of the ARSO and relate to environmental issues (water, nature, weather, earthquakes, environmental protection,...). The contents are arranged by thematic groups: measuring points, environment, climate, water, nature, soil, earthquakes.

"eWater"

Coverage: Slovenia, national

Hazards for STRENCH: floods

Brief description: national portal and GIS about water management

Open access

Source: layers are regularly updated and maintained by national agencies

<https://gisportal.gov.si/portal/apps/webappviewer/index.html?id=11785b60acdf4f599157f33aac8556a6>

eWater is national portal dealing with water management. Part of this platform is also GIS that contains data on water regimes, also floods.

3D Models for risk management

N.a.

Videos/Virtual tour

N.a.

Photographic archives

N.a.

App

N.a.

Time Series

N.a.

Other

N.a.

STRENCH CASE STUDIES

WACHAU CULTURAL LANDSCAPE

Version 1
05 2021



Name of PP(s): PP3 - DUK

Universität für Weiterbildung Krems Donau - Universität Krems

University for Continuing Education - University Krems



WACHAU CULTURAL LANDSCAPE

REGION	COUNTRY	EU ID	CITY	MUNICIPALITY
Lower Austria	Austria	AT		

CULTURAL HERITAGE CATEGORY	HAZARD TYPE
<ul style="list-style-type: none"> Cultural landscapes Hilly hamlets Ruins 	<p>Flood/Flash flood </p> <p>Landslide</p> <p>Fire due to drought </p> <p>Heavy rain </p>

SITE LOCATION

Centroid geographical coordinates (WGS84)

Lat. 48.39018

Long. 15.47489

The Wachau region (AT) is a riverine landscape encapsulated by steep mountainous terrain (granite & gneiss) on each side of the Danube river; it spans 36 km in length. The cultural landscape is characterized by terraced viticulture and medieval town centres, located on the banks of the Danube.



Geographical positioning of the site (left) with delimitation of the area extension (right).

SITE DESCRIPTION

The Wachau is a stretch of the Danube located between the cities of Melk and Krems, with high landscape qualities. The valley shows many traces of its continuous, organic evolution since



prehistoric times, be it in terms of architecture (monasteries, castles, ruins), urban design (towns and villages with basic layouts dating back to the 11th and 12th centuries), or agricultural use (mainly for the cultivation of vines and apricot trees).

The clearing of the natural forest by local peoples began in the Neolithic period, although radical changes did not take place until around 800, when the Bavarian and Salzburg monasteries began to cultivate the slopes of the Wachau, giving the landscape its present characteristic pattern of vine terraces (historic dry stone wall terraces, and orchards of apricot).

In 2000, the “Wachau Cultural Landscape” has been inscribed in the UNESCO List of World Heritage Sites.

TYPOLOGY OF CULTURAL HERITAGE ASSETS

The Wachau is characterised by a multitude of cultural and natural heritage: historic (medieval) city centres, monasteries, ruins, artistic treasures of all periods (starting from the Paleolithic period), various hamlets in the hinterland, terraced vineyards (dry stone walls) and apricot trees.



View of the northern riverbank Rothenhof (left). Northern riverbank vineyards of Weissenkirchen as seen from the nature reserve Steinige Ries © Kaiser



Northern riverbank of Wösendorf in der Wachau as seen from the nature reserve Steinige Ries (left). Danubian cruise ship Wachau (right). © Kaiser

MAIN RISKS IMPACTING THE SITE

Hamlets located directly on the banks of Danube river and at the foot of the descending hills of the valley are vulnerable to Danube floods, landslides from the steeply ascending walls of the Danubian water gap and flash floods from tributary creeks. Museums and galleries located in inundation zones.

Heavy rain can swamp and soak the steep vineyards of the Wachau valley and can cause strong erosion and landslides.

Climate change is a major challenge for ensure the traditional cultivation and the agricultural and forestry land use in the Wachau: e.g., sensitivity of apricot tree to hail and freezing during blossoming period which causes failure of the crop with subsequent damage to the region's economy.

Fire is recognised as big risk the old towns of Wachau, since the roofs of the buildings often are immediately connected, as well as for the natural (and cultural) landscapes, as the pastures and shrubs are often highly dried up due to long drought periods.



