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STRENgthening resilience of Cultural Heritage at risk in a changing environment through proactive transnational cooperation

NEWSLETTER #4

NOVEMBER-FEBRUARY 2021/2022

The EU Interreg Central Europe project **STRENCH** develops ready to use solutions for assessing climate change effects and protecting cultural heritage & cultural landscapes.

Dear Reader,
we are pleased to provide you with the 4th and final STRENCH newsletter covering the project duration November 2021 - February 2022 presenting the following topics to you:

- **Project Progress Q4 2021/2022**
  Visit our Webpage: https://www.interreg-central.eu/Content.Node/STRENCH.html
  And follow us on Facebook: https://www.facebook.com/Strench.InterregCE/

- **STRENCH International Conference 2022**
  - Held on February 24th 2022 from 14:30 to 17:30 hrs CET.
  - Online, hosted as Webinar via Zoom.
  - Held in English language.

- **WebGIS tool- -The Risk Mapping Tool for Cultural Heritage Protection is Reay to Use**

- **Spotlight & Focus: Applying the WebGIS tool for Risk Management, an elaborate Case Study on Zichy Mansion by the Lake Balaton Development Coordination Agency, Hungary**

- **STRENCH Local Working Tables Year 2 (CZ, AUT, ITA)**

STRENCH International Conference 2022

On February 28th 2022 the **2nd STRENCH International Conference** was held. The Conference´s focus lay on the presentation of the STRENCH project results aiming to enhance cooperation and exchange of expertise between various actors involved in the decision-making process for the protection and safeguarding of cultural heritage at risk due to extreme events related to climate change.

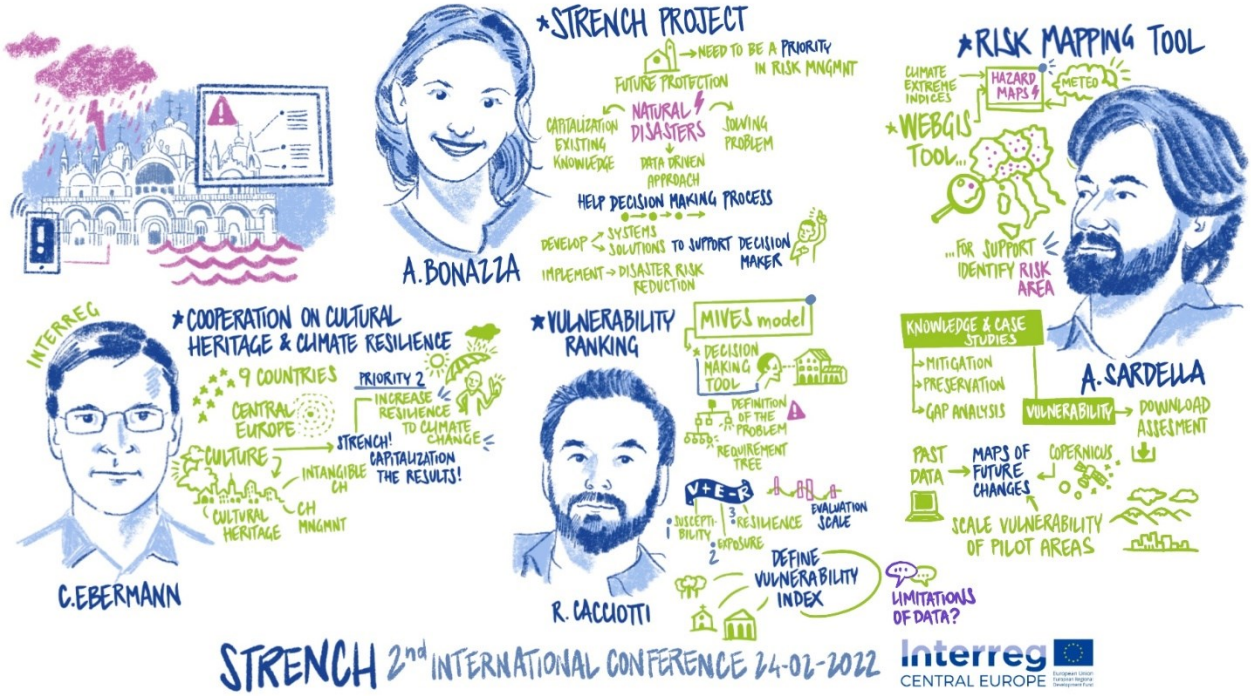
Short summary:

- Held on February 24th 2022 from 14:30 to 17:30 hrs CET.
- Online, hosted as Webinar via Zoom.
- In English language, with 73 participants attending the conference.

Commencing with an initial administrative phase during which the participants established their connection to the virtual meeting room a technical introduction for audience was held by Raffaela Woller of the University for Continuing Education Krems prior to the welcome and opening speeches by Ottavia Ricci of the-Ministero della Cultura -Consigliera del Ministro per la valorizzazione del patrimonio culturale diffuso and Costanza Miliani - Presidenza CNR -Director of the Institute of Heritage Science

After the introduction Alessandra Bonazza of the Institute of Atmospheric Sciences and Climate CNR in Italy together witch Raffaela Woller of the Centre of Cultural Property Protection, University for Continuing Education Krems in Austria acted as moderators for the conference

Starting with the STRENCH project and main achievements an outline of the STRENCH project was presented by Alessandra Bonazza after which Christophe Ebermann of Interreg Central Europe continued on the topic of cooperation on cultural heritage and climate resilience in the Interreg Central Europe Programme. After the outline of the STRENCH project and the funding body Interreg Central Europe had been explained Riccardo Cacciotti of the Institute of Theoretical and Applied Mechanics in the Czech Republic introduced one of the core outputs of the STRENCH project namely the methodology for vulnerability ranking. Which itself is enhanced by an additional tool/output produced in the STRENCH project being the risk mapping tool for cultural heritage protection which was presented by one of the creators Alessandro Sardella from the Institute of Atmospheric Sciences and Climate, CNR, Italy.



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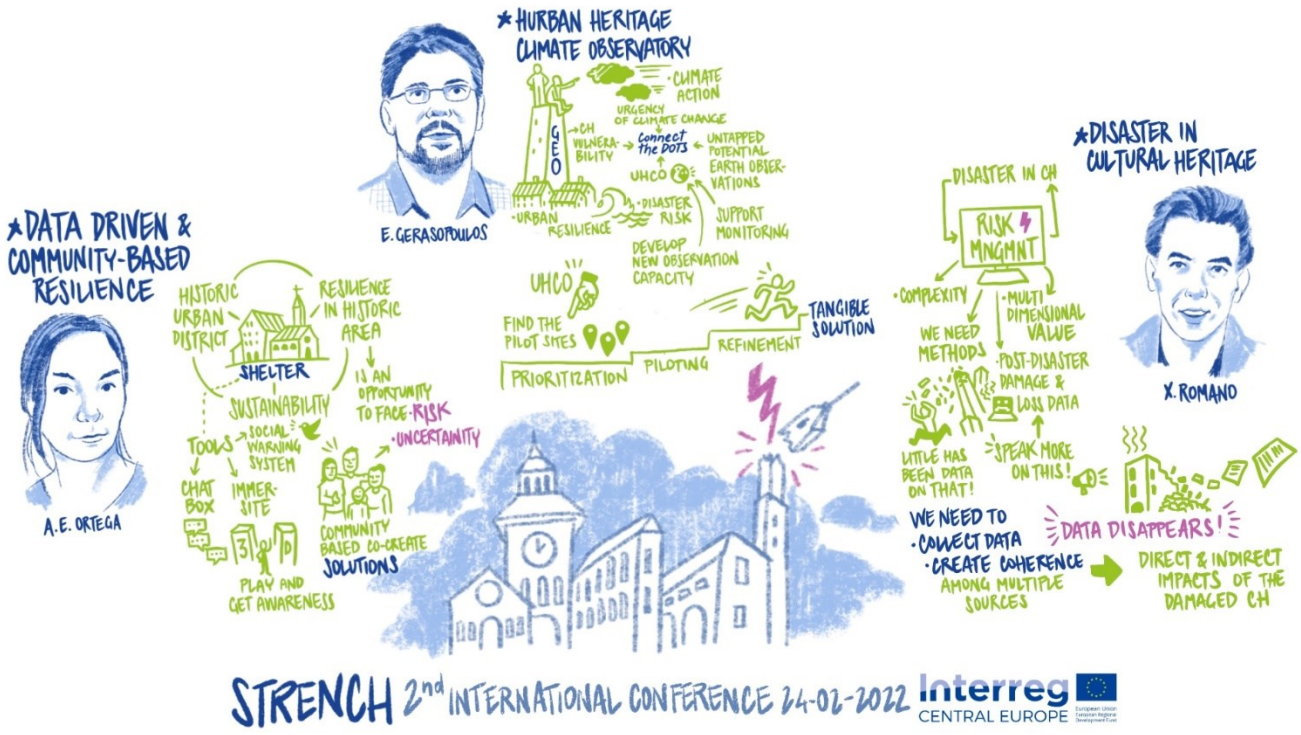
After a comprehensive recap of the main outputs of the 1st session by Raffaela Woller of the UWK the conference continued with the topic of Project Management Strategies and tools for the safeguarding of cultural heritage in the framework of European cooperation. Since the STRENCH project also aims to generate synergies by capitalizing and thus combining the results of 9 relevant previous EU projects the data-driven and community-based resilience for historic areas from the SHELTER project and EU R&I Task Force for Climate Neutral and Resilient Historic Urban Districts was presented by Aitziber Egusquiza Ortega of TECNALIA in Spain.

Before handing the word to Evangelos Gerasopoulos of the National Observatory of Athens, Greece who elaborated on the topic of coordinating earth observation exploitation for cultural heritage at the global scale and the Urban Heritage Climate Observatory Initiative.

Who was followed by Xavier Romão of the Departamento de Engenharia Civil, Universidade do Porto, Portugal. Who continued the tight schedule of the conference by discussing the topic of disasters in cultural heritage -what we need to know for a more effective risk management practice.



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After a brief break the moderators initiated a discussion on gaps in risk management practice and on the key messages to be highlighted from the 2nd session

The final theme of the conference surrounded the future challenges in the management planning of the cultural heritage at risk. In this aspect some of the STRENCH project partners came forth in order to share their lessons learnt and experience gained in STRENCH project itself. These included Valentina Bergonzoni of the Fondazione Villa Ghigi, Italy; Andreas Rösch from the District Council of Forcheim, Germany; Zoltán Heizler of the Lake Balaton Development Coordination Agency, Hungary; Vlasta Vodeb representing the Urban Planning Institute of the Republic of Slovenia; Ana Vržina of the Municipality of Dugopolje, Croatia. Whom of which each would come to elaborate on the unique and sometimes shared threats and challenges faced at their respective site and measure are most likely to succeed in managing these arising challenges.

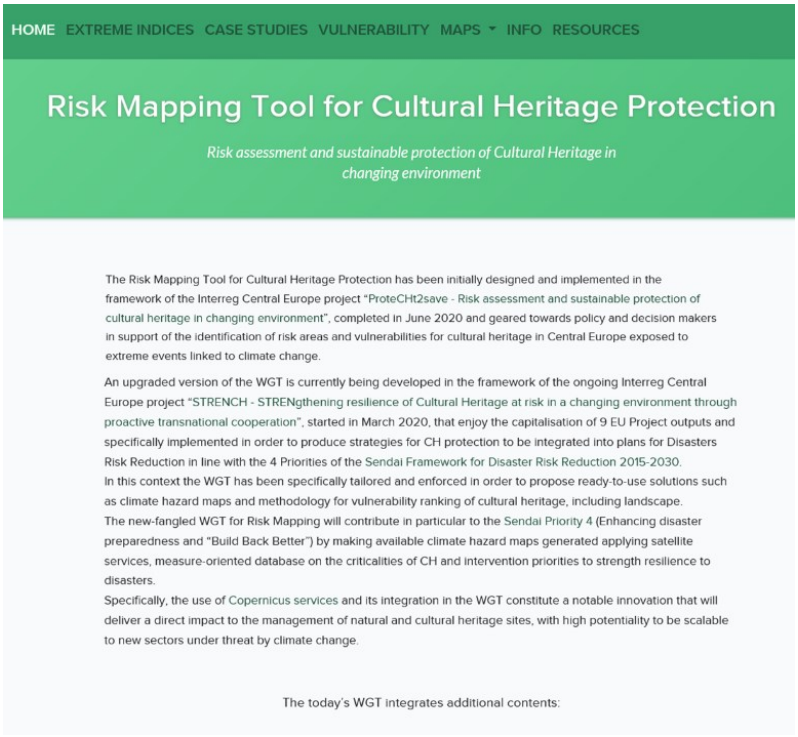
Closing the Conference it was an honor to have Adele Cesi of the UNESCO Office, Italian Ministry of Culture speak on the highly relevant topic of world heritage and risk management. After which the conference was recapped, wrapped up an closed by the moderators concluding a highly productive and successful final conference of the STRENCH project.

