EVALUATION AND ASSESSMENT ZICHY MANSION

Lake Balation Region / Hungary **December 2021**

1. Foreword

This is a risk evaluation of Zichy Mansion which could be considered typical for the Lake Balaton area in the following terms:

- It is a cultural heritage site in medium condition (not at all critical, overlooked or completely abandoned, but the maintenance and protection could be improved in certain areas).
- It has the same typical weather related risks like many Lake Balaton areas. These are mainly high wind speeds, high amount of precipitation and associated flash floods, soil erosion and wildfires.

2. Evaluated site: Zichy Mansion

We intend to demonstrate in this evaluation how we intend to seamlessly integrate the WebGIS tool developed in 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.)

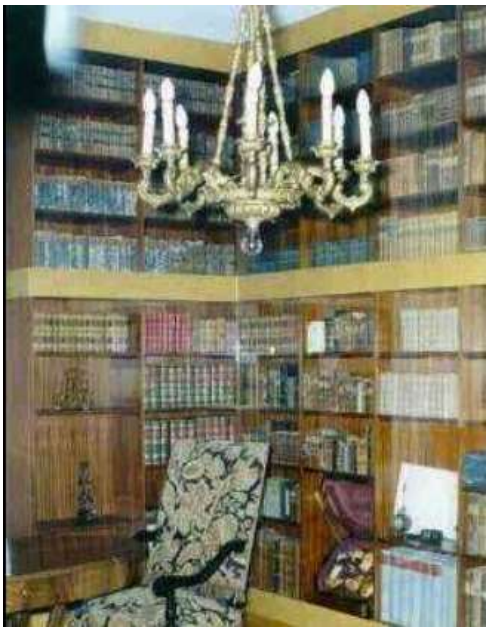
2.1. The Mansion and the surrounding area

The Zichy Mansion evaluated in this document 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, as can be seen in the picture below (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 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 (see the Google Map satellite view cutout below, the Mansion area marked red), 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).

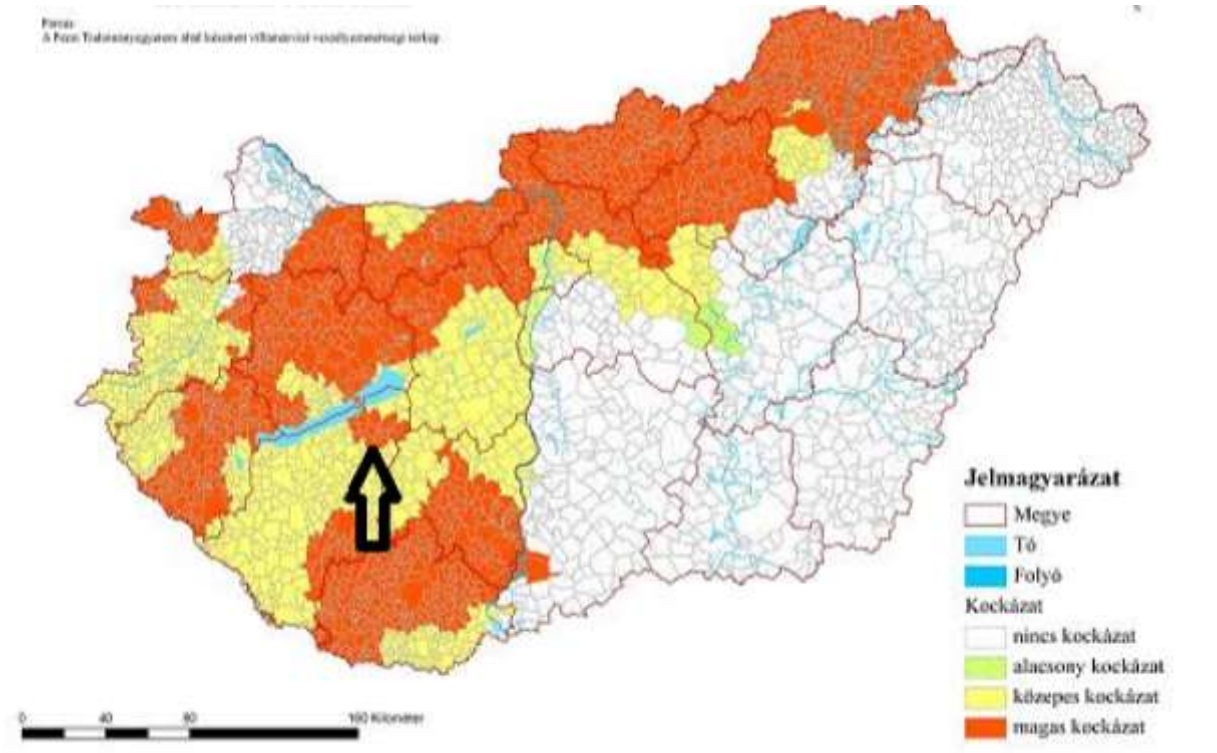
The building itself is in touristic use and in fair state of conservation, maintenance is done periodically, The main problem here is that it is heavily surrounded by trees hence the susceptibility to damage done by falling trees, branches etc. But beyond a certain speed heavy winds could also damage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

