Interreg CENTRAL EUROPE
ProteCHt2save
European Union
European Regional Development Fund

DELIVERABLE D.T1.1.1

Identification of appropriate procedures for assessment of climate impact on cultural heritage.

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With contribution of all partners

CONTENTS

1. INTRODUCTION

WP T1 *Identification of risk areas and priorities* focuses on the analysis of procedures, tools and database to identify the most important hot-spots where different categories of cultural heritage are exposed to individual extreme events due to climate change (heavy precipitation, flood, drought periods). Activity A.T1.1 *Analysis of existing state-of-the-art approaches, methods and models to identify risk areas* is the first step of WP T1 and deliverable D.T1.1.1 *Identification of appropriate procedures for assessment of climate impact on cultural heritage* has the scope of identifying transitional suitable procedure/models for the risk prone areas assessment in Central Europe to extreme events. This Deliverable constitutes the basis of D.T1.1.2 *Report including an inventory of existing tools for risk evaluation*, which will define the inventory of tools fundamental for the AT1.2, AT1.3 and AT2. Section 2 of the present deliverable explains in detail climate models, downscaling approaches and tools of data analysis that will be utilized in ProteCHt2save, while section 3 describes the preliminary identification of pilot sites. Finally, section 4 summarises the criteria adopted for the data collection in order to define a suitable procedure for the evaluation of the impact of extreme events on cultural heritage in Central Europe.

2. CLIMATE MODEL DATA, DOWNSCALING AND ANALYSIS TOOLS

Reliable, high-resolution climate change projections associated with a quantification of their uncertainty are crucial for estimating future climate change impacts and for planning adaptation/mitigation strategies.

The WCRP Coordinated Regional Downscaling Experiment (CORDEX, http://wcrp-cordex.ipsl.jussieu.fr/) is an internationally coordinated effort aiming to harmonize the evaluation of state-of-the-art regional climate models (RCMs) and to generate multi-model ensembles of regional climate projections worldwide.

A sub-ensemble of the CORDEX framework is the EURO-CORDEX initiative (http://www.euro-cordex.net/), which provides regional climate projections for Europe at two different spatial resolutions, namely the "standard" resolution of 0.44 degrees (EUR-44, ~50 km) and a finer resolution of 0.11 degrees (EUR-11, ~12 km).

Within the EURO-CORDEX experiment seven regional climate models are employed to dynamically downscale the Climate Model Intercomparison Project phase 5 (CMIP5) global climate model (GCM) projections using the latest Representative Concentration Pathways (RCPs) emission scenarios. When RCMs are driven by a large-scale global model, in addition to the uncertainties inherent in the specific RCM at hand, additional uncertainty is inherited from the driving GCM, which is affected by model inadequacies as well. In order to estimate this type of uncertainty, a common approach consists in considering an ensemble of simulations performed with a given RCM driven by different GCMs. The spread among the RCM outputs provides an estimate of the effects of GCM diversity on the RCM simulations.

Within ProteCHt2save **we will select the Euro-CORDEX simulations at 0.11 degrees resolution** among those available, listed here: http://euro-cordex.net/imperia/md/content/csc/cordex/20161219-eurocordex-simulations.pdf. We will consider the climate variables useful for the applications of interest in the project, such as, but not limited to, **minimum and maximum surface air temperature and precipitation**.

We will analyse **RCM historical and projection simulations**, to calculate anomalies and changes of future climatologies with respect to past conditions. The **historical period** we will account for is the **time slice 1986-2015** (but this could be changed depending on specific requests at hand and related to the availability of measured data to be used for comparison/validation), while for the **future we will refer to long-term climatologies around mid-21st century (e.g., 2021-2050) band end of century (e.g. 2071-2100)**. We will consider at least **two future emission scenarios** among those employed in the latest IPCC assessment report (AR5), namely **RCP4.5** and **RCP8.5**, whose characteristics are summarized here below:

- RCP 4.5 is a stabilization scenario in which radiative forcing is stabilized at 4.5 W/m2 after 2100, without overshooting the long-run radiative forcing target level (Thomson et al., 2011).
- RCP 8.5 is a high pathway scenario characterized by increasing greenhouse gas emissions over time for which radiative forcing reaches greater than 8.5 W/m2 by 2100 and continues to rise for some amount of time (Riahi et al. 2007). It is also known as "business as usual" scenario.

We will consider also **historical and scenario simulation** with the state-of-the-art high resolution global climate model **EC-Earth** run by ISAC-CNR in the framework of a **PRACE project** (Climate SPHINX, http://sansone.to.isac.cnr.it/sphinx/). These simulations include existing experiments performed at resolutions ranging between 125 and 16 km and the analysis will be focused on the European region.

Additionally we may consider new **high-resolution simulations** performed in the framework of the **PRIMAVERA H2020 project** (https://www.primavera-h2020.eu/).

We will correct the biases the models may eventually exhibit using **state-of-the-art station-based reference datasets**, such as **E-OBS** (http://www.ecad.eu/download/ensembles/ensembles.php), available for the European domain, which is a robust, and widely used dataset, regularly updated. E-OBS provides long term daily precipitation and near surface air temperature climatology (from 1950 to present), its spatial coverage includes all land areas in Europe and in the Mediterranean region, it is supported by a clear documentation on the methods used to derive it (interpolation techniques, underlying stations, etc.) and the underlying orography (elevation data) and individual station data are available as well.