Flooding of the historic center of Melk during the 2013 Danube flood. © KERMER





Reinforced flood barricades in Krems/Stein during the 2013 Danube flood. © APA/Helmut Fohringer

RECORDED PAST EVENTS

Flood

- 13/07/1954, river flood in Danube region.
- 02/07/1975, river flood in Danube region.
- 04/08/1991, river flood in Danube region.
- 14/08/2002, river flood in connection with heavy rain in Danube region.
- 04/07/2013, river flood in connection with heavy rain in Danube region: water penetration in the churches of Mitterarnsdorf and Hofarnsdorf with destruction of the floor.
- 2008, flash flood/overflow of the tributary Grubbach (during the construction of the flood protection) in Weißenkirchen town (Wachau).

Landslide

- 14/08/2002, heavy rain with consequent landslides in the whole Danube region: partial collapse and destruction of the characteristic dry-stone walls.
- 04/07/2013, heavy rain with consequent landslides in the whole Danube region: partial collapse and destruction of the characteristic dry-stone walls.

ADOPTED MEASURES

- In towns along river Danube exist mobile flood barriers or other flood protection.
- Fire management plan: plans and strategies for firefighting in the old towns of Krems and Stein exist and are currently updated.
- Hail planes which mitigate the damage caused by hail (particles of silver iodide are introduced into the cloud base, which is to prevent the hailstones from becoming too large).
- Some winemakers try to cultivate new vines which root deeper and therefore become more resistant against long lasting drought periods. Public security advisory board including the following bodies/organizations: county police headquarters, county disaster management directorates, water police, civil protection, ambulance service, water ambulance service.

POINTS TO BE ADDRESSED AT LOCAL LEVEL

There are several cultural sites (galleries, museums, churches etc.) in the Wachau valley which do not have an emergency plan in the event of a disaster.



SUPPLEMENTARY MATERIAL

Regional/Local Strategies/Plans for the protection of Cultural Heritage

- Flood emergency plan for Melk: well-structured procedure defined in clear phases in accordance with the water level; the municipality of Melk has tailored the general plan to their special needs.
- Emergency plan Dürnstein: the basic emergency plan for the whole county has been adapted for the local needs of the municipality of Dürnstein, taking rock fall into account.
- Danube River Basin Management Plan: the DRBM Plan aims to protect and enhance the status of all waters, to prevent their deterioration and to ensure the sustainable, long-term use of water resources. It includes latest assessments on significant pressures, water status and a programme of measures jointly agreed by the Danube countries for the period 2015 until 2021.
<https://www.icpdr.org/main/management-plans-danube-river-basin-published>
- Management Plan Wachau World Heritage: including a presentation of the territory, potential risks, regional strategies and initiatives, etc.
https://www.weltkulturerbe-wachau.at/fileadmin/Bibliothek/projects/_Projekte/WachauProjekte/ManagementPlanWorldHeritageWachau_20170710.pdf

Regional/Local Web GIS Platforms for Hazard/Risk assessment

- HORA (Natural Hazard Overview & Risk Assessment Austria): a digital map of the natural hazards that includes flood (water outflow, risk areas, height. etc.), earthquake, landslides, storm, snow load, pollution available after registration.
<https://www.hora.gv.at/>
- Forest Fire Database Austria: a detailed description and location is currently available for over 6000 fire events in Austria, of which around 5000 are forest fires.
<https://fire.boku.ac.at/firedb/en/>
- NOE Government: measure of precipitation and other value related to water in Lower Austria.
<https://www.noegv.at/wasserstand/#/de/Messstellen>
- NOE Atlas: maps of the Lower Austria with several information (nature reserves, cultural heritage, registration of atmospheric emissions, floods, etc.)
[https://atlas.noegv.at/webgisatlas/\(S\(vqlk54vxqv4wsxwod1cxdrjo\)\)/init.aspx?karte=atlas_hochwasser&ks=wasser&cms=atlas_wasser&redliningid=5vgu1ubiplpvrr1ejrowctuv&box=551644.461752033%3b310899.347151007%3b752003.758780466%3b403057.161612875&srs=31259&t=637497792874382984](https://atlas.noegv.at/webgisatlas/(S(vqlk54vxqv4wsxwod1cxdrjo))/init.aspx?karte=atlas_hochwasser&ks=wasser&cms=atlas_wasser&redliningid=5vgu1ubiplpvrr1ejrowctuv&box=551644.461752033%3b310899.347151007%3b752003.758780466%3b403057.161612875&srs=31259&t=637497792874382984)

Regional/Local Maps for Hazard/Risk assessment including cultural/natural heritage