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

Although it is beyond the scope of this document 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.

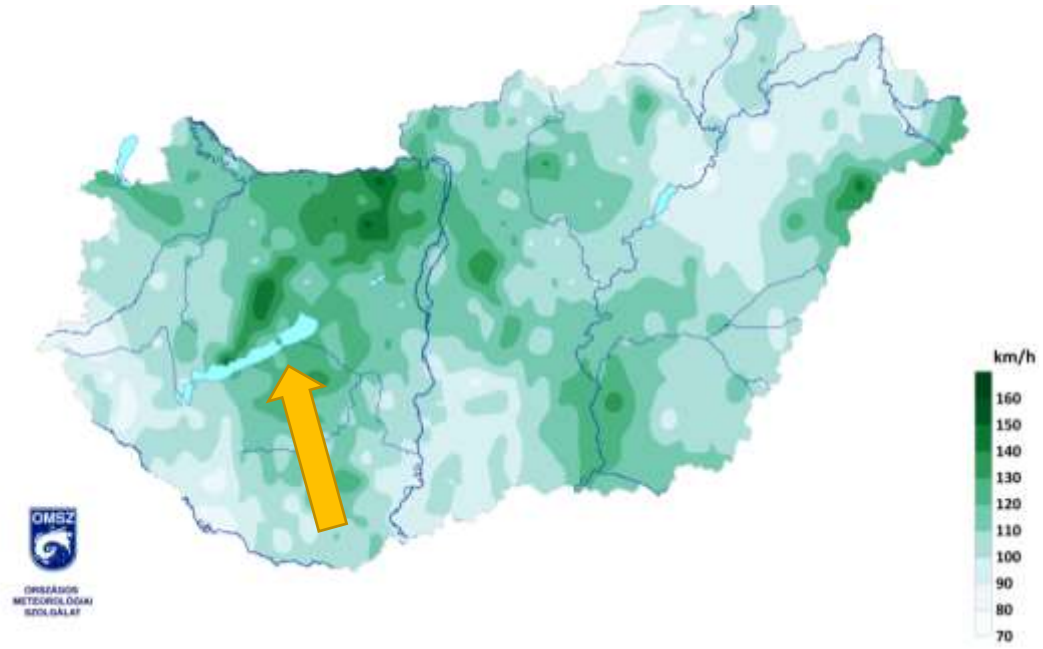


Flash flood risk map of Hungary. Legend: red = high risk, yellow = medium risk, green = low risk, white = no risk.

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).



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).