Bias correction will be carried out on the long-term climatology and pixel by pixel. We will use a technique based on the adjustment of the mean value, either by adding a temporally constant offset (for the temperature correction) or by applying a constant correction factor (for precipitation) to the simulated data. The additive or multiplicative constant is applied to counterbalance the average bias between the simulated and the observed time series over a baseline period taken as the reference. As an alternative, we could plan to use the very **recently developed bias-corrected CORDEX dataset** built from CORDEX after application of bias correction procedures, which is now available (http://cordex.org/news/bias-adjusted-cordex-data-freely-available/).

For some specific applications, the original ~12 km resolution of the CORDEX RCMs might not be appropriate. In such cases, the RCM data will be further downscaled for precipitation and temperature. This will allow to obtain both temperature and precipitation data at the point scale as well as high-resolution (1kmx1km) grids of these climate variables. A t**emperature downscaling based on orographic correction** (using the atmospheric temperature lapse rate) and a stochastic downscaling for precipitation, also taking into account orography, will be used. For the **precipitation**, we will use the **RainFARM stochastic precipitation downscaling method** originally developed at ISAC-CNR (D'Onofrio et al., 2014). This method has also the advantage that it allows us to produce, from large-scale spatio-temporal precipitation fields, ensembles of stochastic realizations at finer spatial resolution (typically 1 km or slightly less), thus providing an estimate of the uncertainty to be associated to the small scale precipitation fields.

The analysis of climate projections, in particular of the changes in extremes such as dry spells or intense precipitation, will exploit software tools which are being developed in the framework of the **Copernicus C3S project MAGIC** (C3S 34a lot2) by ISAC-CNR (http://portal.c3s-magic.eu/).

3. CASE STUDIES IDENTIFICATION

It should be pointed out that even though the final definition of the pilot sites is to be conducted by November 2018 (Deliverable D.T1.3.2), a preliminary identification through information exchange and consultation among team members based mainly on previously experienced catastrophic events by the Municipalities involved in the partnership has been done.

Specifically in ProteCHt2save seven pilot actions will be conducted linked to climate change and variability associated with hydrometeorological and climate extremes (flood, heavy rain, drought period). In the project we took into consideration the hazard terminology developed by the UNISDR (United Nations International Strategy for Disaster Reduction) in 2009 on disaster risk reduction (https://www.unisdr.org/we/inform/terminology). Following this terminology, hydrometeorological hazards are of atmospheric, hydrological or oceanographic origin. Examples are tropical cyclones (also known as typhoons and hurricanes); floods, including flash floods; drought; heatwaves and cold spells; and coastal storm surges. Hydrometeorological conditions may also be a factor in other hazards such as landslides, wildland fires, locust plagues, epidemics and in the transport and dispersal of toxic substances and volcanic eruption material.

The selected pilot sites (Fig. 1) are located in Ferrara (IT), Troja (CZ), Kastela (HR), Kocevje (SL), Krems (AT), Pècs (HU), Bielsko-Biala (PL) for the following hazards:

- Flood (Troja, Krems, Kocevje)
- Fire due to drought (Kastela)
- Heavy rain (Ferrara, Kastela, Bielsko-Biala, Pècs)
- Sea flood (Kastela)

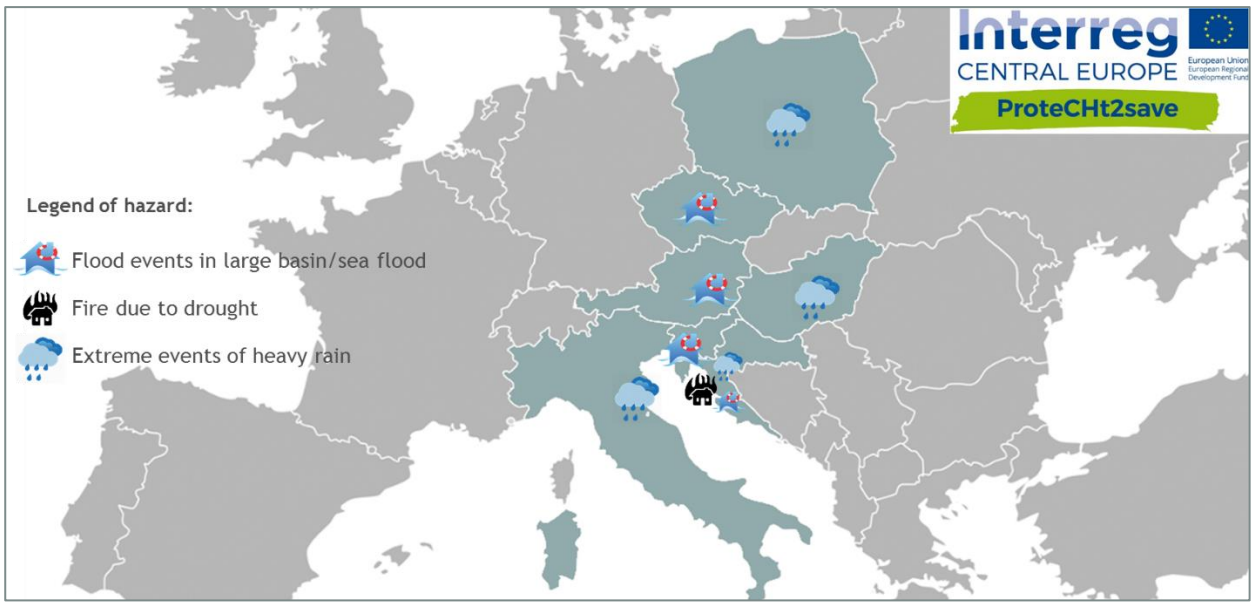


Figure 1. ProteCHt2save pilot sites.