- Earthquake maps and lists: earthquakes recorded by the ZAMG network of seismic stations in Austria over the last 14 days.
<https://www.zamg.ac.at/cms/de/geophysik/erdbeben/aktuelle-erdbeben/karten-und-listen>
- Risk of forest fires: based on parameters such as air temperature, humidity, wind speed and amount of precipitation) and is therefore a purely meteorological assessment.
<https://www.zamg.ac.at/cms/de/wetter/wetter-oesterreich/waldbrand>
- Pollution: map of predicted pollution, expressed as air quality index, for the current and upcoming days.
<https://www.zamg.ac.at/cms/de/umwelt/luftqualitaetsvorhersagen/caqi>
- Flood hazard areas: maps and data provided by ICPDR containing flood risk information for the Danube basin.
<https://www.icpdr.org/main/issues/floods>

3D Models for risk management

N.a.

Videos/Virtual tour

N.a.

Photographic archives

Pictures presented in this file were taken by Dr. Anna Kaiser, the APA (Austrian Press Agency) Helmut Fohringer and the Austrian Armed Forces (KERMER)

App

N.a.

Time Series

N.a

Other

N.a.

STRENCH CASE STUDIES

VILLA GHIGI PARK
Parco Villa Ghigi

Version 1
05 2021



Name of PP(s): PP4 - FVG
Fondazione Villa Ghigi
Villa Ghigi Foundation





VILLA GHIGI PARK

REGION	COUNTRY	EU ID	CITY	MUNICIPALITY
Emilia-Romagna	Italy	IT	Bologna	Bologna

CULTURAL HERITAGE CATEGORY	HAZARD TYPE
<ul style="list-style-type: none"> • Cultural landscapes • Natural heritage • Historic park 	Flood  Landslide Heavy rain  Windstorm

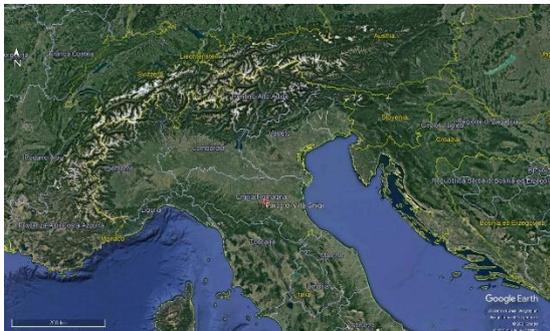
SITE LOCATION

Centroid geographical coordinates

Lat. 44.47610

Long. 11.32632

The Villa Ghigi Park extends for 29 hectares on the first hills around Bologna, just 2 km far from Piazza Maggiore (the heart of the city), on the right side of the valley of the Rio Fontane, a tributary of the Aposa stream. The difference in height ranges from 104 meters at the bottom of the Rio Fontane valley to 243 meters at the highest point of the park, towards the top of the Ronzano hill.



Geographical positioning of the site (left) with delimitation of the area extension (right).



SITE DESCRIPTION

Villa Ghigi is a public historical park of about 29 hectares located in a peri-urban area on the hills close to Bologna (just 2 km far from Piazza Maggiore, the heart of the city). Until 1970 the villa was inhabited by the Ghigi family and in 1974 the green area was opened to the public. The park extends on the right side of the Rio Fontane (tributary of the Aposa stream) valley in an ancient agricultural estate with a 17th manor, now abandoned. The urbanized area grown on the valley of the Aposa stream in the second half of the 20th century directly affected the ancient estate as part of the land was divided and used for building. Today the park still retains the rural settings of the past and it is characterized by several environments, offering an exemplary synthesis of the Bolognese hilly landscape (and of its dynamics and problems). The park (but not the buildings inside) is carefully managed by the Villa Ghigi Foundation which has had its headquarters in the park since the early 2000's, taking care of its direct management and carrying out educational, extracurricular and citizenship activity.

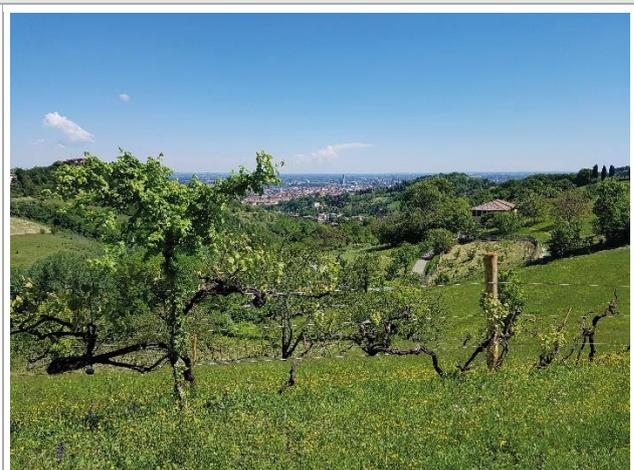
TPOLOGY OF CULTURAL HERITAGE ASSETS

The historical Villa Ghigi Park is located within the protected natural and semi-natural landscape "San Luca Hills", a vast green area protected by the Emilia-Romagna Region for its landscape characteristics.