The STRENCH Project Partnership would like to express their gratitude to all speakers and guests alike for partaking in this event.

WebGIS tool –The Risk Mapping Tool for Cultural Heritage Protection is ready to use

(by Alessandro Sardella,)

The last integrations and updates foreseen within the STRENCH project have been completed and now the Risk Mapping Tool for Cultural Heritage Protection is ready to be used, making available its methodology for the multi-risk assessment of cultural heritage exposed to climate extreme events to a large number of stakeholders from policy and decision makers to researchers and professional figures in charge for the protection of cultural heritage sites.



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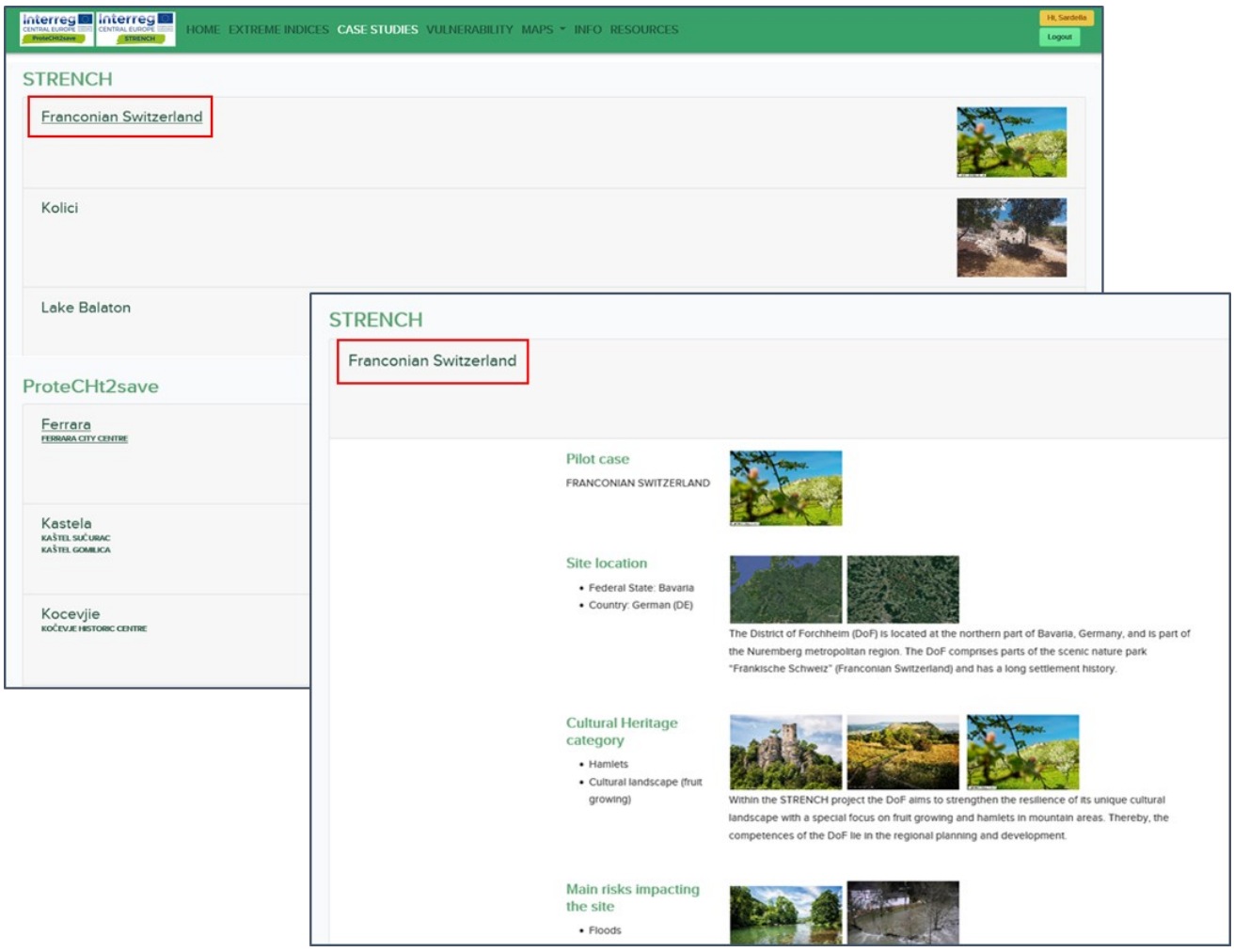
Starting from a general overview of its history, from the design and first implementation in ProteCHt2save to the further integration and improvements in STRENCH, the WebGIS tool offers now the possibility to browse within its tools and case histories offering the possibility to see and understand how the tools has been applied on the case studies as well as put into practice the acquired knowledge by using the same tools to perform an analysis of a case study assessing its potential exposure to any past and future extreme climate events and to assess the vulnerability for its protection.

What you will find in this Risk Mapping Tool for Cultural Heritage Protection?

When navigating the online platform, the users will be able to uncover an in deep knowledge of the case studies involved in ProteCHt2save and STRENCH projects by showcasing their geographical context with a focus on their unique cultural and natural heritage also highlighting main climate hazards impacting the sites. A survey on the past calamitous events recorded at the site and subsequent prevention, mitigation and adaptation measures put in place. In addition, a series of additional information being useful to understand what tools can be available at local level for the protection of cultural heritage at risk is also available in order to provide a thorough knowledge of the site and a thorough analysis of the existing gaps within the protection efforts.



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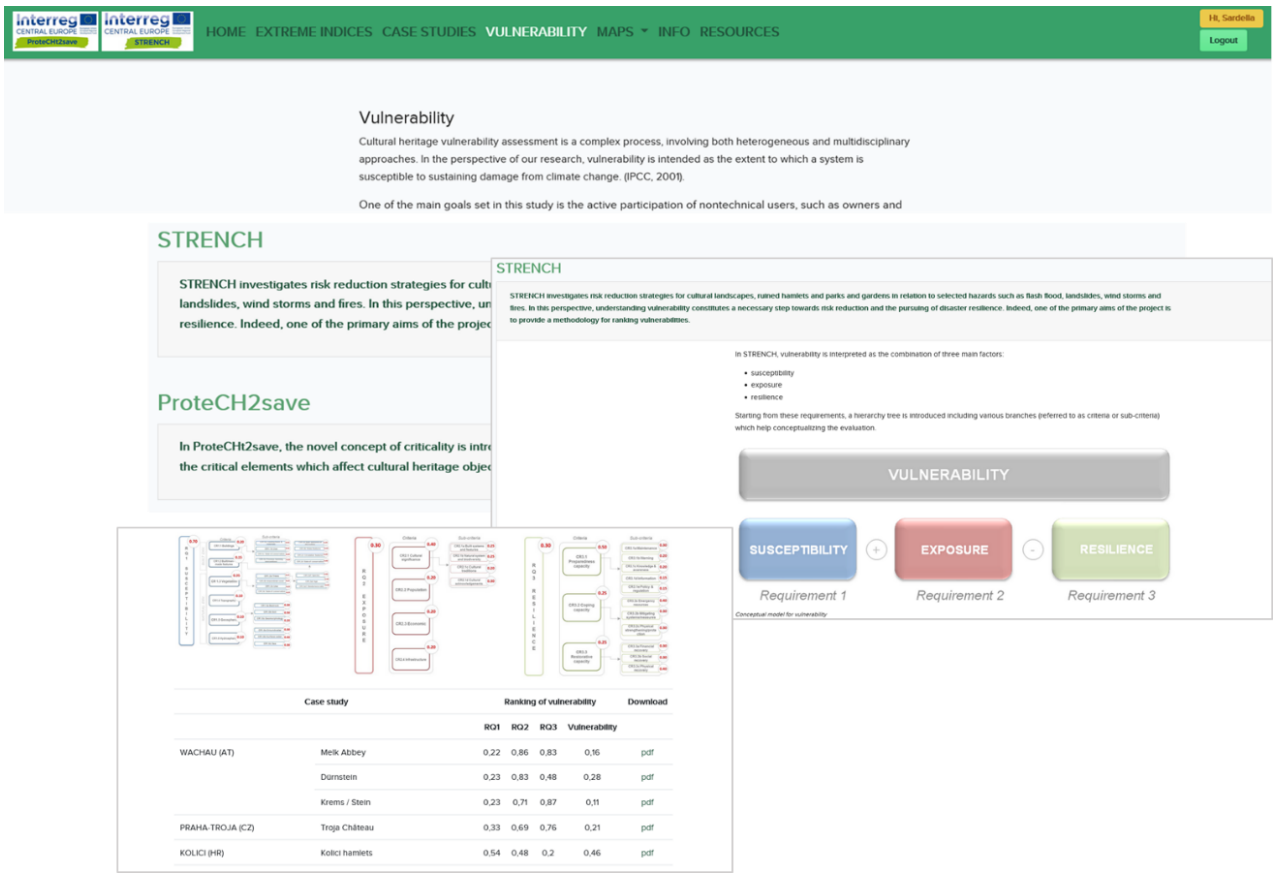
Within the Web-GIS user will find tools designed for the assessment of the vulnerability adding a building scale comprising either the methodology developed in ProteCHt2save related to the introduction of the concept of physical and managerial criticalities of the cultural heritage assets and the methodology setup in STRENCH which considers the vulnerability as a result of interaction from susceptibility, exposure and resilience.

Examples on how these methodologies have been applied in the projects case studies are available and can be downloaded including detailed descriptions and visualizations of each vulnerability assessment.

In addition, users can generate excel files providing the decision support tool for the assessment of the vulnerability by using the STRENCH methodology which is also available for the users in order to rank the vulnerability of the users own case study.



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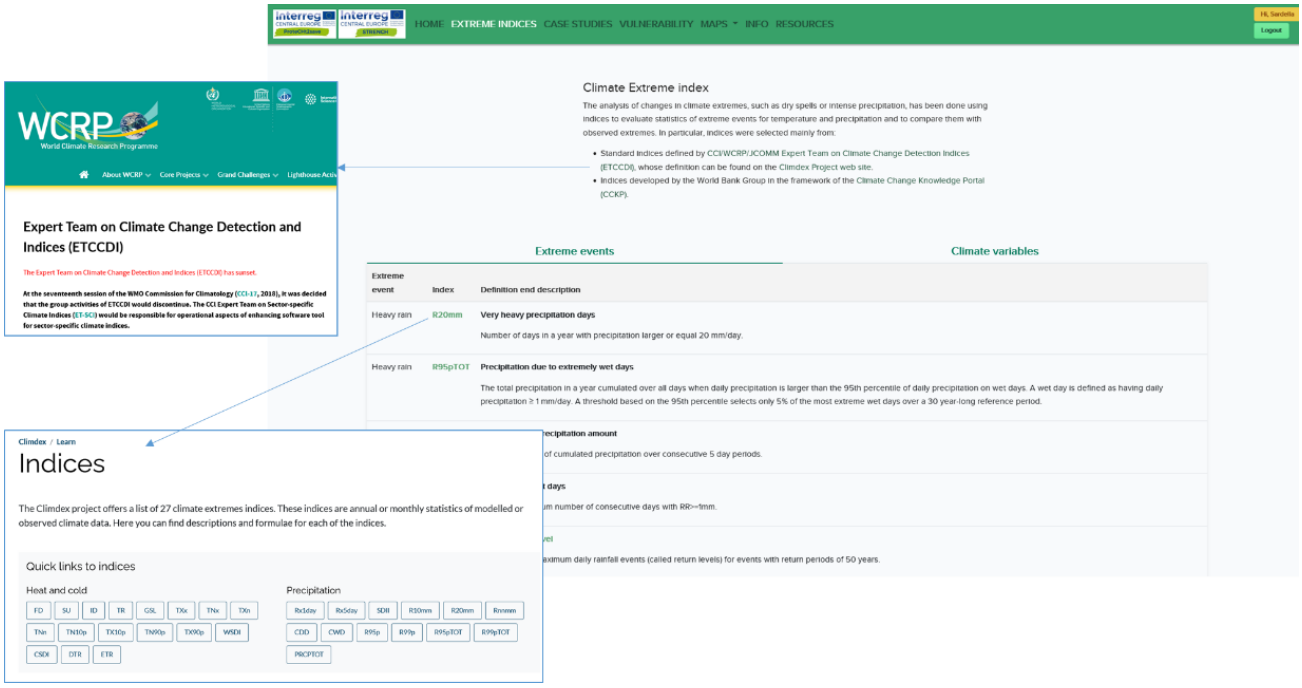
In addition an informative page dedicated to the detailed description of the climate variables and extreme indexes selected for the project is made available to the user. These indices, selected among the 27 climate index defined by the ETCDD, are internationally accepted by the scientific community for representing change in climate extreme, such as dry spell or intense precipitation.