4. DATA COLLECTION CRITERIA

In addition to the application of the tools described in section 2 concerning climate modelling, specific data for each Country/Region involved in ProteCHt2save were collected and are currently under elaboration in order to define a suitable procedure for the evaluation of the impact of extreme events on cultural heritage in Central Europe making use of a State-of-Art approach. The elaboration of the collected data at different territorial levels (local/regional/national/international) will be the object of Deliverable D.T1.1.2. with the aim of identifying strengths and weakness in the risk management process with focus on cultural heritage safeguarding.

By the active collaboration of ProteCHt2save partners, information concerning the following issues were collected:
- Past disasters occurred in the areas under study.
- Currently existing plans and strategies (preparedness, response, recovery) of risk disaster reduction and adaptation to climate change, including extreme events.
- Outputs from past and on-going research projects on risk assessment in relation to extreme events.
- Existing tools like vulnerability/risk maps and GIS platforms at national and regional scale for the Countries involved.
- Monitoring stations of climate parameters in the proximity of the areas under study.

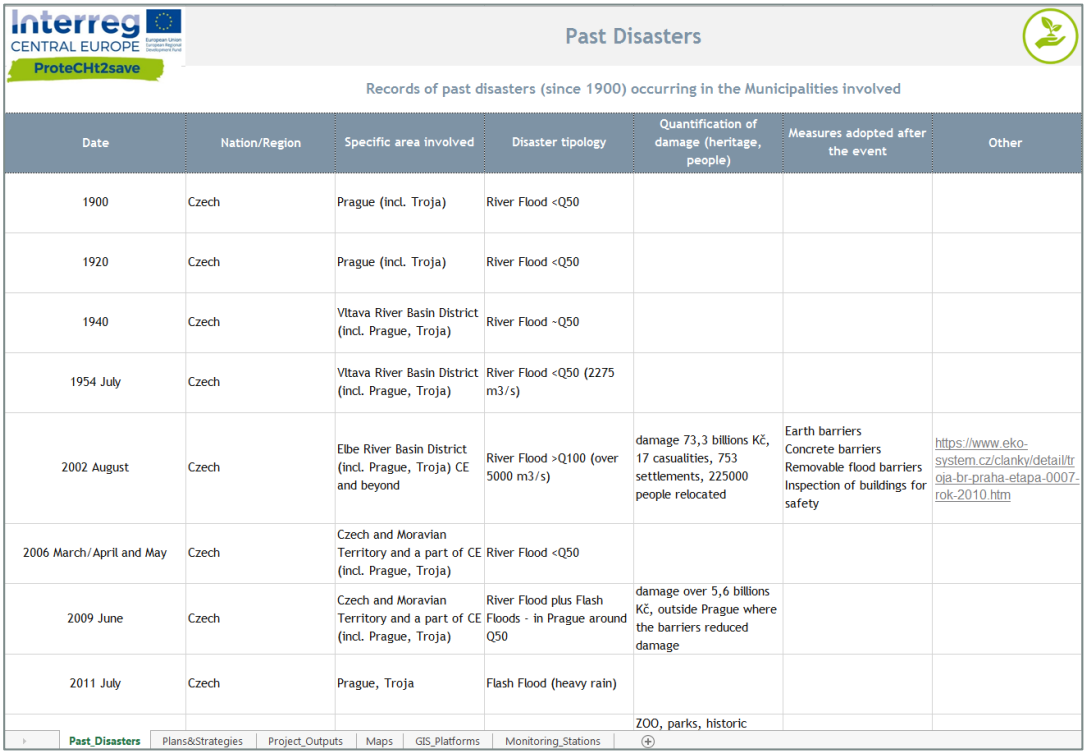
The collection of the data was organized using an excel file with different sheets on the basis of the specific information required (past disasters, plans&strategies, projects, maps, GIS platforms, monitoring stations). Data and information provided by each partner are delivered as annexes at the present document (excel files).

4.1. Past Disaster

Type and number of extreme events occurred since 1900 and documented in the countries of Central Europe participating in the project are reported, with particular reference to the areas where the pilot sites are located. Different scales are considered (local, regional and national) and the damage experienced on built heritage is evidenced.

The extract of the excel sheet “Past Disaster” in Fig. 2 shows the information required for each dangerous extreme events recorded, in particular:

- Date of the event.
- Geographical distribution of the event and specific sites involved.
- Type of extreme event: flood (flash, river, tidal), heavy precipitations (rain, hail, snow), strong wind, drought, multiple events, etc.
- Quantification of damage in terms of people involved and damages to the environment and urban settlement with specific attention to the built heritage.
- Measure adopted after disaster and other useful information.