The hills around Bologna have been protected for decades on the basis of Legislative Decree 42/2004 art. 136: Code of Cultural Heritage and Landscape - ex Law 1497/1939. In particular, the specific Ministerial Decree (dated 9 November 1955) refers to the area south of Bologna, which has been declared of considerable public interest.

The central and panoramic position is occupied by a seventeenth-century manor, now abandoned, which belonged to noble Bolognese families. The villa and the surrounding green space are cultural objects declared on the basis of Legislative Decree 42/2004 art. 13 - Code of Cultural Heritage and Landscape (according to the Law 1089/1939).

Many centuries-old trees stand out, including a monumental specimen of *Cedrus deodara* protected at national level (Law 10/2013).





A view of the park characterised by a rich mosaic of meadows alternating with rows of trees, hedges, shrubs, strips of wood and cultivated fields (left). In the foreground, an old row of vines hides the view over the historic center of Bologna (right).



Left, a glimpse of the Villa Ghigi building with a majestic downy oak (*Quercus pubescens*) in the foreground and, next to the villa, a monumental cedar (*Cedrus deodara*).

Right, a typical grassy path in the upper area of the park, close to the premises of the Villa Ghigi Foundation; in the background the Basilica of San Luca.

MAIN RISKS IMPACTING THE SITE

Geological, geomorphological and hydrogeological nature of the slope where the park is located constitutes the most important risk since the increasingly frequent episodes of intense rainfall concentrated in very short time and the poor efficiency of the current drainage network cause landslides and localized flooding.

Moreover, plants (in particular senescent trees) show static problems, sensitivity to certain phytosanitary problems and poor adaptation to changing climate conditions: these issues are related to sporadic episodes of strong wind and abundant or “out of season” snowfall as well as drought.

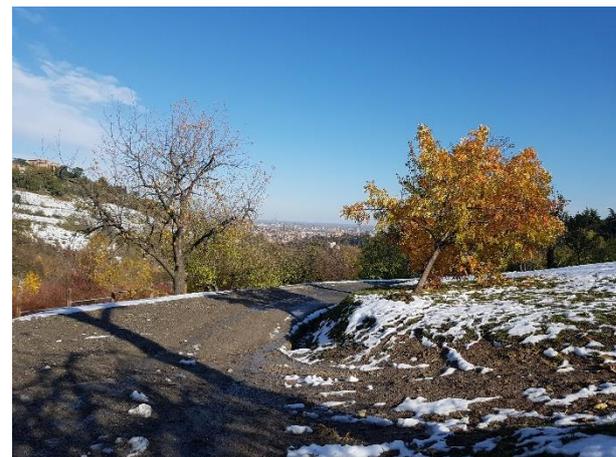
Also, the widespread presence of large-scale wildlife (wild boars and roe deer) causes damage to plants and biodiversity of the park.

Furthermore, the high attendance of the park by visitors and school groups during events that attract a large audience can represent a weak point for the conservation of the green area along with the opening at night-time of the park and the lack of an enclosure that may subject the site to vandalism, theft and tampering.

In addition, the insufficient economic resources available to the Foundation for the management of the park did not allow to address some strategic issues for the park (reorganization of the entrances, restoration of the main road network, arrangement of specific art and artifacts, etc.).



A detail of the detachment niche due to the landslide generated in 2013 (left). Flooding of one of the park entrances (via Martucci) after an intense rain concentrated in a short time (right).



The path along the Rio Fontane is temporarily closed following the damage of some trees due to a windy and rainy storm (left). An unseasonable autumn snowfall, when trees were still covered with leaves, caused a young specimen of *Sorbus domestica* to tilt (right).

RECORDED PAST EVENTS

Heavy rain and Flash flood

- 21/07/1932, cloudburst (134 mm) caused the overflowing of the Aposa, Ravone and Meloncello streams (and other minor rivers) leading to flooding in the foothills. Trees, branches, and mud were transported to the city walls.
(Storm clouds and hydraulic risk in the Bolognese hills: the case study of the Ravone BOLOGNA torrent, October 2013).
- 16/07/1995, cloudburst with heavy rains (53 mm in 1 h) in the foothills area causing numerous mudslides on the road and flash flood.
(Storm clouds and hydraulic risk in the Bolognese hills: the case study of the Ravone BOLOGNA torrent, October 2013).