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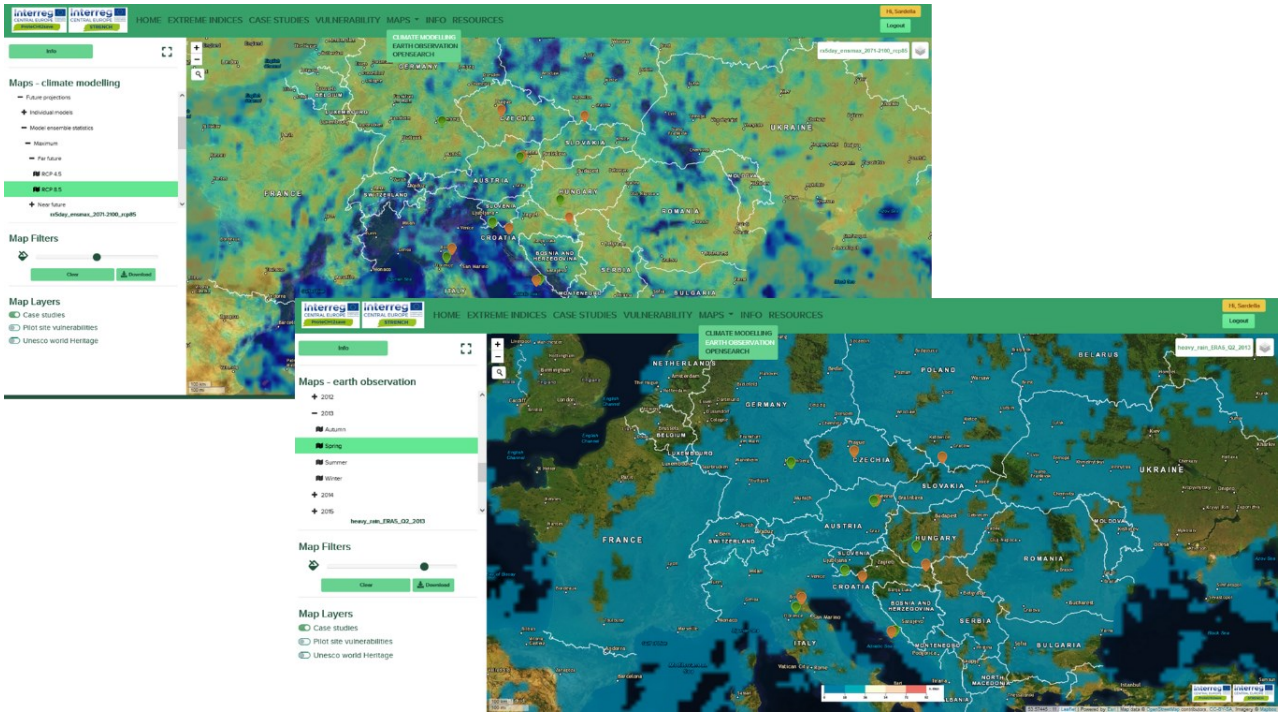
Users of the Web-GIS have unlimited access to tools specifically conceived and implemented to visualize and download climate data and maps elaborated by using climate modelling (EuroCordex experiment) and earth observation dataset (Copernicus C3S and NASA GPM IMERG).

Visualized maps explain how and where a defined climate extreme index selected varies in a designated area of Central Europe (and Mediterranean Basin) considering both historic variation (EOBS dataset and ERA5 reanalysis) and future projections (near and far future) under two different IPCC scenarios, stabilizing (RCP4.5) and pessimistic (RCP8.5).



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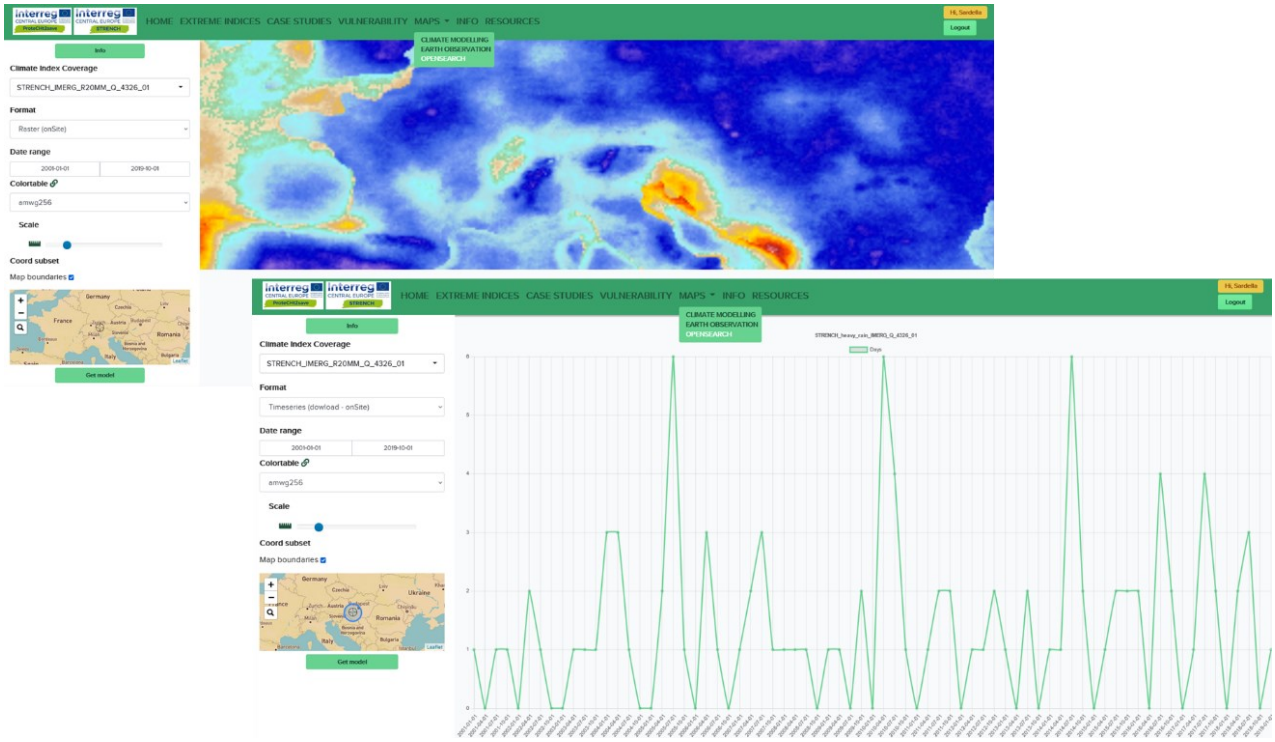
An additional feature was implemented in order to grant access to a large database of earth observation data. This tool, gives the user the possibility to query the database independently by choosing the extension of the area of interest directly on the map or to choose just the position based on geographical coordinates.

Once the point / area of interest has been identified, it will be possible to choose the climate index and the time period of interest.

The final output can therefore be, depending on the choices, a numeric data (e.g. a time series of values on a specific point in a readable file format, such as csv), a colour scale map or a numerical matrix. All information acquired with the "OPENSEARCH" tool is always be geocoded.

The purpose is to allow a specific analysis of the climate indices by the stakeholders.



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The Web-GIS Tool is freely available on the ProteCHt2save homepage after a brief online registration. Further session where the user has access to additional resources including a detailed tutorial for the use of the Web GIS tool and additional references to research papers and websites of interest.

Access the WebGIS tool "Risk mapping tool for cultural heritage protection" via: **https://www.protecht2save-wgt.eu/**.

WebGIS tool – Tutorial PDF:**https://www.interreg-central.eu/Content.Node/STRENCH/CE1665-STRENCH-D.T1.3.3-Tutorial-development-for-user-friend.pdf**

WEB GIS Testing Evaluation and Assessment of the Zichy Mansion

(by Dr. Zita Könczölné Egerszegi and Zoltán Heizler of the LBDCA)

In the STRENCH project the developed integrated WebGIS tool was tested on the 7 overall pilot sites located in Italy, Austria, Czech Republic, Germany, Hungary, Slovenia and Croatia (IT, AT, CZ, HU, DE, SL, HR). With the aim to evaluate the usability and application of the WebGIS tool on vacirous cultural heritage sites with their strongly differing hazards which are predominately found within them.

Zichy Mansion is located in the Hungarian village of Zala within the Balaton Region and was choosen as an example to illustrate the Web-GIS testing perfomred on the STRENCH Pilot Sites The shown risk evaluation of Zichy Mansion can be considered as typical for the Lake Balaton area in Hungary and encompass in the following issues:

- Zichy Mansion is a cultural heritage site which can be describes as being in medium condition (not in a critical state of decay, overlooked or completely abandoned, but the maintenance and protection of the site could be improved in certain areas).
- Zichy Mansion is exposed to typical weather related risks like many sites in the Lake Balaton areas. These are mainly high wind speeds, a large amount of precipitation with associated flash floods, soil erosion and finaly when lacking precipation wildfires.

A. 2. Evaluated site: Zichy Mansion

In their assessment the Lake Balaton Development Coordination Agency integratet the use of the WebGIS tool within the framework of the STRENCH project into the Hungarian disaster management practices concerning the protection of the greater Lake Balaton area. (Cultural heritage protection here being a part of disaster management in the sense of preventing and/or mitigating the effects of weather related incidents on both natural and human built environment.)

2.1. The Mansion and the surrounding area

The Zichy Mansion is located in Hungary, in the greater Balaton region (in the village of Zala specifically). Famous painter Mihály Zichy was born in this mansion in 1827; the building itself today is operating as a museum which was founded in 1927, on the occasion of the centenary of the painter's birth by his granddaughter, Mária Alexandra Zichy and her husband István Csicsery-Rónay.

The exhibition was opened in 1979, then renovated and rearranged in 1992. The furniture in the exhibition is original and has been preserved by the Zichy family. The material of the exhibition can be viewed in eight halls, partly presenting the artist's paintings, drawings, as well as the objects, documents and collection of his life. Most of the 4,000-volume family library consists of German and Latin books.

The building is surrounded by a park broken into two segments, (see picture below, in which the park segments are marked with red, the red dot represents the building itself). The park was planted around 1820. The park is a nature reserve with significant cultural and historical values. The 12-

hectare park is divided by the village traffic road and the Zala stream. The mansion is surrounded by spruce trees in the upper park, and the lower park is surrounded by a row of horse chestnuts (Aesculus hippocastanum). There are nine protected tree species and 16 protected bird species in the park, which is under landscape protection, so *it is part of the cultural landscape at Lake Balaton.*

2.2. Zichy Mansion and park: the features

The Zichy Mansion itself is located on stable slopes, with low inclination (less than 15 degrees), which makes it somewhat susceptible to heavy rainfall, flash floods.

The soil around the building and on the park area is fine-grained soil (high silt and loess content). Note that land segments in agricultural use surround the park itself, so the potential heavy rainfall and/or flash floods have the effect of moving the loose soil into the lower part of the park itself.

The higher part of the park houses some 130 year trees but has little to no ground covering foliage. Because of this heavy rainfall and/or flash floods also have the ability to moderately or even heavily erode the ground itself, which weakens the grip of the tree roots in the ground and makes the trees themselves susceptible to heavy winds (which are prevalent in the area, see later).

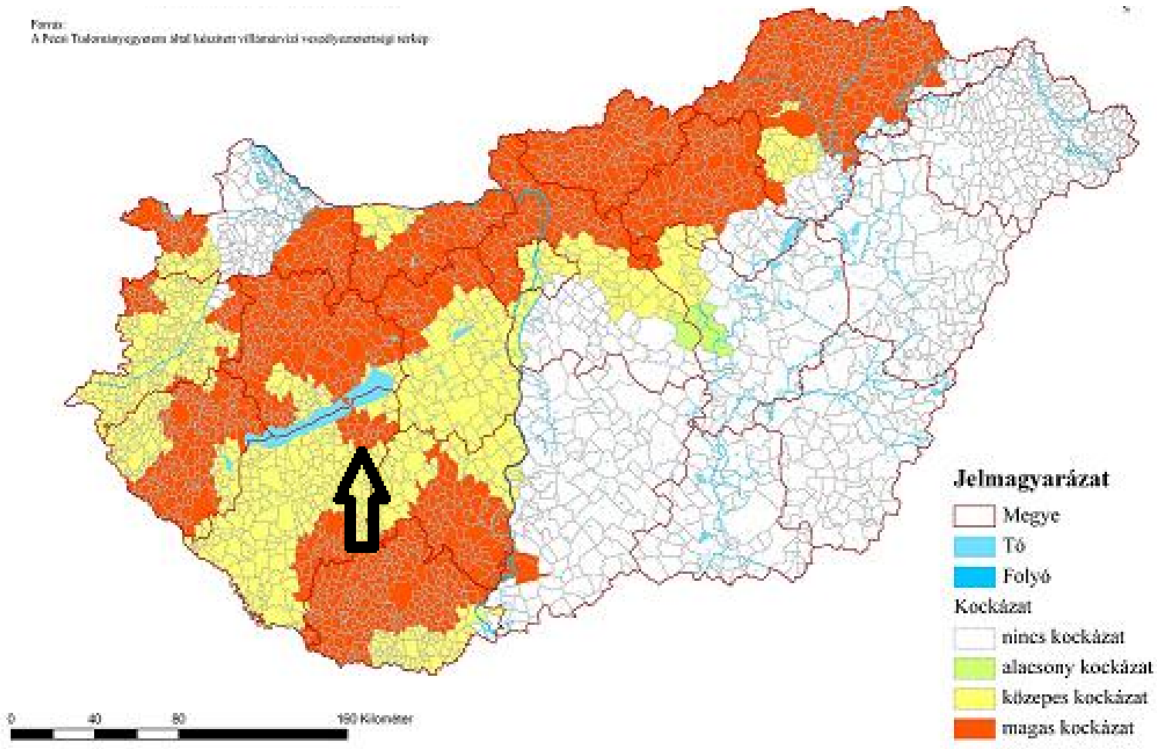
The building itself is in touristic use and in fair state of conservation, maintenance is done periodically, The main problem here is that it is heavily surrounded by trees hence the susceptibility to damage done by falling trees, branches etc. But beyond a certain speed heavy winds could also damage the roof structure itself, opening the building to rain damages.