Past Disasters

Records of past disasters (since 1900) occurring in the Municipalities involved

Date	Nation/Region	Specific area involved	Disaster tipology	Quantification of damage (heritage, people)	Measures adopted after the event	Other
1900	Czech	Prague (incl. Troja)	River Flood <Q50			
1920	Czech	Prague (incl. Troja)	River Flood <Q50			
1940	Czech	Vltava River Basin District (incl. Prague, Troja)	River Flood ~Q50			
1954 July	Czech	Vltava River Basin District (incl. Prague, Troja)	River Flood <Q50 (2275 m3/s)			
2002 August	Czech	Elbe River Basin District (incl. Prague, Troja) CE and beyond	River Flood >Q100 (over 5000 m3/s)	damage 73,3 billions Kč, 17 casualities, 753 settlements, 225000 people relocated	Earth barriers Concrete barriers Removable flood barriers Inspection of buildings for safety	https://www.eko-system.cz/clanky/detail/troja-br-praha-etapa-0007-rok-2010.htm
2006 March/April and May	Czech	Czech and Moravian Territory and a part of CE (incl. Prague, Troja)	River Flood <Q50			
2009 June	Czech	Czech and Moravian Territory and a part of CE (incl. Prague, Troja)	River Flood plus Flash Floods - in Prague around Q50	damage over 5,6 billions Kč, outside Prague where the barriers reduced damage		
2011 July	Czech	Prague, Troja	Flash Flood (heavy rain)			
				ZOO, parks, historic		

Past_Disasters | Plans&Strategies | Project_Outputs | Maps | GIS_Platforms | Monitoring_Stations

Figure 2. Example of the excel data sheet “Past Disasters” for Municipal District Praha-Troja (PP2-PP7).

4.2. Plans & Strategies

This section focuses on the collection of the information on existing plans and strategies at European, national, regional and local level provided by authorities and research centres concerning the management of the risks and resilience measures against natural disasters and extreme weather actions. In the further analysis planned for Activity A.T1.1 particular attention will be paid to highlight which plans and strategies among those listed include measures for the protection of cultural heritage. In synergy with the activities conducted for D.T2.1.1 *Identification of barriers/challenges in different countries on cultural heritage vulnerability*, the review of existing policies is fundamental for discovering possible still existing gaps which overcoming is needed in order to improve and optimise the efficiency and adequacy of risk management measures.

Concerning this issue, the following information were collected (Fig.3):

- Identification name of specific plan/strategy.
- Territorial competence (International, National, Regional, Local).
- Specific natural or anthropogenic hazard taken in to account.
- Brief description.
- Web site or provider to whom ask the permission for downloading the documents.

National/Regional Plans and Strategies

Existing National and Regional Plans and Strategies for risk management (particularly related to areas of the municipalities/pilot sites involved).

Identification name	Scale (Regional/National)	Specific area involved	Natural hazards (Flood, heavy rain, fire, etc.)	Brief Description	Web site/Provider	Other
Assessment of the vulnerability of the population, material and cultural goods and the environment Kaštela City, January 2015	Local	Kastela City	flood, heavy rain, fire, earthquaqe, drougrt, tehnical disasters,	Overall document that analize spatial situation in Kastela City and mayor threats and possible disasters with damage estimation	http://www.kastela.hr/wp-content/uploads/2015/04/procjena-ugro%C5%BEenosti-stanovni%C5%A1tva-materijalnih-i kulturnih-dobara-i-okoli%C5%A1a.pdf	
Water areas management plan	National	Croatia	flood	Overall document that analize watercourse and coast area of Croatia	http://www.voda.hr/sites/default/files/dokumenti/dodatak2.pdf	
Water managemet strategy	National	Croatia	flood	Overall document that analize watercourse and coast area of Croatia	http://www.voda.hr/sites/default/files/dokumenti/strategija_upravljanja_vodama.pdf	
Managemet plan of water areas	National	Croatia	flood	Overall document that analize watercourse and coast area of Croatia	http://www.voda.hr/sites/default/files/plan_upravljanja_vodnim_podrucjima_2016._-_2021_0.pdf	
Disaster risk assessment for Croatia	National	Croatia	flood, heavy rain, fire, earthquaqe, drougrt, tehnical disasters,	Overall document that analize spatial situation in Croatia and mayor threats and possible disasters with damage estimation	http://stari.duzs.hr/download.aspx?f=dokumenti/Clanci/ProcjenarizikaodkatastrofauRH.pdf	

4_Past_Disasters | 2_Plans&Strategies | 1_Project_Outputs | 3_Maps | 5_GIS_Platforms | 6_Monitoring_Stations ...