- 04/11/1966, heavy rain causing widespread floods of the Rhine and its tributaries. (Civil protection plan for Reno, Lavino, Samoggia).
- 27/08/1999, storm with heavy rain (63 cm in 1 h) in the Sasso Marconi area with flash flood. Saturation of the hilly terrain; overflow of hilly streams, sewerage crisis and roads' interruption.
(Storm clouds and hydraulic risk in the Bologna hills: the case study of the Ravone stream BOLOGNA, October 2013 Declared the National Emergency State with O.P.C.M. No. 3237/02 with the allocation for the restoration and safety of the affected area of over 5.5 million euros).
- 11/05/2002, thunderstorm with heavy rain in Bologna and province (130 mm in 4 h preceded by a further 40 mm in the previous day).
(Storm clouds and hydraulic risk in the Bolognese hills: the case study of the Ravone BOLOGNA torrent, October 2013).
- 06/03/2010, thunderstorm with heavy rain at Villa Ghigi Park. Cloudburst with mud flows at the park entrance on via Martucci.
(Data and photos of the Villa Ghigi Foundation archive).
- 02/04/2013, thunderstorm with heavy rain caused cloudburst with mud flows at the entrance on via Martucci in Villa Ghigi Park.
(Data and photos of the Villa Ghigi Foundation archive).
- 05/04/2013, cloudburst following heavy rainfall in the previous period of March and April that caused the flood of the Ravone stream.
(Storm clouds and hydraulic risk in the Bolognese hills: the case study of the Ravone BOLOGNA torrent, October 2013).
- 18/03/2013, thunderstorm with heavy rain causing the flood of the Reno river.
(Civil protection plan Unione Reno, Lavino, Samoggia).
- 27/08/2013, thunderstorm with heavy rain in the city of Bologna causing some flooding.
(<http://www.centrometeo.com/articoli-reportage-approfondimenti/climatologia/5029-analisi-climatologica-agosto-2013-milano-bologna>).
- 14/06/2014, cloudburst causing flooding and fallen trees in the city of Bologna.
(<http://www.bolognatoday.it/cronaca/maltempo-conta-dei-danni-nubifragio-bologna-14-giugno.html>).
- 05-06/02/2015, rain and snow causing hydraulic regulation problems and numerous slits on trees in Villa Ghigi Park.
(Data and photos of the Villa Ghigi Foundation archive).
- 15/03/2015, 29/02/2016, 14/10/2016, thunderstorm with heavy rain causing cloudburst with mud flows at the entrance to the park in via Martucci. Problems of hydraulic regulation and flooding.
(Data and photos of the Villa Ghigi Foundation archive).
- 06/02/2017, 06/08/2017, thunderstorm with heavy rain causing cloudburst with mud flows at the entrance to the park in via Martucci. Problems of hydraulic regulation and flooding.
(Data and photos of the Villa Ghigi Foundation archive).



- 22-23/02/2018, 05/07/2018, 16/07/2018, thunderstorm with heavy rain caused cloudburst with mud flows at the entrance of the park in via Martucci, problem of water regulation and tree nicks.
(<http://www.bolognatoday.it/cronaca/nubifragio-vigili-fuoco-temporale-danni.html>
<http://www.bolognatoday.it/cronaca/maltempo-bologna-pioggia-allagamenti-disagi.html>).
- 18/05/2019, 22/06/2019, cloudburst with heavy rain causing flooding in the city of Bologna and in the surrounding zones as Villa Ghigi Park.
(Data and photos of the Villa Ghigi Foundation archive,
<https://www.bolognatoday.it/cronaca/nubifragio-grandine-interventi-danni-22-giugno-2019.html>).