B. 3. Weather related risks in the Balaton region and around the mansion

Although it is beyond the scope of this case study to evaluate the whole of the Lake Balaton area, we have to consider some characteristics of the area in which the Zichy Mansion is located in.

3.1. Flash flood (rainfall)

According to the disaster management evaluation of Hungary, a serious portion of Lake Balaton area is categorised as high flash flood risk. Zichy Mansion (the approximate location on the map below is shown with a black arrow) is located on the only portion of the South-Balaton area with high flash flood risk.



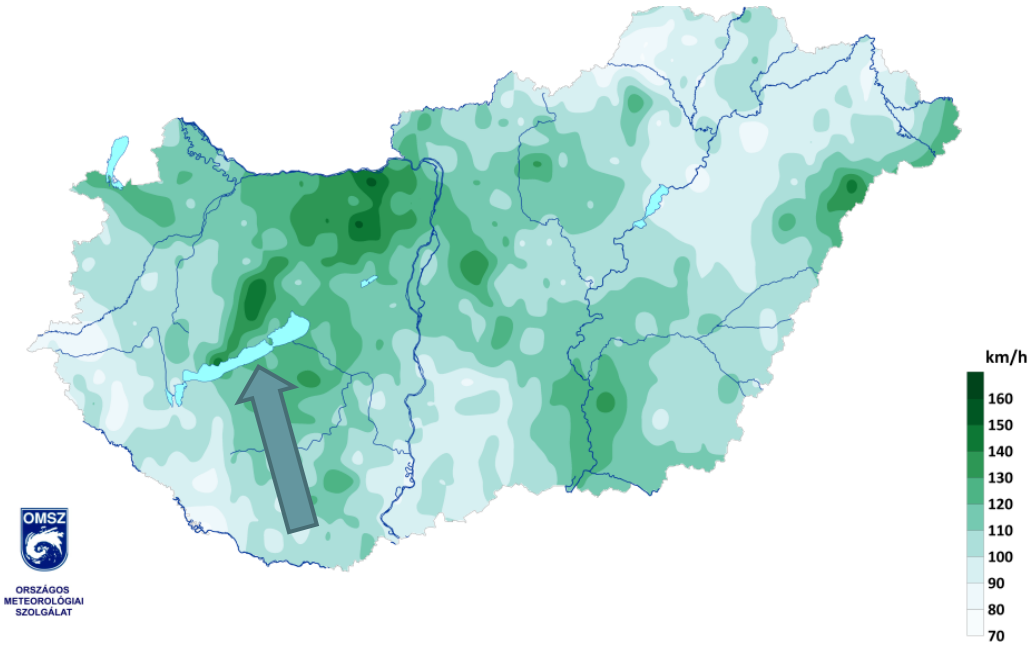
Flash flood risk map of Hungary. Legend: red = high risk, yellow = medium risk, green = low risk, white = no risk. © OMSZ

The problem with flash flood in connection with the park and the mansion building itself is that a) it could partially or wholly fill the upper area with sediment, b) the resulting erosion could damage the 130 year trees and to some extent even the building itself, c) it could damage roads in the area impeding the touristic use of the building/park.

3.2. Heavy winds (windspeed)

Heavy and damaging winds are a decade long problem in the greater Lake Balaton area. The effect of wind on the lake itself is especially interesting: strong wind gusts tend to „push" the water from one end of the lake from another. This so called „swing" could result in an increase/decrease of 10-20 cm water level (depending on the point of measure).

© Lake Balaton Development Coordination Agency



Maximum wind speeds in Hungary in a 30 year period (see legend in the bottom right corner for values). Note that the Zichy Mansion (marked with yellow arrow) is located in an area plagued by frequent high wind speeds (100–120 km/h winds are fairly frequent and pose a danger to infrastructure).

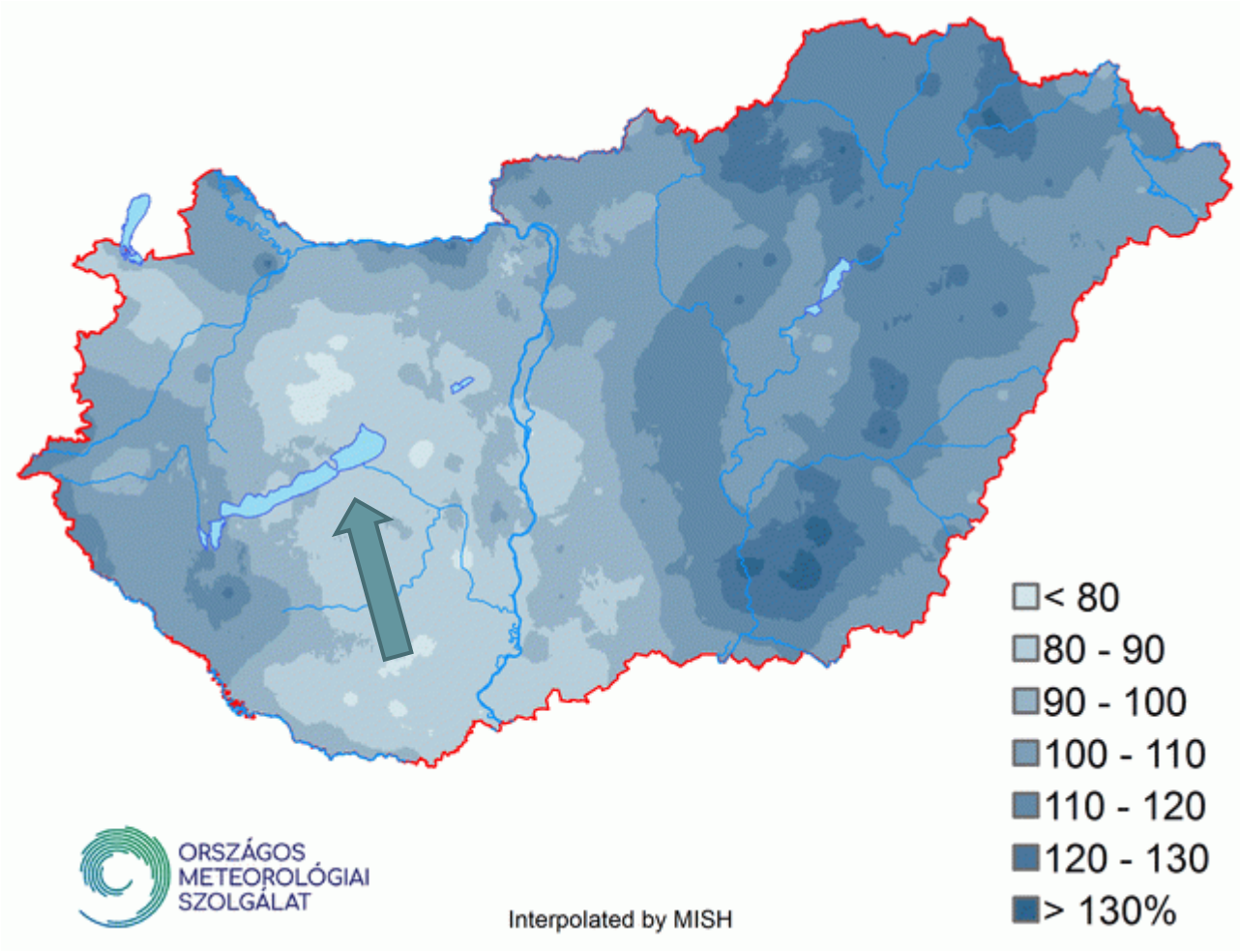
The Zichy site is located in an area with wind 90+ km/h wind speeds. The main problem is the constantly growing rate at which these wind speeds are happening. According to Hungarian meteorological research of the area, the following statements are true for the Lake Balaton area:

- In the first decade of the 21st century, there were **44 days** on which **90+ km/h** wind speeds were measured.
- In 2010–2020, there were **77 days** on which **90+ km/h** wind speeds were measured.
- In the first decade of the 21st century, there were **8 day**s on which **110+ km/h** wind speeds were measured.
- In 2010–2020, there were **27 days** on which **110+ km/h** wind speeds were measured.

The days with 90+ km/h wind speeds almost doubled, the days with 110+ km/h wind speeds tripled in the last 20 years. Strong wind gusts alone are enough of a threat but they are almost always coupled with heavy rainfall and storm activity, which increases the likelihood of flash floods, fallen trees, damages to infrastructure etc.

3.3. Heavy rainfall

According to the Hungarian meteorological datasets, the yearly average rainfall was the same or less in the whole of Lake Balaton region. As can be clearly seen in the map below (the approximate location of the mansion is marked with a yellow arrow), the overall yearly precipitation decreased in the lower south-east Balaton area.



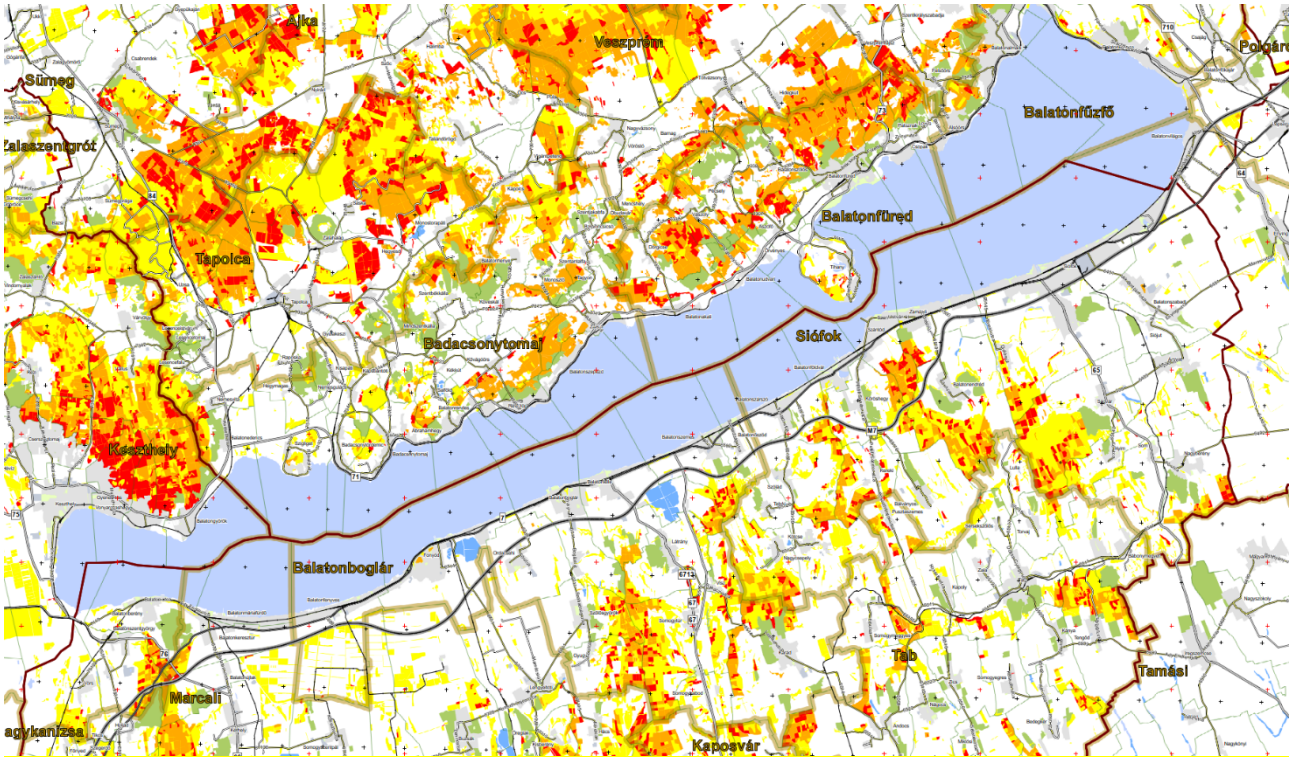
Precipitation amount for 2020 as percentage of yearly average for the 1981-2010 period (based on homogenised, interpolated data)

This lowers the risk posed by rain but in fact doesn't necessarily decrease the risk posed by flash floods.