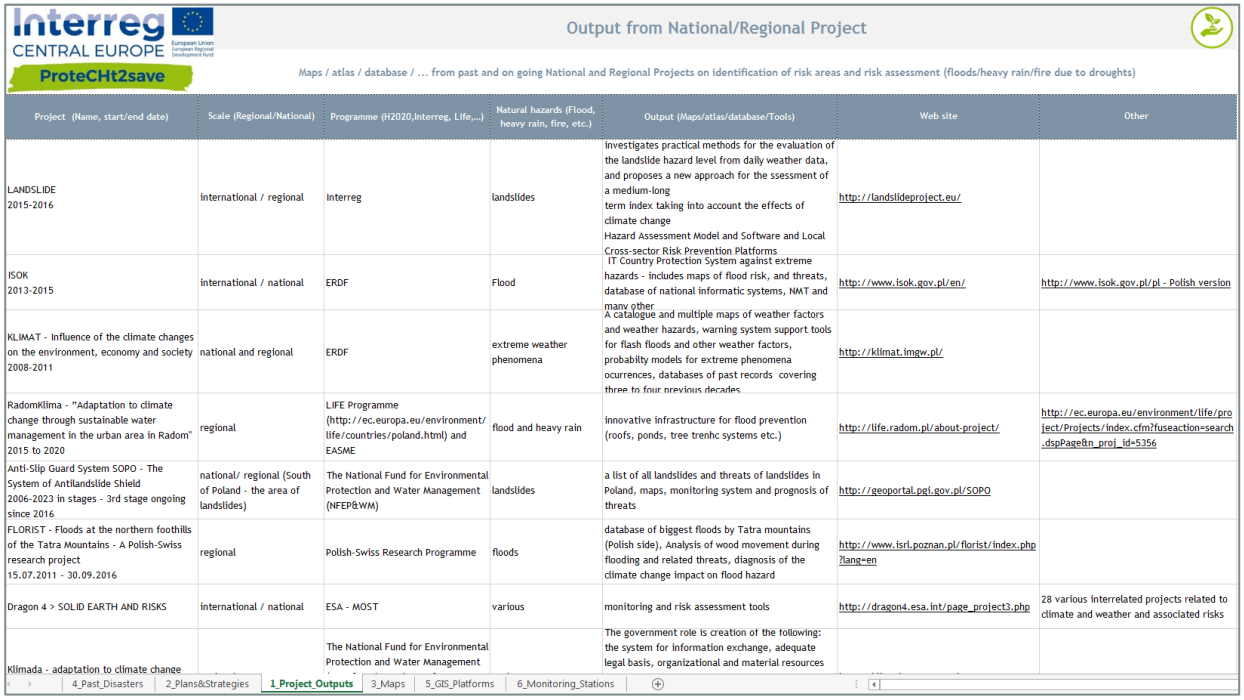
Figure 3. Example of the excel data sheet “Plans&Strategies” for City of Kastela (PP9).

4.3. Project outputs

This section relates to the outputs (maps/atlas/database…) from past and current National and Regional Projects on the identification of risk areas and risk assessment due to floods, heavy rain, fire caused by drought. The purpose of the collection of these data is to outline which is the current state of research in the Countries/Regions involved in the project concerning the topics mentioned above, which are the issues with priority in resources allocation and which are still existing gaps to be addressed. In addition particular attention will be paid during the subsequent elaboration (DT1.1.2) on identifying the possible inclusion of cultural heritage in the framework of these actions.

Concerning this section, the following information were collected (Fig.4):

- Identification name, start/end date.
- Scale (International, National, Regional, Local).
- Funding programme.
- Specific natural or anthropogenic hazard taken in to account.
- Brief description of outputs.
- Web site.



Output from National/Regional Project

Maps / atlas / database / ... from past and on going National and Regional Projects on identification of risk areas and risk assessment (floods/heavy rain/fire due to droughts)

Project (Name, start/end date)	Scale (Regional/National)	Programme (H2020,Interreg, Life,...)	Natural hazards (Flood, heavy rain, fire, etc.)	Output (Maps/atlas/database/Tools)	Web site	Other
LANDSLIDE 2015-2016	international / regional	Interreg	landslides	investigates practical methods for the evaluation of the landslide hazard level from daily weather data, and proposes a new approach for the ssessment of a medium-long term index taking into account the effects of climate change Hazard Assessment Model and Software and Local Cross-sector Risk Prevention Platforms	http://landslideproject.eu/	
ISOK 2013-2015	international / national	ERDF	Flood	IT Country Protection System against extreme hazards - includes maps of flood risk, and threats, database of national informatic systems, NMT and many other	http://www.isok.gov.pl/en/	http://www.isok.gov.pl/pl - Polish version
KLIMAT - Influence of the climate changes on the environment, economy and society 2008-2011	national and regional	ERDF	extreme weather phenomena	A catalogue and multiple maps of weather factors and weather hazards, warning system support tools for flash floods and other weather factors, probabilty models for extreme phenomena ocurrences, databases of past records covering three to four previous decades	http://klimat.imgw.pl/	
RadomKlima - "Adaptation to climate change through sustainable water management in the urban area in Radom" 2015 to 2020	regional	LIFE Programme (http://ec.europa.eu/environment/life/countries/poland.html) and EASME	flood and heavy rain	innovative infrastructure for flood prevention (roofs, ponds, tree trenhc systems etc.)	http://life.radom.pl/about-project/	http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=5356
Anti-Slip Guard System SOPO - The System of Antilandslide Shield 2006-2023 in stages - 3rd stage ongoing since 2016	national/ regional (South of Poland - the area of landslides)	The National Fund for Environmental Protection and Water Management (NFEP&WM)	landslides	a list of all landslides and threats of landslides in Poland, maps, monitoring system and prognosis of threats	http://geoportal.pgi.gov.pl/SOPO	
FLORIST - Floods at the northern foothills of the Tatra Mountains - A Polish-Swiss research project 15.07.2011 - 30.09.2016	regional	Polish-Swiss Research Programme	floods	database of biggest floods by Tatra mountains (Polish side), Analysis of wood movement during flooding and related threats, diagnosis of the climate change impact on flood hazard	http://www.isrl.poznan.pl/florist/index.php?lang=en	
Dragon 4 > SOLID EARTH AND RISKS	international / national	ESA - MOST	various	monitoring and risk assessment tools	http://dragon4.esa.int/page_project3.php	28 various interrelated projects related to climate and weather and associated risks
Klimada - adaptation to climate change		The National Fund for Environmental Protection and Water Management		The government role is creation of the following: the system for information exchange, adequate legal basis, organizational and material resources		