Heavy snow

- 10-14/02/1929, the entire city and province of Bologna were affected by the event (80 cm of snow on the ground and low temperature around -15°). Among the damages: slits and collapse of trees, drying of plant species sensitive to cold.
(https://www.bibliotecasalaborsa.it/cronologia/bologna/1929/una_ecezionale_nevicata
https://it.wikipedia.org/wiki/Ondata_di_freddo_del_1929)
- 10-14/02/1956, heavy snow in Bologna and in the metropolitan territory with 63 cm on the ground and low temperature (ranging from -15 to -26.2°).
(https://it.wikipedia.org/wiki/Ondata_di_freddo_e_nevicata_del_febbraio_1956
https://www.arpae.it/dettaglio_notizia.asp?id=2901&idlivello=32#)
- 14-17/12/1963, accumulation on the ground of 50 cm of snow.
(THE HISTORICAL SNOWFALLS OF THE CITY OF BOLOGNA
https://www.arpae.it/dettaglio_notizia.asp?id=2901&idlivello=32#)
- 14-17/01/1985, the event is remembered as "the snow of the century". In one snowfall, which lasted over 72 hours, 75-80 cm of snow fell in Bologna.
(THE HISTORICAL SNOWFALLS OF THE CITY OF BOLOGNA
https://www.arpae.it/dettaglio_notizia.asp?id=2901&idlivello=32#
https://www.bibliotecasalaborsa.it/cronologia/bologna/1985/nevicate_record)
- 11-15/01/1987, snowfall with an accumulation of 69 cm.
(THE HISTORICAL SNOWFALLS OF THE CITY OF BOLOGNA
https://www.arpae.it/dettaglio_notizia.asp?id=2901&idlivello=32#).
- 17-18/04/1991, thunderstorm and subsequent late snowfall with several cm of accumulation of very wet snow even in the city, and considerable thickness on the hills. The temperature dropped from $+20^{\circ}\text{C}$ in April 17 to zero on the following night and day.
(<https://www.meteolive.it/news/A-tutta-neve/36/le-nevicate-tardive-a-bologna/59593/>).
- 13/11/2017, snowfall causing numerous damages on the trees of Villa Ghigi Park.
(Data and photos of the Villa Ghigi Foundation archive).

Thunderstorm with lightning



- 1990's, lightning strikes an imposing specimen of Cedrus deodora at Villa Ghigi and cut off its tap. The tree shows signs of suffering due to the worsening of its vegetative and phytosanitary conditions.
- 01/02/2012, snowfall with 45 cm of accumulation that caused various slits on the trees in the Villa Ghigi Park. The event repeated also in 2013.
- (THE HISTORICAL SNOWFALLS OF THE CITY OF BOLOGNA
- https://www.arpae.it/dettaglio_notizia.asp?id=2901&idlivello=32#).

Windstorm

- 13/01/2017, strong wind that caused the collapse of a dead trees in Villa Ghigi Park. (Data and photos of the Villa Ghigi Foundation archive).
- 06/08/2017, thunderstorm with heavy rain and wind causing damage to the municipal arboreal heritage for about 300 thousand euros ((50 trees irreversibly damaged by felling, detachments of branches on about 2000 trees, 150 trees subjected to ground and altitude stability checks).
(<http://www.bolognatoday.it/cronaca/nubifragio-bologna-7-agosto-danni.html>).
- 17/01/2018, strong wind caused the cut off of several trees in Villa Ghigi. (Data and photos of the Villa Ghigi Foundation archive)

Landslides

- 04-05/04/2013, paroxysmal landslide movement in conjunction with heavy rains in the Villa Ghigi Park. Rotational detachment with niche which has an evident arched traction slot; limited deformation and swelling of the ground at the foot of the movement. The movement involved a sector of lawn (located upstream of the dirt road direct to the park entrance on via di Gaibola), the dirt road and the foot of the dirt parking lawn.
- (See "Geological, hydrogeological and geotechnical examination of the landslide affecting the right side of the Rio Fontane valley inside the Villa Ghigi Park. Indications for intervention").
- 03/11/2017, landslide that affects the side of the Osservanza hill intercepting via di Gaibola near the entrance to the Villa Ghigi Park. Accentuated sagging of the road surface, failure of the reinforced concrete wall upstream of the road which is heavily damaged and inclined

ADOPTED MEASURES

An annual management plan run by the Villa Ghigi Foundation with the support of a social cooperative of proven competence aim at park reorganization and requalification. The presence of Foundation headquarters within the green area allows its constant and careful monitoring and prompt intervention. The maintenance interventions are based on low environmental impact techniques, inspired by the principles of organic agriculture and sustainability (Bio-Habitat Method). The regular monitoring of trees and the programme of visual and instrumental investigations entrusted to specialized technicians for assessing their stability and the risk of possible sagging, helps to prevent and reduce the danger of collapses and damage. The presence



in the park of a meteorological station installed in 2017 by Arpa Emilia-Romagna allows better managing the amount of water necessary for the irrigation verifying the trend of precipitation. Moreover, a renewal plan of the park's vegetation cover and of its arboreal heritage through the planting of new trees belonging to species suitable for the context creates an enrichment of its environmental, landscape and historical features.