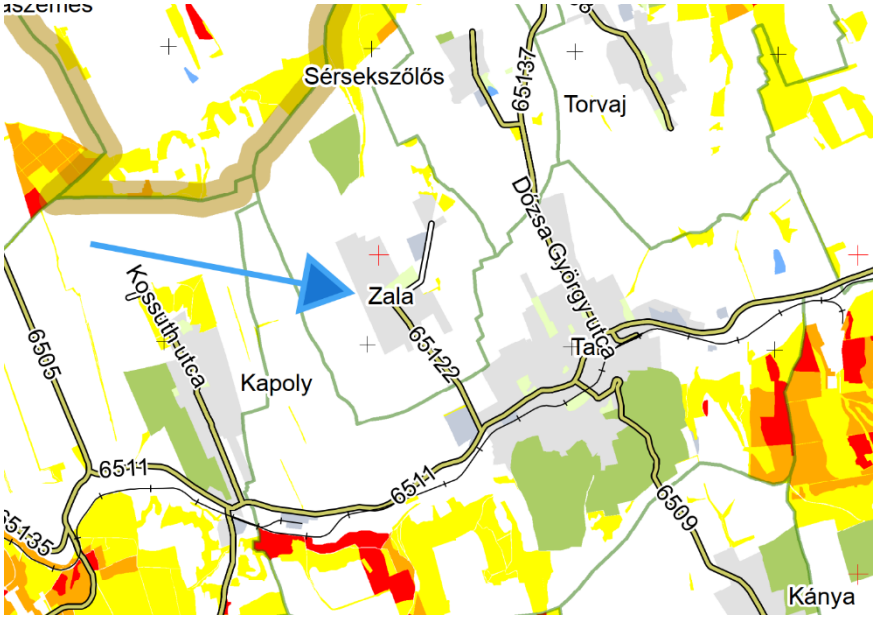
Additionally, there is a creek running only 180 meters from the Zichy Mansion). This creek, being a tributary to a larger creek called Kis-Koppány (which was already overflooded in the past, eg. in 2014), could theoretically spill its creek bed and join in the forming of a larger flash flood, filling the upper part of the mansion area with debris. When overflowing, the water and the debris could cross the road itself into the upper part of the mansion

3.4. Fire risk

There are several high fire risk areas in the Lake Balaton region, particularly the northern territories.



Fire risk map of the Lake Balaton area. Legend: red = forestal areas with high fire risk, orange = forestal areas with moderate fire risk, yellow = forestal areas with no fire risk. © OMSZ



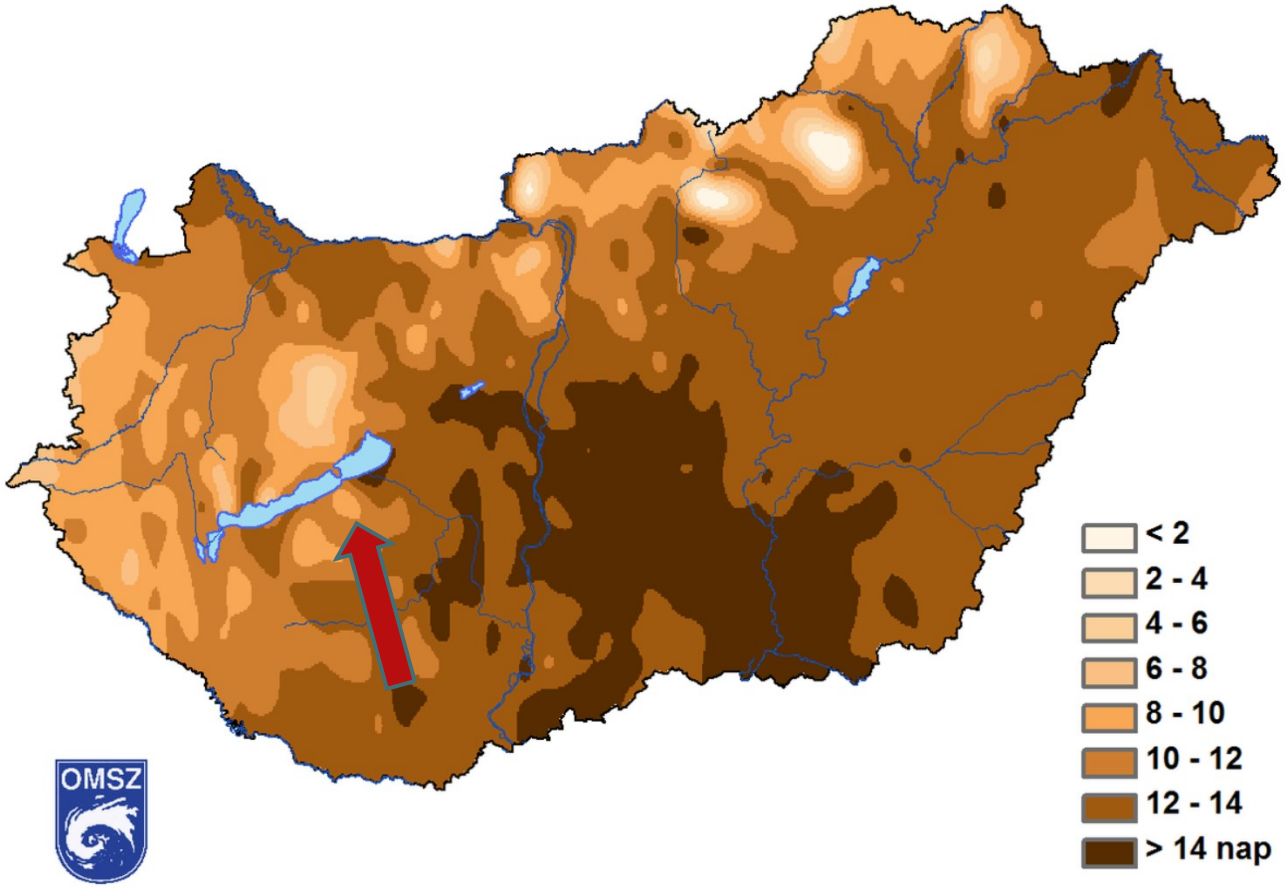
Cutout from the map above, Zichy Mansion marked with a blue arrow. © OMSZ

Although the mansion/park itself is not marked as a forest fire risk (mainly because the park is not large enough to be considered a forest), there are some high fire risk areas in the vicinity. (Note especially the red areas to the south and south-east in the first map. The second map shows a satellite image of roughly the same area, with one high fire risk area marked with red arrow.) In

theory, these are far enough not to pose a direct threat, but if you consider the possibility of the fire accelerating effects of strong wind gusts, they are a risk to be calculated with.

Another (although lesser) problem is that in dry periods the surrounding agricultural land strips pose a threat. The use of agricultural machinery (tractors, harvesters etc.) is always a fire risk given the mix of overheated metal and dry harvested goods.

It is worth considering the temperature charasteristics of the area. The map below (the approximate location of the mansion is marked with a blue arrow) indicates how the days with a heatwave per year changed in Hungary in a 36-year period. The area surrounding the park suffered a moderate to heavy (8-12 days per year) increase. The problem is clear: more heatwaves and thus longer hot and dry periods with higher fire risk.



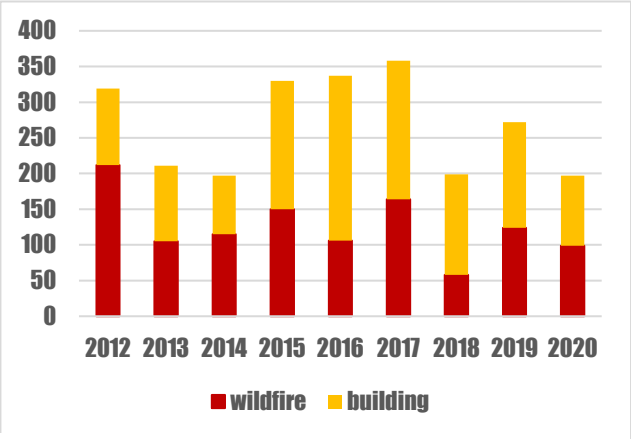
Days with a heatwave (daily avg. temp. 25+ °C) in a 36 years period in Hungary.

C. 4. Risk matrix from a disaster management perspective

Considering all of the above it should be possible to establish a risk matrix for the mansion and the surrounding area, focusing on disaster management statistics and meteorological observations.

4.1. Disaster management statistics

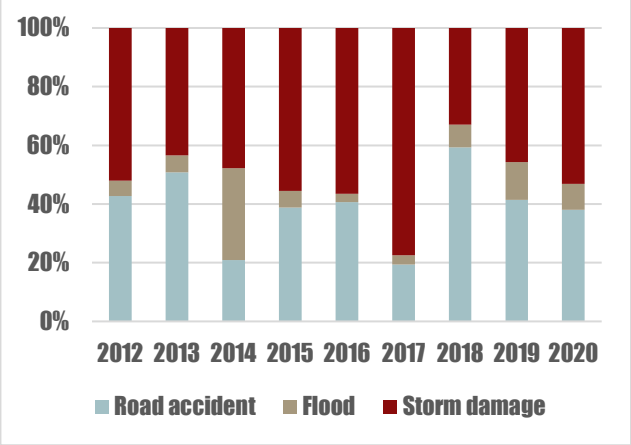
This subchapter is focused on the evaluation of certain Hungarian disaster management aspects characteristic to the Lake Balaton area. The source of the data is the National Directorate General for Disaster Management (Hungary).



© Lake Balaton Development Coordination Agency

Fires in the larger South-Balaton area where the mansion itself is located. „Wildfire" means every incident where firefighters have to extinguish a fire affecting a natural environment (mainly forest, but also areas with foliage, agricultural areas with crop etc.). „Building" means every incident where firefighters have to extinguish a fire affecting a built environment (any type of building, infrastructure).

For the sake of this case study the fires were divided into two categories. Wildfires (aside from a few years) are less common in this area, but overall they give a significant portion of firefighter's work.



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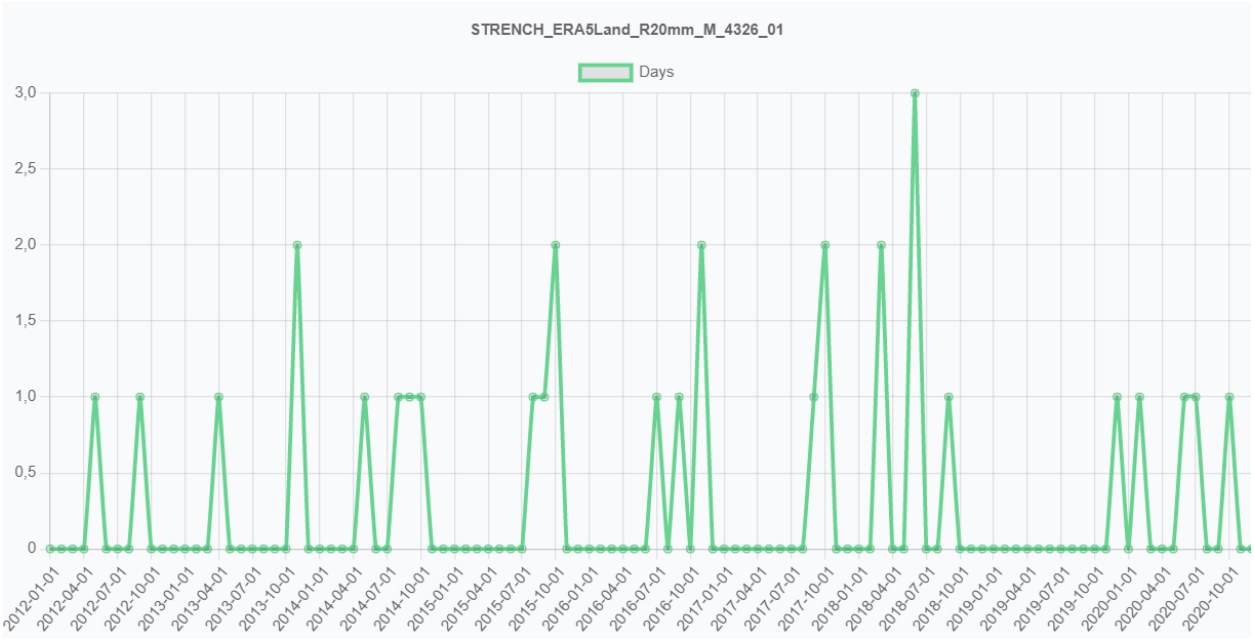
The proportion of disaster management damage types in the larger South-Balaton area where the mansion itself is located. A„road accident" means an incident that involves some form of moving vehicle (eg. two cars crashing into each other, a car crashing in a tree etc.). A „flood" means an incident where water gets on/into built environment not meant to withstand large amounts of water (eg. basement, house) or where it impedes the normal use of that environment (eg. roads, railroads). „Storm damage" means every incident where firefighters have to mitigate damages done by the storm to natural and/or built environment which impede the normal use of that environment (eg. trees fallen to roads or seriously damaged roofs) or pose a threat to people (eg. loose bricks).