4_Past_Disasters | 2_Plans&Strategies | 1_Project_Outputs | 3_Maps | 5_GIS_Platforms | 6_Monitoring_Stations

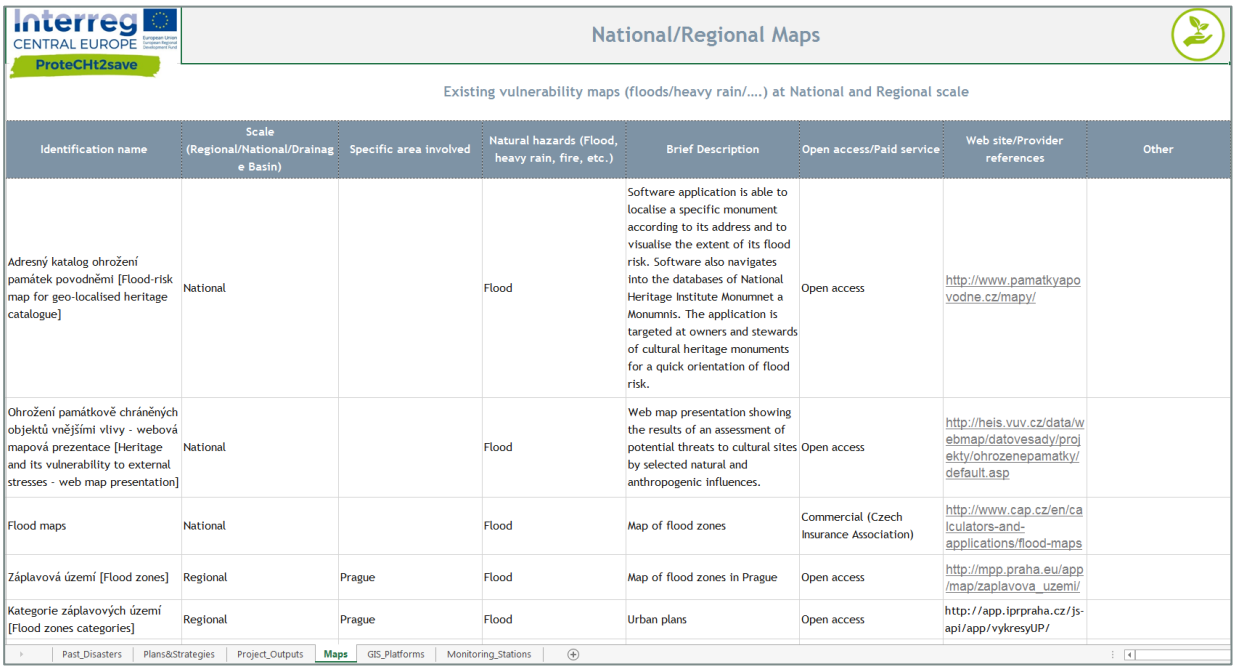
Figure 4. Example of the excel data sheet “Project Outputs” for Bielsko-Biala (PP4 and PP5).

4.4. Maps and GIS Platforms

This section is devoted to understand which are the available tools in the Regions/Countries participating at ProteCHt2save that can be useful for the assessment of potential threats to cultural sites by selected natural and anthropogenic influences. Existing tools like vulnerability/risk maps and GIS platforms at national and regional scale were considered (Figs. 5 and 6).

Concerning this section, the following information were collected (Figs. 5 and 6):

- Identification name.
- Scale (International, National, Regional, Local).
- Geographical area involved.
- Specific natural or anthropogenic hazard taken in to account.
- Eventual connected projects.
- Brief description.
- Open access/Paid service.
- Web site/Provider references.