POINTS TO BE ADDRESSED AT LOCAL LEVEL

At local level, some issues are reported, common to the entire hilly area of Bologna starting from the foothills in direct contact with the city, which to a different extent relate to the dynamics connected to the current climate changes: the hydrogeological instability and the fallout on the infrastructures of the territory, the management of the vegetation cover, the abandonment of crops and the consequent evolutionary dynamics of the naturalized environments, the alteration of the typical characteristics of the hilly landscape, and the management of fauna. The strategic role of public green, and more generally of the hill, is recalled in the background for the rebalancing of urban development, the ecological regeneration of the city, as a reserve of biodiversity and a privileged area for the use and leisure of Bolognese people.

In addressing these issues, the Foundation promotes dissemination and participatory actions of citizens, residents of the hill area and more generally of all the stakeholders (administrators, Voluntary Ecological Guards, local police, etc.). They relate the vulnerability of the territory and climate change, as well as raising awareness of the importance of green, public and private, as a fundamental resource for urban resilience and sustainable development of the territory.

SUPPLEMENTARY MATERIAL

Regional/Local Strategies/Plans for the protection of Cultural Heritage

- The Bolognese hills and their hydraulic-agricultural-forestry arrangement: the plan, devised by the Departmental Inspectorate of the Forests in the figure of Francesco Carullo, dates back to 1955. It led to the construction of large-scale hydraulic forestry works and massive forestry works on large sectors of the Bologna hill, aimed at consolidating the slopes, making use of essences unsuitable for the context (evergreen conifers) and improperly used in prestigious historical parks (San Michele in Bosco).
- A new set-up for the Bologna hill: The work was born as a contribution for the definition of the Municipal Structural Plan and aims to outline objectives and strategic choices for the organization of the hilly area of Bologna starting from its critical issues but also great potential.
http://sit.comune.bologna.it/alfresco/d/d/workspace/SpacesStore/2840f974-648e-44c2-8a04-d9b049522a11/Nuovo_assetto_collina.pdf
- PSC (Municipal Strategic Plan): The Plan establishes the general guidelines that will guide the urban development of the municipal area of Bologna for the twenty-year period 2008-2028.
<http://www.comune.bologna.it/psc/>



- Covenant of Mayors: administrations sign a voluntary pact with Europe in which they commit to reducing CO₂ emissions by 2020 and to carry out a series of actions. In December 2008, the Municipality of Bologna adhered to the Covenant of Mayors committing themselves to drawing up a Plan for Sustainable Energy and Climate.
<https://www.pattodeisindaci.eu/it/>
https://www.pattodeisindaci.eu/about-it/la-comunita-del-patto/firmatari/risultati.html?scity_id=11963
- Mayors adapt - European and national Climate Change Strategy, 2014: Bologna joined "Mayors Adapt" in October 2014, subsequently approving the Local Adaptation Strategy and, in 2015, the Adaptation Plan.
<http://www.mayors-adapt.eu/>
- Municipal civil protection plan: to represent and analyse the municipal area in relation to risks; provide an adequate, functional, and agile structure to counter the emergency, updating it periodically in relation to the risk indices identified on its territory; constitute a tool for information to the population and for its assistance in the event of an emergency.
<http://www.comune.bologna.it/poliziamunicipale/servizi/118:9650/29397/>
- Climate Change Adaptation Plan City of Bologna: the objectives of the Plan include the protection of cultural heritage from the effects of climate change and the improvement of the resilience of cultural heritage.
www.blueap.eu
- Reno River and Bolognese Canals Agreement: it was born as a response to the need to acquire a collaborative and participatory tool aimed at the protection, the correct management of water resources, the enhancement of river areas and the protection from hydraulic risk, also contributing to local development.
<http://www.cdfrenocanalibologna.it/>
- PAESC Action Plan for Sustainable Energy and Climate: action that the Municipality intends to adopt to achieve at least 40% reduction in climate-changing emissions by 2030 and carbon neutrality by 2050.
<http://www.comune.bologna.it/paes/notizie/143:47201/>
- Flood Risk Management Plan (PGRA): the plan aims to build a homogeneous framework at the district level for the assessment and management of risks from flooding phenomena, in order to reduce the negative consequences for human life and health, the environment, cultural heritage and activities economic and strategic infrastructure.
<https://ambiente.regione.emilia-romagna.it/it/suolo-bacino/sezioni/piano-di-gestione-del-rischio-alluvioni>
- Guidelines for the management of public arboreal assets (from the perspective of Risk Management): the essential topics related to the management of the public arboreal heritage, tree safety, emergency plans in case of extreme meteoric events, damage caused by the fall of trees are dealt with.
<http://www.pubblicigiardini.it/wp-content/uploads/2015/07/Linee-Guida-per-la-gestione-dei-patrimoni-arborei-pubblici.pdf>
- Guidelines for the management of urban green areas and first indications for sustainable planning: it is a consultation and information tool for all Italian municipalities useful for proceeding correctly and profitably in urban green planning and management activities.