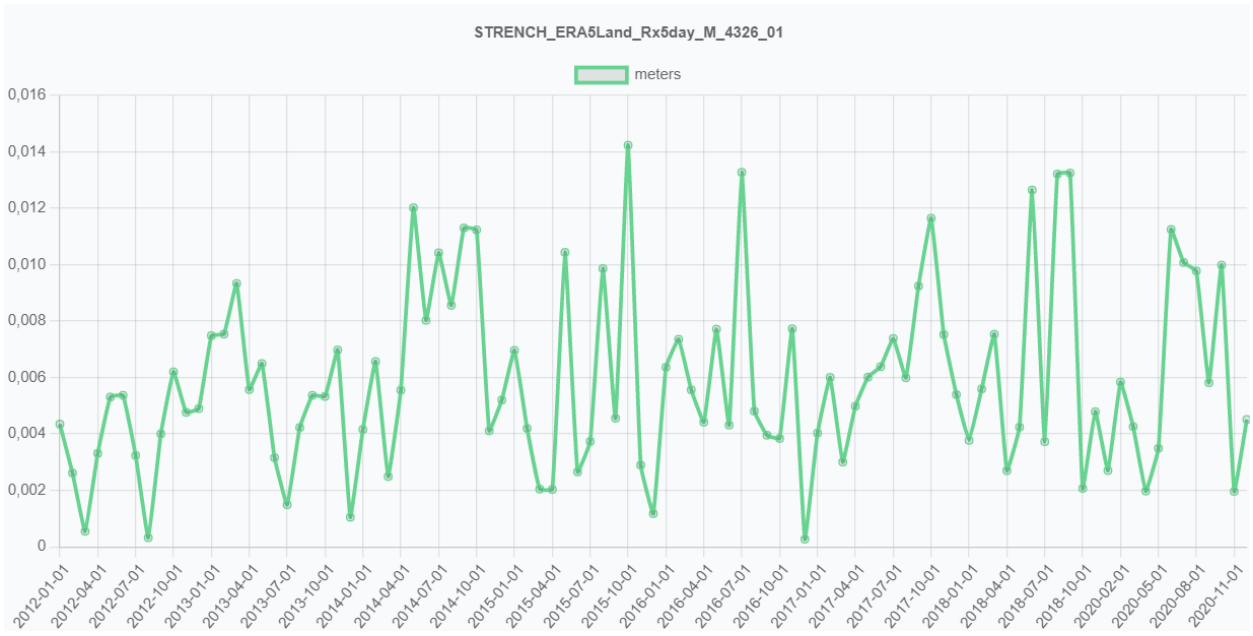
As can be seen from the diagram above, there are a lot of storm related damages in the southern Lake Balaton area. As we have already established, the Balaton region in general is plagued by high speed winds and heavy storms which of course take their toll on infrastructure. From the viewpoint

of this case study alone, road accidents are less relevant (although we should mention that certain trucks carrying hazardous material are a threat to the landscape itself). And finally, flood presents a small but significant portion of firefighters' work.

4.2. Meteorological observations of past events



Climate index: R20 mm / Dataset: ERA5-Land 2012–2020



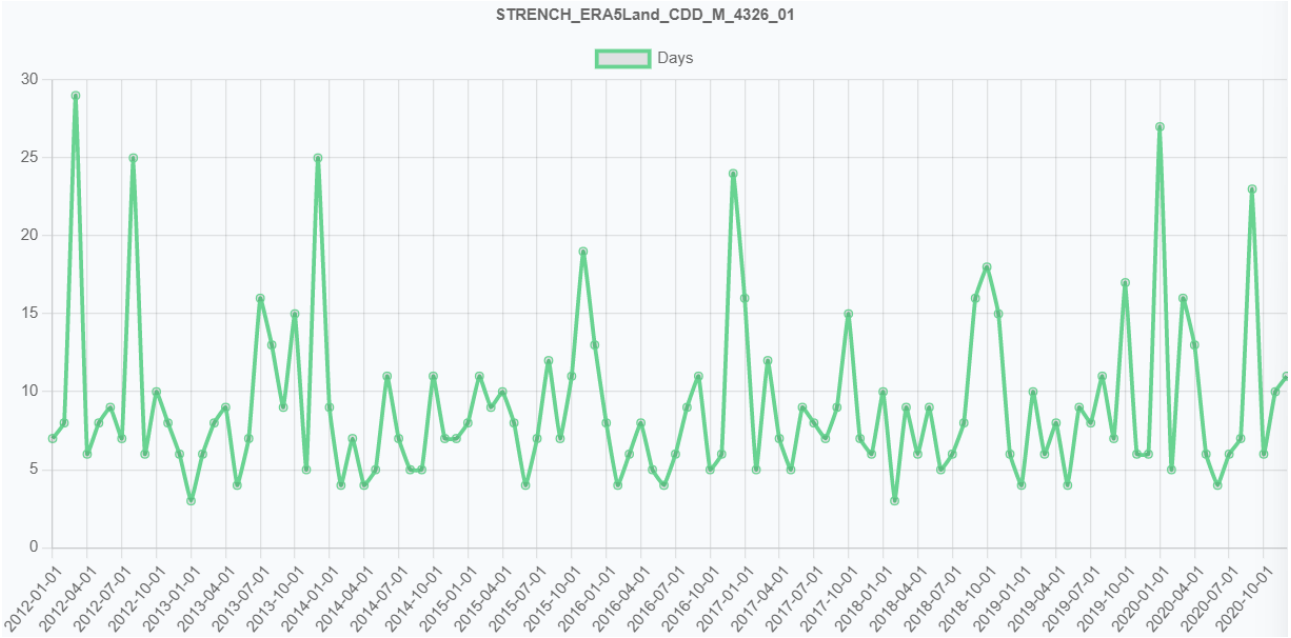
Climate index: Rx5day / Dataset: ERA5-Land 2012–2020

It is interesting to observe how the meteorological datasets align with the disaster management deployments. The two diagrams above represents the 2010–2020 ERA5-Land public use dataset for the very heavy precipitation days and the highest 5-day precipitation amount in the area around the

Zichy Mansion. Although not an exact match (since the disaster management data corresponds to a somewhat larger area), there are significant correlations.

- For instance there were 8 days with very heavy precipitation in 2014 in the area. This year had the second highest precipitation related disaster management deployment number (flood+storm combined) and an all-time high on flood-related deployments (see 4.1.).
- Also, there is a plateau in 2014 in the Rx5day diagram, likely indicating the reason for the rise in flood-related deployements in 2014. It is worth noting however, that there is seemingly no correlation in 2017 (the meteorological observation does not justify the high precipitation related deployments).

Another example would be the dataset about maximum number of consecutive dry days.



Climate index: Rx5day / Dataset: ERA5-Land 2012–2020

There is a strong correlation in 2012 (see 4. 1.), which was a year with record high wildfire-related incidents. 2015 and 2017 have their high values as well, but interestingly, although 2020 saw record droughts, the wildifre-related deployments were relatively low.

These are just two examples, which show the possible use of meteorological datasets for corroborating certain hypotheses based on disaster management activity in a certain area. **The main takeaway here is that these kinds of datasets could be useful in determining which weather index to use in case of an evaluation.**

The diagrams used were generated with the OpenSearch / TimeSeries option of the WebGIS tool.

4.3. Disaster management risk matrix

The disaster management risk matrix is made up of a likelihood and a threat level, which together give each weather related risk a threat index. This index is viewed in connection with the evaluation of Zichy Mansion and is only used in this case study. The matrix was complied considering the disaster management deployment (source: NDGDM, see 4. 1.) and meteorological data series (source: WebGIS OpenSearch tool, see 4. 2.).

	minor threat (1)	moderate threat (2)	serious threat (3)	very serious threat (4)
low chance (A)	road accident			earthquake
moderate chance (B)			wildfire heavy rainfall	flash flood erosion
good chance (C)		heatwave drought		high wind speeds

Evaluation in case of Zichy Mansion:

- Category C4: high wind speeds
- Category B4: flash flood and erosion
- Category B3: wildfire and heavy rainfall

Other risks are either too low a chance to occur or else not serious enough to consider in the scope of this evaluation.

The vulnerability value for Zichy Mansion – calculated in the framework of the STRENCH project earlier – is 0.38.

The more prominent shortcomings in the vulnerability evaluation were:

- stocky constructions made of materials prone to degradation or impact damage
- large openings at ground floor
- fine-grained soil
- vegetation prone to serious damage
- financial recovery funds available but insufficient

To sum up the findings so far, the criticalities in this area include:

High wind speeds. Considered in connection with either heavy rainfall or wildfire. Although an uncontained wildfire is not a very high risk when looking at the mansion or the surrounding trees itself, there is a slight chance that a fire further away could „skip" some distances on a very windy day. Moreover, when coupled with heavy rainfall, wind speeds in the 120+ km/h range may be able to fall some of the 130-year old trees because of the soil getting too soft with rain and the trees losing their grip.

Erosion. There are several spots in the Lake Balaton area in which erosion is a huge issue (eg. loess high cliffs near the shoreline or several other flat areas further away). The problem around Zichy Mansion is not as pronounced but nonetheless the silt-like soil is prone to small shifts and movements when exposed to large amount of sustained raining. This could affect the park and in very serious cases the building itself.

Heavy rainfall. Interestingly, in itself, rain is not necessarily a prominent risk (but when coupled with wind it is, see above). The surface shape (mild slopes, agricultural areas etc.) means however that if flash floods form, there could be medium to serious damages.

Wildfire. Although only a moderate risk here, fires nonetheless form a caveat worth preparing for, maybe assessing future dry periods and calculating them into disaster management plans as well.

D. 5. Evaluated site: Zichy Mansion

WebGIS indices used:

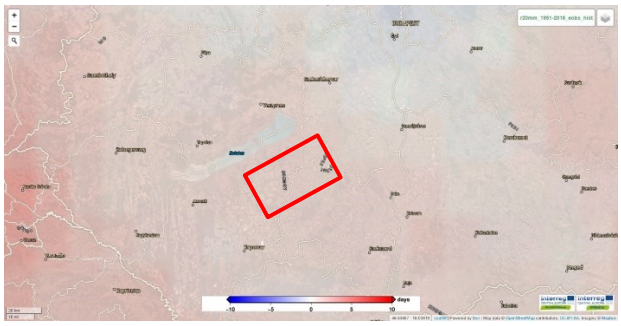
Index	Definition / description	Reason
R20mm	Very heavy precipitation days Number of days in a year with precipitation larger or equal 20 mm/day.	slow erosion, possible flash floods
R95pTOT	Precipitation due to extremely wet days The total precipitation in a year cumulated over all days when daily precipitation is larger than the 95th percentile of daily precipitation on wet days. A wet day is defined as having daily precipitation ≥ 1 mm/day. A threshold based on the 95th percentile selects only 5% of the most extreme wet days over a 30 year-long reference period.	slow erosion, possible flash floods
Rx5day	Highest 5-day precipitation amount Yearly maximum of cumulated precipitation over consecutive 5 day periods.	possibility of heavy erosion & flash floods
CDD	Maximum number of consecutive dry days Maximum length of a dry spell in a year, that is the maximum number in a year of consecutive dry days with daily precipitation smaller than 1 mm/day.	higher risk of wildfires
Tx90p	Extremely warm days Percentage of days in a year when daily maximum temperature is greater than the 90th percentile. A threshold based on the 90th percentile selects only 10% of the warmest days over a 30 year-long reference period.	possible vegetation damage

The approach was to collect maps of the area from the WebGIS application with past (1951–2016), near future (2021–2050) and far future (2071–2100) projections (Model ensemble statistics / Maximum / RCP 4.5). We found that the robust visualization tool of the WebGIS application is better suited for comparison (not to mention in case of decision preparation materials when the readers

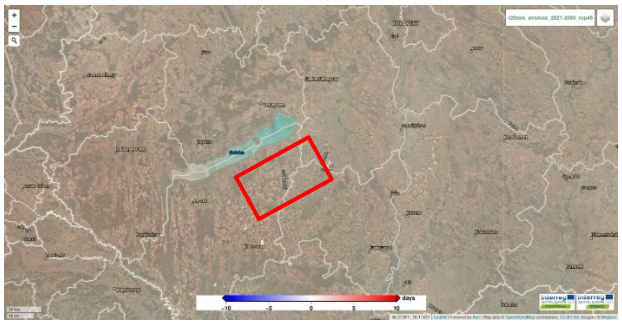
are laymen) than raw datasets. We divided this section in 5 segments, each dedicated to a weather index detailed above, and containing three maps with additional information and interpretation.

In the case of every map, an approximate smaller area was marked with a red/black (depending of the visibility) rectangle for comparison only. The idea was to get a general idea for the southern Balaton-area as the weather related phenomena and its consequences are not always constrained.