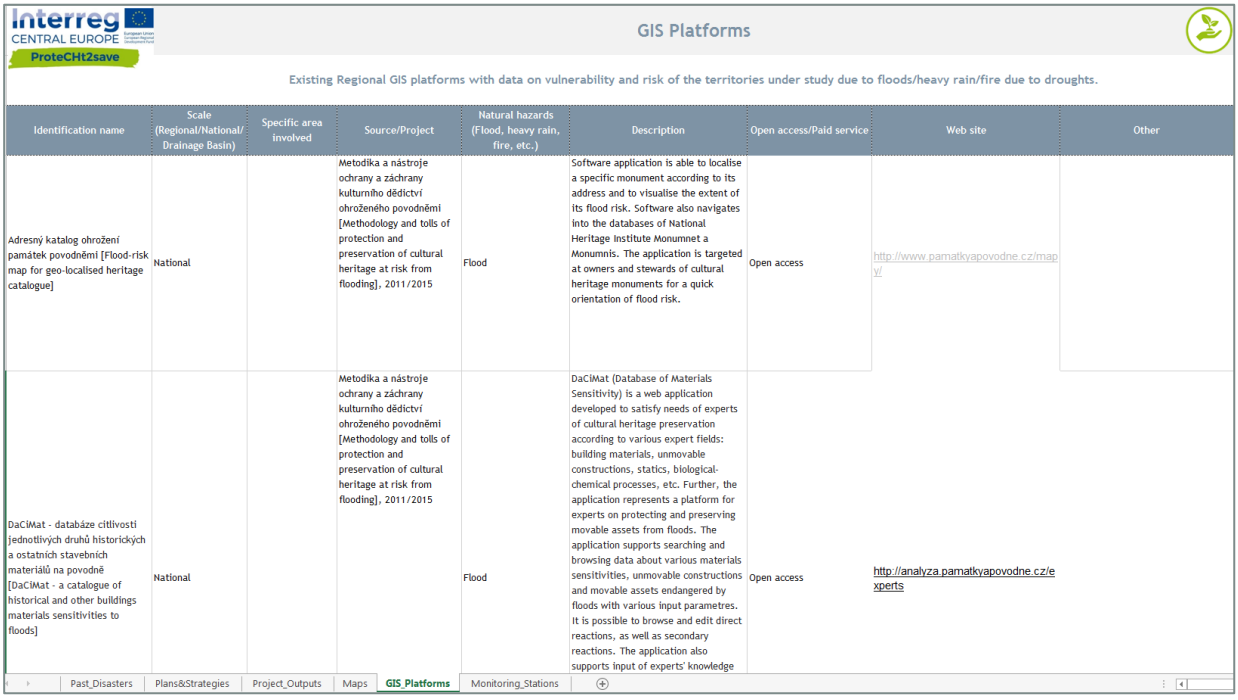
National/Regional Maps

Existing vulnerability maps (floods/heavy rain/....) at National and Regional scale

Identification name	Scale (Regional/National/Drainage Basin)	Specific area involved	Natural hazards (Flood, heavy rain, fire, etc.)	Brief Description	Open access/Paid service	Web site/Provider references	Other
Adresný katalog ohrožení památek povodněmi [Flood-risk map for geo-localised heritage catalogue]	National		Flood	Software application is able to localise a specific monument according to its address and to visualise the extent of its flood risk. Software also navigates into the databases of National Heritage Institute Monumnet a Monumnis. The application is targeted at owners and stewards of cultural heritage monuments for a quick orientation of flood risk.	Open access	http://www.pamatkyapovodne.cz/mapy/	
Ohrožení památkově chráněných objektů vnějšími vlivy - webová mapová prezentace [Heritage and its vulnerability to external stresses - web map presentation]	National		Flood	Web map presentation showing the results of an assessment of potential threats to cultural sites by selected natural and anthropogenic influences.	Open access	http://heis.vuv.cz/data/webmap/datovesady/projekty/ohrozenepamatky/default.asp	
Flood maps	National		Flood	Map of flood zones	Commercial (Czech Insurance Association)	http://www.cap.cz/en/calculators-and-applications/flood-maps	
Záplavová území [Flood zones]	Regional	Prague	Flood	Map of flood zones in Prague	Open access	http://mpp.praha.eu/app/map/zaplavova_uzemi/	
Kategorie záplavových území [Flood zones categories]	Regional	Prague	Flood	Urban plans	Open access	http://app.iprpraha.cz/js-api/app/vykresyUP/	

Past_Disasters | Plans&Strategies | Project_Outputs | Maps | GIS_Platforms | Monitoring_Stations

Figure 5. Example of the excel data sheet “Maps” for Municipal District Praha-Troja (PP2-PP7).



GIS Platforms

Existing Regional GIS platforms with data on vulnerability and risk of the territories under study due to floods/heavy rain/fire due to droughts.

Identification name	Scale (Regional/National/ Drainage Basin)	Specific area involved	Source/Project	Natural hazards (Flood, heavy rain, fire, etc.)	Description	Open access/Paid service	Web site	Other
Adresný katalog ohrožení památek povodněmi [Flood-risk map for geo-localised heritage catalogue]	National		Metodika a nástroje ochrany a záchrany kulturního dědictví ohroženého povodněmi [Methodology and tolls of protection and preservation of cultural heritage at risk from flooding], 2011/2015	Flood	Software application is able to localise a specific monument according to its address and to visualise the extent of its flood risk. Software also navigates into the databases of National Heritage Institute Monumnet a Monumnis. The application is targeted at owners and stewards of cultural heritage monuments for a quick orientation of flood risk.	Open access	http://www.pamatkyapovodne.cz/mapy/	
DaCiMat - databáze citlivosti jednotlivých druhů historických a ostatních stavebních materiálů na povodně [DaCiMat - a catalogue of historical and other buildings materials sensitivities to floods]	National		Metodika a nástroje ochrany a záchrany kulturního dědictví ohroženého povodněmi [Methodology and tolls of protection and preservation of cultural heritage at risk from flooding], 2011/2015	Flood	DaCiMat (Database of Materials Sensitivity) is a web application developed to satisfy needs of experts of cultural heritage preservation according to various expert fields: building materials, unmovable constructions, statics, biological-chemical processes, etc. Further, the application represents a platform for experts on protecting and preserving movable assets from floods. The application supports searching and browsing data about various materials sensitivities, unmovable constructions and movable assets endangered by floods with various input parametres. It is possible to browse and edit direct reactions, as well as secondary reactions. The application also supports input of experts' knowledge	Open access	http://analyza.pamatkyapovodne.cz/experts	