https://www.minambiente.it/sites/default/files/archivio/allegati/comitato%20verde%20pubblico/lineeguida_finale_25_maggio_17.pdf

- Guidelines for the care and protection of Monumental Trees: it presents a spectrum of good practices for those who manage a monumental arboreal heritage.
https://www.minambiente.it/sites/default/files/archivio/allegati/comitato%20verde%20pubblico/lineeguida_finale_25_maggio_17.pdf
- Guidelines on urban and peri-urban forestry: this document is intended to assist in developing urban and peri-urban forests as a way of meeting the present and future needs of cities for forest products and ecosystem services.
<http://www.fao.org/documents/card/en/c/e068e0d9-0c97-41c7-a856-05556a1bd10b/>

Regional/Local Web GIS Platforms for Hazard/Risk assessment

- Territorial Information System (SIT) of Municipality of Bologna: WebGis application dedicated to the General Urban Plan showing the interactive maps and cartographic data that make up the Plan and allowing to obtain an extract of the Plan Regulations or links to the Table of constraints.
<http://sitmappe.comune.bologna.it/PUG/>
- SIT PSC Municipal Information System of the Bologna Metropolitan Area: WebGis of the mosaic of the municipal PSC.
<http://cartografia.cittametropolitana.bo.it/psc/>
- Cultural Heritage of Emilia-Romagna: map of the protected cultural heritage (architectural and archaeological heritage protected by a specific provision whose location could be traced, and a part of the heritage protected under the law) and the related information made available by the MiBACT Regional Secretariat for Emilia-Romagna.
<https://www.patrimonioculturale-er.it/webgis/>
- The Moka WebGis application: a project concerning the creation of a reference site for the visualization of a series of specific vectorial thematic consisting of perimeter of geographical areas that could be affected by floods according to specific probability scenarios, maps of exposed elements, risk maps.
<https://servizimoka.regione.emilia-romagna.it/mokaApp/apps/DA/index.html>
- Territorial Environmental and Landscape Information System (SITAP): Ministry of Cultural Heritage and Activities has published the landscape constraints of Italy with a new interactive geographical consultation interface.
<http://www.sitap.beniculturali.it/>
- General Catalog Information System (SIGECweb): Web-based platform with closed-access that manages the entire flow of cataloging from the production and dissemination of cataloging standards, the assignment of unique catalog codes, cataloging of assets, to the publication of catalog cards for use on the site of the general catalog of cultural heritage (www.catalogo.beniculturali.it).
<http://www.sigecweb.beniculturali.it>
- Vincoli in Rete: created by the Istituto Superiore per la Conservazione ed il Restauro as a consultation service for several existing ministerial databases. In this section, colored cultural assets in Italy are represented by type (architectural and archaeological) and by



the presence of administrative acts (concluded, in progress, absent). Cartographic interrogation is assisted by specific functions for in-depth analysis of the territory.
<http://vincoliinrete.beniculturali.it/vir/vir/vir.html>

Regional/Local Maps for Hazard/Risk assessment including cultural/natural heritage

- Municipal Strategic Plan (PSC) of Municipality of Bologna: the interactive maps allow dynamic navigation of the cartographic works, of the rules and documents of the Structural Plan for the municipal territory, including its environmental, architectural, and historical-landscape emergencies.
<http://sitmappe.comune.bologna.it/pucviewer/#!/app/map/default>
- Flood hazard and risk maps (from PGRA Flood Risk Management Plan): flood hazard tables relating to the network of natural watercourses within the Areas of Significant Potential Risk (APSEFR) in the Emilia-Romagna region.
<https://ambiente.regione.emilia-romagna.it/it/suolo-bacino/sezioni/piano-di-gestione-del-rischio-alluvioni/piano-gestione-rischio-alluvioni-2021/documenti-1/tavole-pericolosita>

3D Models for risk management

Videos/Virtual tour

Photographic archives

App

Time Series

Other