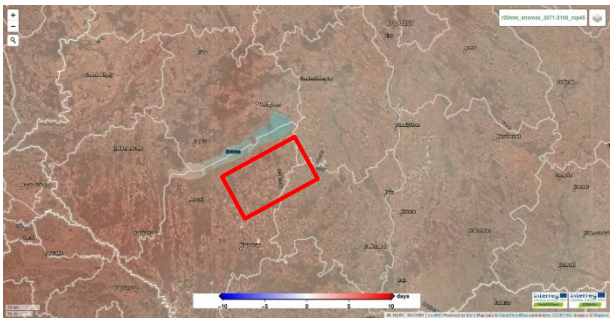
5.1. Very heavy precipitation days



Map for the past dataset on r20mm



Map for the near future dataset on r20mm

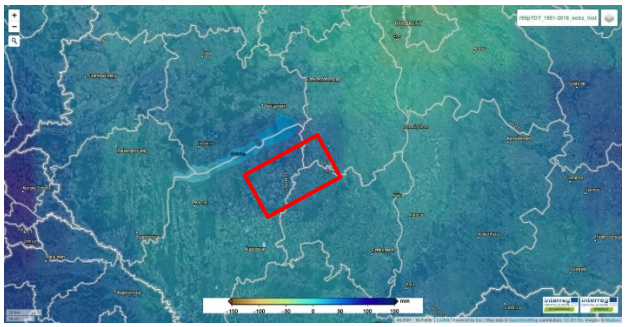


© WebGIS

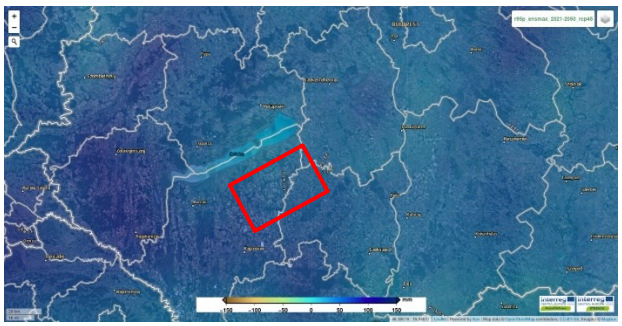
for the far future dataset on r20mm

The base for the evaluation is somewhere in the 0–1 days range as can be seen in the first map. The near future projections show a clear increase being in the 2–3 range but the far *Map* future projections have the real dramatic effect: it shows 4-5+ values.

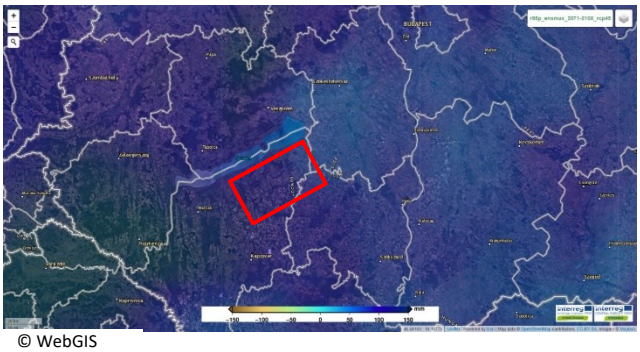
5.2. Precipitation due to extremely wet days



Map for the past dataset on R95pTOT



Map for the near future dataset on R95pTOT

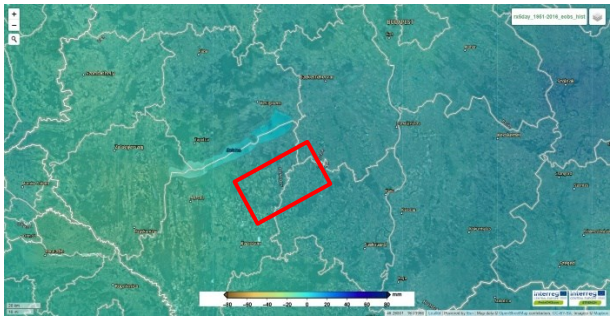


© WebGIS

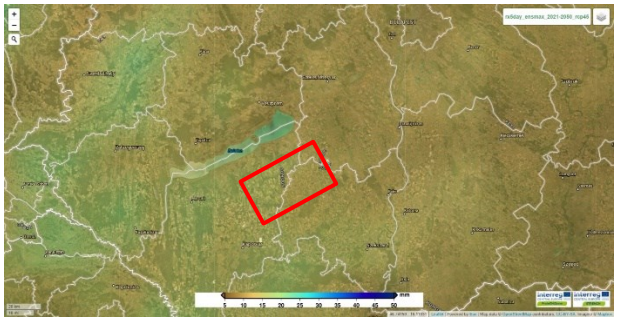
Map for the far future dataset on R95pTOT

The base for the evaluation is somewhere in the 40-50 mm range for the whole southern region. The near future projection increases this slightly in the 60-70 mm range, and the far future projections show a huge increase (100+ mm range).

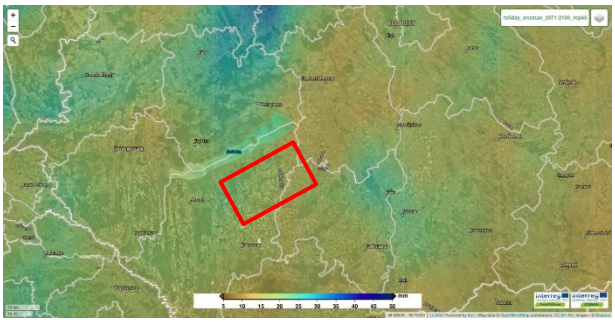
5.3. Highest 5-day precipitation amount



Map for the past dataset on Rx5day



Map for the near future dataset on Rx5day

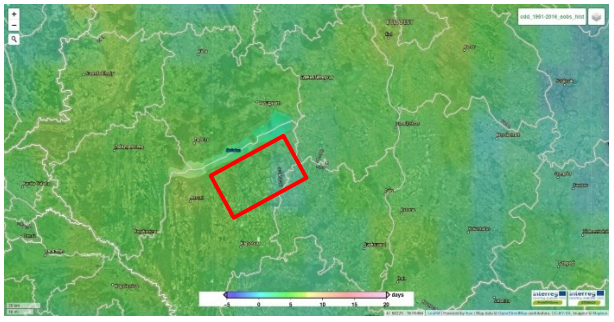


© WebGIS

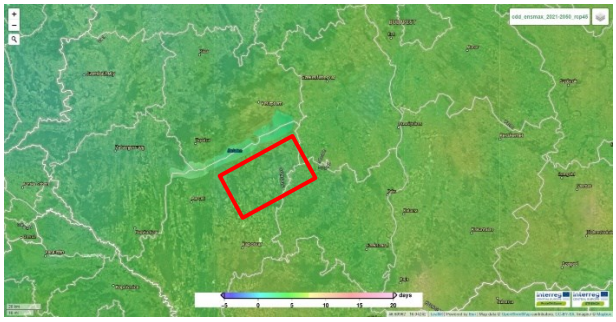
Map for the far future dataset on Rx5day

The two future projections show the southern Lake Balaton region being in the 12 and then the 20-25 mm range.

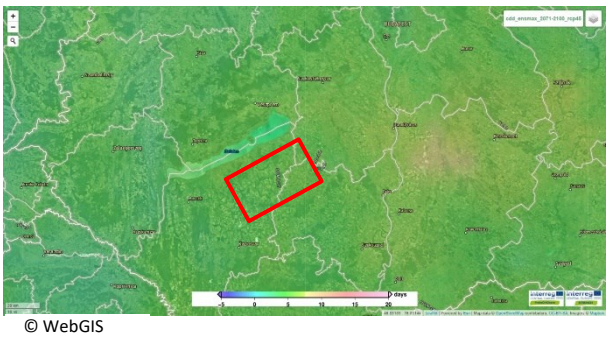
5.4. Maximum number of consecutive dry days



Map for the past dataset on CDD



Map for the near future dataset on CDD



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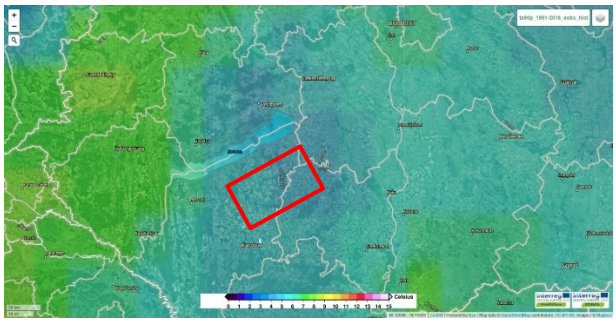
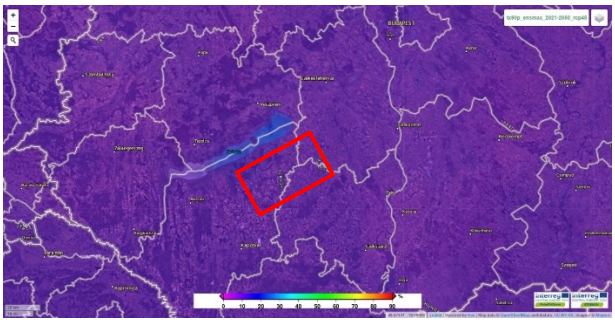
Interestingly there is no significant increase in an 80 years timespan. In this instance, judging from the visual representation, the risk stays more or less the same, so we must plan accordingly (more on that later, see Chapter 6).

Map for the far future dataset on CDD

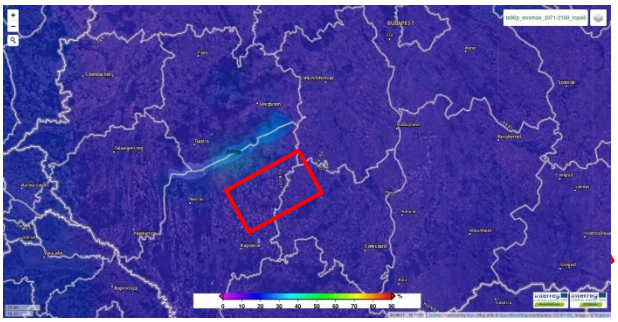
5.5. Extremely warm days



Map for the past dataset on Tx90p



Map for the near future dataset on Tx90p



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A 8-10 percentage value in an almost 30 years timespan, and then an increase in the 18-20 percentage range 50 years after that. According to the visual representation, the amount of extremely warm days will be much higher in the future, increasing the likelihood of damage done to the plants (more on that later, see Chapter 6).

Map for the far future dataset on Tx90p

E. 6. Conclusions and suggestions

The projections have provided the following conclusions:

Heavy rainfall is going to be the main problem in the area. The maps on *very heavy precipitation days* and *precipitation due to extremely wet days* show a distinct increase of precipitation in general. This means that in the future the loose, silt-like soil is going to be a more emphasized risk factor and the likelihood of erosion is going to increase. Just the same with flash floods: although the connection with rain tends to be more complex than „*the more rain the more floods*", it is very much possible that flooding, especially in the creek area, is going to be an issue too. Also, with the increase of the *highest 5-day precipitation amount* landslides may very well be forming on the otherwise mild slopes of the area.

Heat indices were somewhat of a mixed bag. Severe drought may not be a greater threat than it is now (which does not mean that it is to be taken lightly). On the other hand, the increase of extremely warm days could be the foreshadowing of possible vegetation damage in tha park, which could speed up erosion (the mix of damaged and already missing foliage means fewer roots to contain

slow erosion and quick landlsides). Extreme heat could also lead to fire risks although it is not certain to which extent.

Calculating these factors in the planning for the future, the following suggestions can be made in the preservation of Zichy Mansion and the landscape elements (mainly the arboretum and especially the 130-year old trees).

Heavy rainfall, flash floods, erosion. At the moment there are some weaknesses that need to be addressed, even more so in the face of the projetctions. Rain is going to be an emphasized problem, and although we had no chance to test storm related indices, it should be a good rule of thumb to link heavy rainfall with storm (and so wind speeds), thus making the prognosis of steadily increasing windy days aswell. This makes the following suggestions feasible.

First and foremost: volunteer firefighter associations play a great role in the Hungarian disaster management system, yet they are not included the cultural heritage protection planning, their use is ad hoc in this regard, and is usually limited to general damage mitigation. The local assets should be contacted and used in case of emergencies like flash floods. Local volunteer firefighters often have the capacity to conduct defense alone, without the help of professional (state) firefighters. The use of defensive measures (sandbags, ditches etc.) is practically impossible without the help of the local workforce.

Careful planting in the park area, replacing the missing foliage should be a priority. The absence of adequate small plant covering means that the area is more prone to erosion damage, maybe even landslide. A firm rooting can keep the silt-like soil in place. The plant planning should really be careful as the temperature indices suggest an increase in heat load on the foliage (see the next segment).

A survey of the large trees in the park. Especially the 130-year trees could be a serious damage factor if the soil loosened by the sustained raining is resulting in trees falling over. There should be some form of cataloging of trees (according to size, location and/or possible weaknesses).