Past_Disasters | Plans&Strategies | Project_Outputs | Maps | GIS_Platforms | Monitoring_Stations

Figure 6. Example of the excel data sheet “GIS Platform” for Municipal District Praha-Troja (PP2-PP7).

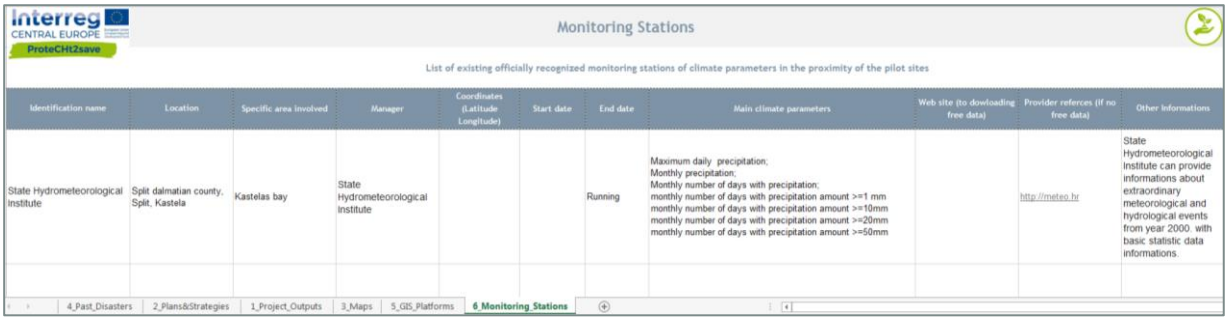
4.5. Monitoring stations

The list of existing officially recognized monitoring stations of climate parameters (monitoring at least Temperature, Relative Humidity, Precipitation) in the proximity of the pilot sites were collected. These data will be useful for evaluating continuously the meteorological situation and identifying main

deterioration processes due to climate parameters that can occur at the case studies. Additionally, measured data are necessary for possible corrections of the simulated ones from climate models.

The information required for the selected monitoring stations were:

- Identification name.
- Location and specific area involved.
- Manager.
- Coordinate (Latitude and Longitude).
- Starting date of working/currently monitoring or not.
- Main climate parameters monitored.
- Website/provider reference.



Monitoring Stations

List of existing officially recognized monitoring stations of climate parameters in the proximity of the pilot sites

Identification name	Location	Specific area involved	Manager	Coordinates (Latitude Longitude)	Start date	End date	Main climate parameters	Web site (to dowloading free data)	Provider referces (if no free data)	Other informations
State Hydrometeorological Institute	Split dalmatian county, Split, Kastela	Kastelas bay	State Hydrometeorological Institute			Running	Maximum daily precipitation; Monthly precipitation; Monthly number of days with precipitation; monthly number of days with precipitation amount >=1 mm monthly number of days with precipitation amount >=10mm monthly number of days with precipitation amount >=20mm monthly number of days with precipitation amount >=50mm		http://meteo.hr	State Hydrometeorological Institute can provide informations about extraordinary meteorological and hydrological events from year 2000. with basic statistic data informations.

4_Past_Disasters | 2_Plans&Strategies | 1_Project_Outputs | 3_Maps | 5_GIS_Platforms | 6_Monitoring_Stations

Figure 7. Example of the excel data sheet “Monitoring Stations” for City of Kastela (PP9).

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D'Onofrio, D., Palazzi, E., von Hardenberg, J., Provenzale, A., and Calmanti, S. (2014). Stochastic rainfall downscaling of climate models. Journal of Hydrometeorology, 15(2), 830-843.

Riahi K, Grübler A, Nakicenovic N. (2007). Scenarios of long-term socio-economic and environmental development under climate stabilization. Technol Forecast Soc Chang 74:887–935

Thomson AM, Calvin KV, Smith SJ, Kyle GP, Volke A, Patel P, Delgado-Arias S, Bond-Lamberty B, Wise MA, Clarke LE et al., (2011). RCP4.5: a pathway for stabilization of radiative forcing by 2100.Climatic Change. doi: 10.1007/s10584-011-0151-4.

ANNEX

Annex_1_D.T1.1.1_PP2_PP7_ITAM_TROJAAnnex 2. PP3 DUK
Annex_2_D.T1.1.1_PP3_DUKAnnex 4. PP6 MUF
Annex_3_D.T1.1.1_PP4_PP5_BBD&ARRSA
Annex_4_D.T1.1.1_PP6_MUF
Annex_5_D.T1.1.1_PP8_GBC
Annex_6_D.T1.1.1_PP9_MOK
Annex_7_D.T1.1.1_PP10_COK