Re-thinking the current agricultural and/or land use regulation in the Zichy Mansion area. Agricultural vegetation and the one sided land use decreases plants with the ability to „hold soil" (i.e. firmer roots going deeper, resisting erosion or larger landslides).

Further regulation of the Kis-Koppány tributaries in the region may be desirable, especially so in the case of Zala creek. The creek itself may not be a problem now, but with the increasing rainfall this could change.

The draining is going to become more important in the future. A careful re-thinking and planning of draining ditches is needed.

High windspeeds. Based on the projections it would be wise to anticipate an increase in storms (both quantity and „quality", i.e. more severe storms). There already is a complex storm warning system in place around Lake Balaton, but this mainly focuses on the lake itself (meaning: it warns sailing boats, ships and people in the water and on the shores).

The details about volunteer firefighter associations mentioned above is also true here.

A secondary storm warning system of sorts would be of great help to CH sites. Of course this would be the focus of an entire project but in this case Zichy Mansion could benefit from direct storm warnings filtering out only the events which could be really harmful to the site itself.

It is advisable to evaluate and in case strengthen the roof structure of Zichy Mansion. Currently there are no greater issues but the possibility of increasing heavy wind speeds (120+ km/h) mean more wind load to the roof structure.

The park survey mentioned above could also prove beneficial in this case. Mapping weak trees should be useful.

Wildfires. Fires are not an emphasized issue now. The reach of hungarian disaster management units is adequate (i.e. how fast they are on the scene in case of a fire). There are only some general advices to consider:

Agricultural work should be monitored and, if necessary, regulated.Fire ban periods (i.e. hot and dry periods in which it is forbidden to light any open fires outdoors) should be strictly enforced. Fire warning systems of the mansion should be checked regularly.

Rescue / salvage of cultural assets in case of emergency. In general, a more detailed and comprehensive emergency planning is needed. Suggestions:

Comprehensive mapping of cultural assets in and around the mansion. This includes the categorization of assets by value, size, weight, handling needs etc. Bearing these attributes in mind, it should be possible to lay out an emergency plan which contains what to do if there is an emergency, what should be moved first, what can't be moved, how and where things should be stored etc.

Volunteer firefighter organizations should be included in the planning and executions of the cultural asset rescue in some form. Volunteer firefighters represent an ever growing part of the Hungarian disaster management system: they are recognized, supported through monetary contributions, and, in some cases they can be deployed alone, without the support of state firefighters. Because of these reasons it would be a waste not to count on them – but to do this, they need to trained aswell. CH rescue courses, trainings could prove very useful, but at the very least they should be made aware of the problems.

The WebGIS application has a place in the Hungarian disaster / cultural heritage management practice. The robust visualization tool of the WebGIS application is suitable for disaster management planning and short but catchy decision preparation materials as instead of raw numbers it produces easy to understand visual maps of the area in question. Moreover, the possibility to compare past datasets with near and far future projections the change is easily grasped and because of the dramatic contrast, also better suited for presentations.

STRENCH Local Working Tables Year 2

While being an important tool for disseminating STRENCH project outputs and especially for gathering valuable insights, feedback and overall expertise the STRENCH Working tables were conducted in all partner countries bringing together experts in heritage protection on two occasions during the project duration.

STENCH Local Working Table Year 2 ITAM (CZ)

On February 25th the STRENCH project partner Institute of Theoretical and Applied Mechanics (ITAM) hosted their second STRENCH Local Working table as an online event attacting 39 representatives from Regional Offices in the Czech Republic, specifically those responsible for protection of cultural heritage and risk management to get a fresh feedback and broader audience (one of the attendees was from the Olomoucký region in which the Kroměříž Archbishop's Chateau and Gardens – a UNESCO site – are located). As they were a completely new audience, it was necessary to briefly acquaint them with the past initiatives of cultural heritage protection on the European level. Part of the presentation (conducted by prof. Miloš Drdácký) was devoted to ProteCHt2save results (criticalities, tools, Manual for Managers and Owners of the Cultural Heritage). After that, a smooth followed up with the results of the STRENCH project was conducted. The most important of which was regarding the webGIS tool. The use of the tool was demonstrated with an example and possible ways were discussed on how to incorporate it. In addition the numerical calculation of the vulnerability of the CH at risk was mentioned.

© ITAM

The discussion comprised of the feedback on the presented results – the attendees expressed their interest in both the Manual and the webGIS tool (both those who attended and those who were invited received links to the online version of the Manual and the webGIS tool website) – and of deficiencies still existing in the CH protection strategies against natural and man-made disasters. ITAM team remains available for further consultations and expertise regarding the development of the strategies and hazard maps in regions.

Expected effects are greater awareness of the ProteCHt2save and STRENCH results and tools in regions (not only in our Pilot location), greater prioritization of cultural heritage protection during extreme events and possible cooperation in developing local CH protection strategies. Possible future cooperation with the Regional Office in Olomouc regarding the UNESCO sites.

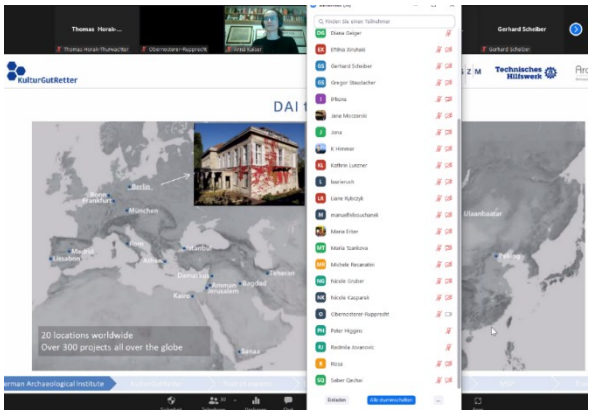
Link to invitation on ITAM website: http://www.itam.cas.cz/sd/novinky/aktuality/22-02-18_Aktualita178.html /
AV21 Strategy website: http://strategieav21-mesto-stavby.cz/2022/02/21/pozvanka-na-setkani-k-projektu-strench-lwt-2/

STENCH Local Working Table Year 2 UWK & SISTEMA (AUT)

After having to cancel the originally planned and already fully organized guided tour through the Wachau region Höhereck in collaboration with the Verein Welterbegemeinden Wachau and experts on dry stone walls at the last minute due to the Covid-19 pandemic in late 2021 an alternative STRENCH Local Working Table 2 (LWT2) was held online on February 08th 2022.

Hosted by the Center of Cultural Property Protection of the University for Continuing Education Krems the STRENCH project together with Synergizing the Project "KulturGutRetter" was presented to numerous participants with the focus on bringing together stakeholders from various levels and professions in order share and discuss the developments and tools and ways to contribute to sustainable implementation efforts in cultural heritage protection and to foster a transfer of knowledge of all stakeholders regarding cultural heritage management and protection strategies.

The presented content strongly emphasized the required synergy of expertise from cultural heritage experts, civil protection experts and local partners while discussing new and useful tools and management methods such as risk assessment as seen in the STRENCH project and how these tools may benefit in the cycle of crisis response, recovery, mitigation and preparedness. All in all further awareness raising of the STRENCH project, outputs and tools and networking between heritage protection organizations and enthusiasts was performed and strongly enhanced. Weblinks Local Working Table Year 2 (abbr. LWT2):



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Promotion LWT2: https://www.donau-uni.ac.at/de/universitaet/fakultaeten/bildung-kunst-architektur/departments/bauen-umwelt/news-veranstaltungen/veranstaltungen/2022/strench-local-working-table-2022.html

Registration LWT2: https://www.donau-uni.ac.at/en/university/faculties/education-arts-architecture/departments/building-environment/news---events/events/2022/strench-local-working-table/form-registration-strench-local-working-table.html

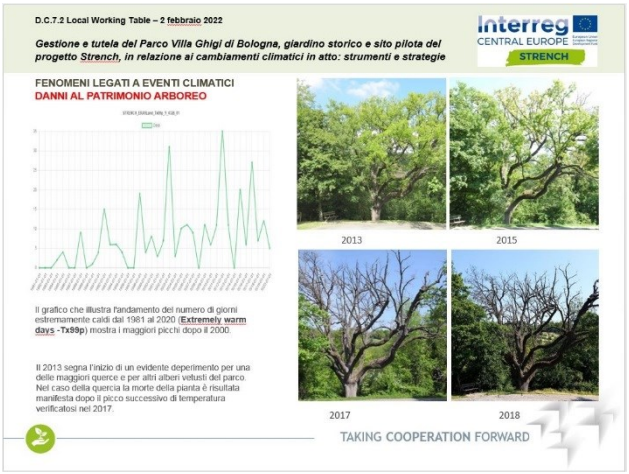
Article Published on STRENCH in close proximity to the LWT2 for promotional purposes: https://www.donau-uni.ac.at/de/aktuelles/news/2022/wetterextreme--gefahren-fuer-kulturgueter-abschaetzbar-machen.html

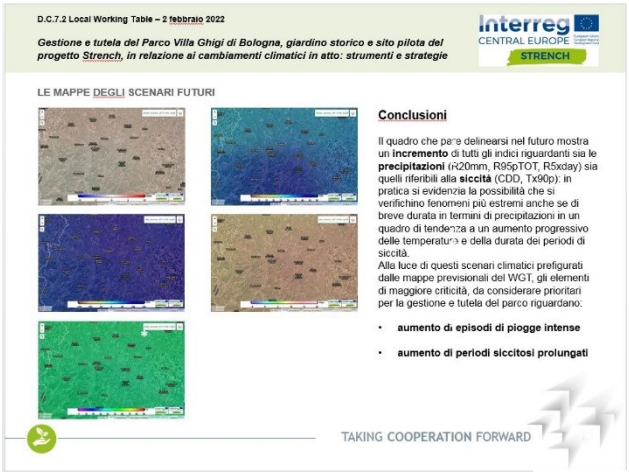
Weblink of KulturGutRetter (Guest speaker and Synergy-Project): https://www.kulturgutretter.org/

STRENCH Local Working Table Year 2 (FVG) & (ISAC), Italy

On February 2th 2022 the Villa Ghigi Foundation (FVG) and the Institute of Atmospheric Sciences and Climate (ISAC) hosted the second STRENCH Local Working Table in remote mode with ZOOM, due to the limitations due to COVID 19 pandemic still ongoing. In addition to the project coordinators of ISAC-CNR (Alessandra Bonazza, Paola De Nuntiis, Alessandro Sardella) and of the PP4 -Villa Ghigi Foundation (Valentina Bergonzoni, Ivan Bisetti, Mariateresa Guerra), managers and technical managers of public greens of some cities in northern Italia (Genova, Mantova, Parma, Bolzano, Padova and Grado) and the president of the Italian Association of Directors and Public Technicians Gardens (AIDTPG) participated in the meeting. After a general presentation of the project and of the Web GIS Tool for the protection of cultural and landscape heritage held by ISAC-CNR, the technicians of FVG presented the case study of the pilot site Villa Ghigi Park illustrating the general characteristics, the vulnerabilities and the current management strategies, including one application of the *Risk Mapping Tool* to the green area to show the potential of the tool at local level.

In the second part of the meeting, a discussion table opened with the participants during which, starting from the contents of the project the strategies and good management practices for the protection of the Cultural Heritage from extreme hydro-meteorological events were discussed, with a particular attention to historical gardens.
Participants have been invited to reflect and intervene on some specific issues: the characteristics of the green spaces of their own territory, the strategies adopted in the management of the green in the case of extreme hydro-meteorological events, the management strategies and the prevention measures to be foreseen in the future on the basis of the ongoing climate changes. The debate highlighted the general interest of the participants in the *Risk Mapping Tool* and a number of priority issues on which to focus attention and resources for the future, starting from the consideration that extreme events are no longer to be considered emergencies, but rather recurring and frequent phenomena that therefore require specific programs and action plans.





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Interreg CENTRAL EUROPE
European Union
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STRENCH

STRENgthening Resilience of Cultural Heritage at Risk

READY-TO-USE SOLUTIONS

» WebGIS tool for multi-risk assessment on cultural heritage in Central Europe
» hazard maps of extreme events in Central Europe for decision making in disaster risk reduction
» methodology for vulnerability assessment of cultural heritage at risk
» sustainable risk management strategies for cultural heritage

CULTURAL HERITAGE CATEGORIES

» cultural landscapes
» ruined villages
» historic parks
» archaeological sites in mountain and coastal areas

HAZARDS

» heavy rain
» (large basin) floods
» flash floods
» landslides
» fire due to drought
» windstorm

PROJECTS CAPITALISED

» Interreg Central Europe – BhENEFIT
» Interreg Central Europe – RUINS
» Interreg Central Europe – ProteCHt2save
» Interreg Central Europe- HICAPS
» H2020 – HERACLES
» H2020 – SHELTER
» FP6 – Noah's Ark
» FP7 – Climate for Culture
» DG-EAC – Safeguarding Cultural Heritage from Natural and Man-Made Disasters

PROJECT DURATION

01.03.2020 – 28.02.2022

€ ERDF co-financing 1.064.956,62 €

total eligible budget 1.301.712,50 €

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