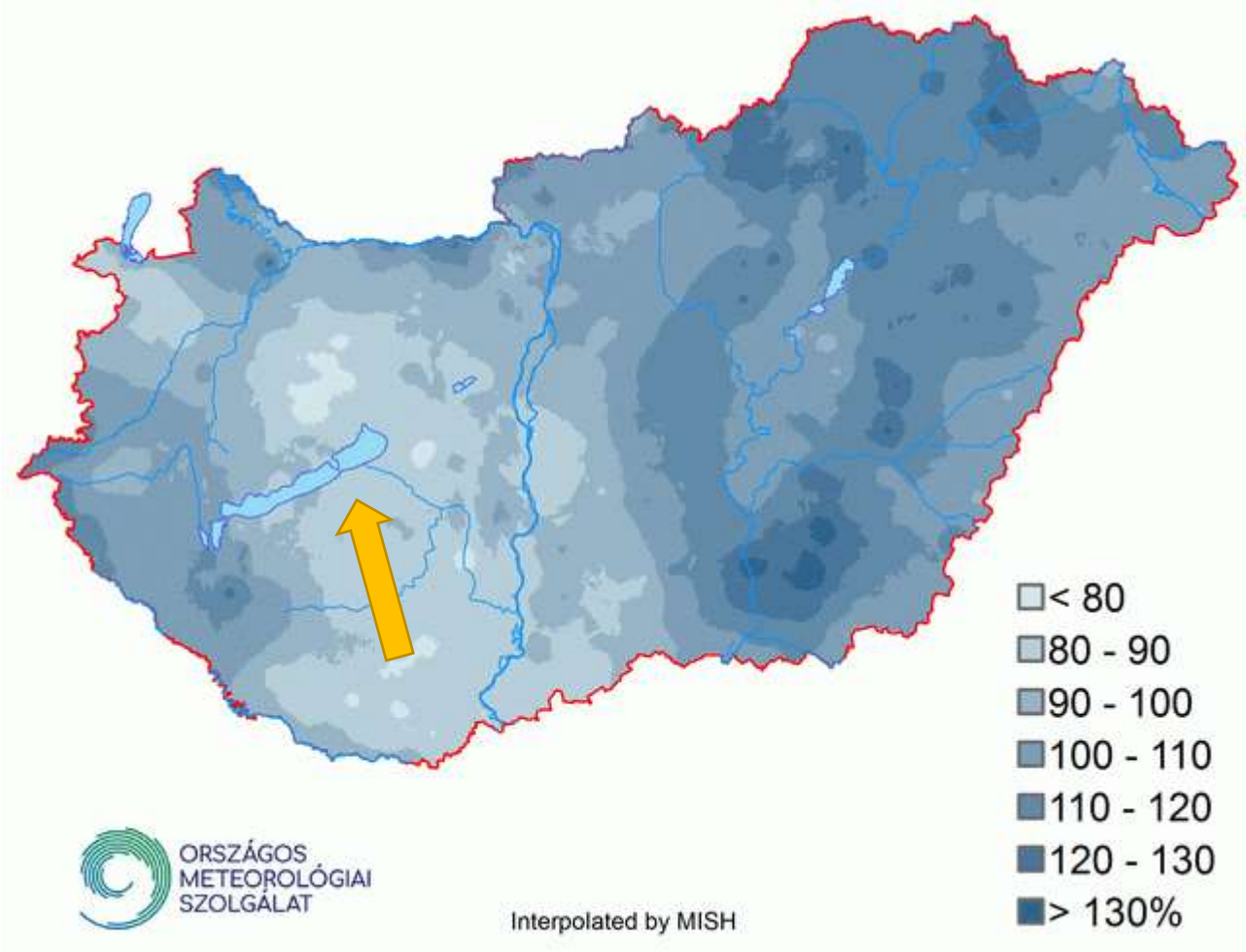
The Zichy site is located in an area with wind 90+ km/h wind speeds. The main problem is the constantly growing rate at which these wind speeds are happening. According to Hungarian meteorological research of the area, the following statements are true for the Lake Balaton area:

- 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

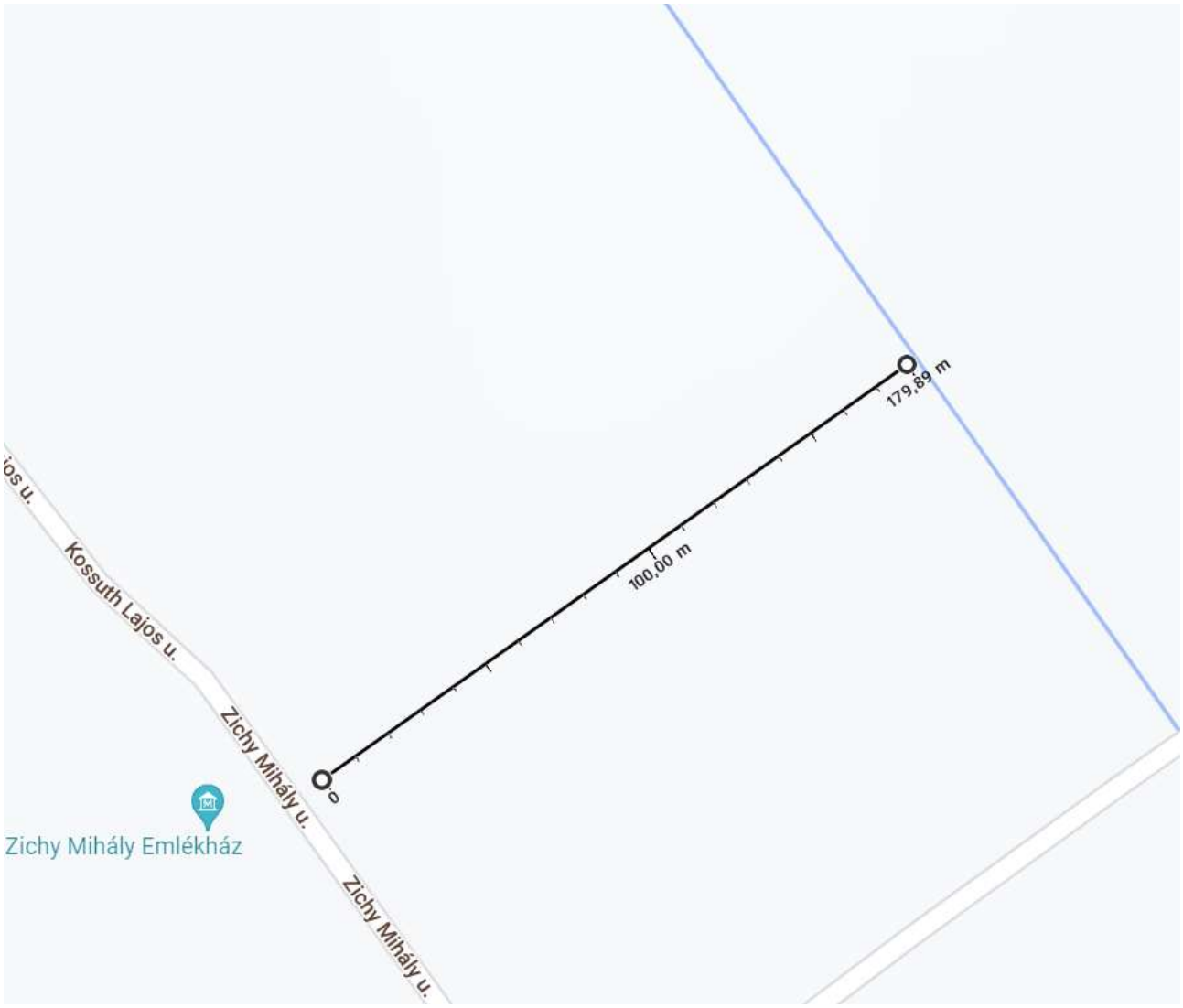
According to the Hungarian meteorological datasets, the yearly average rainfall was the same or less in the whole of Lake Balaton region. As can be clearly seen in the map below (the approximate location of the mansion is marked with a yellow arrow), the overall yearly precipitation decreased in the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

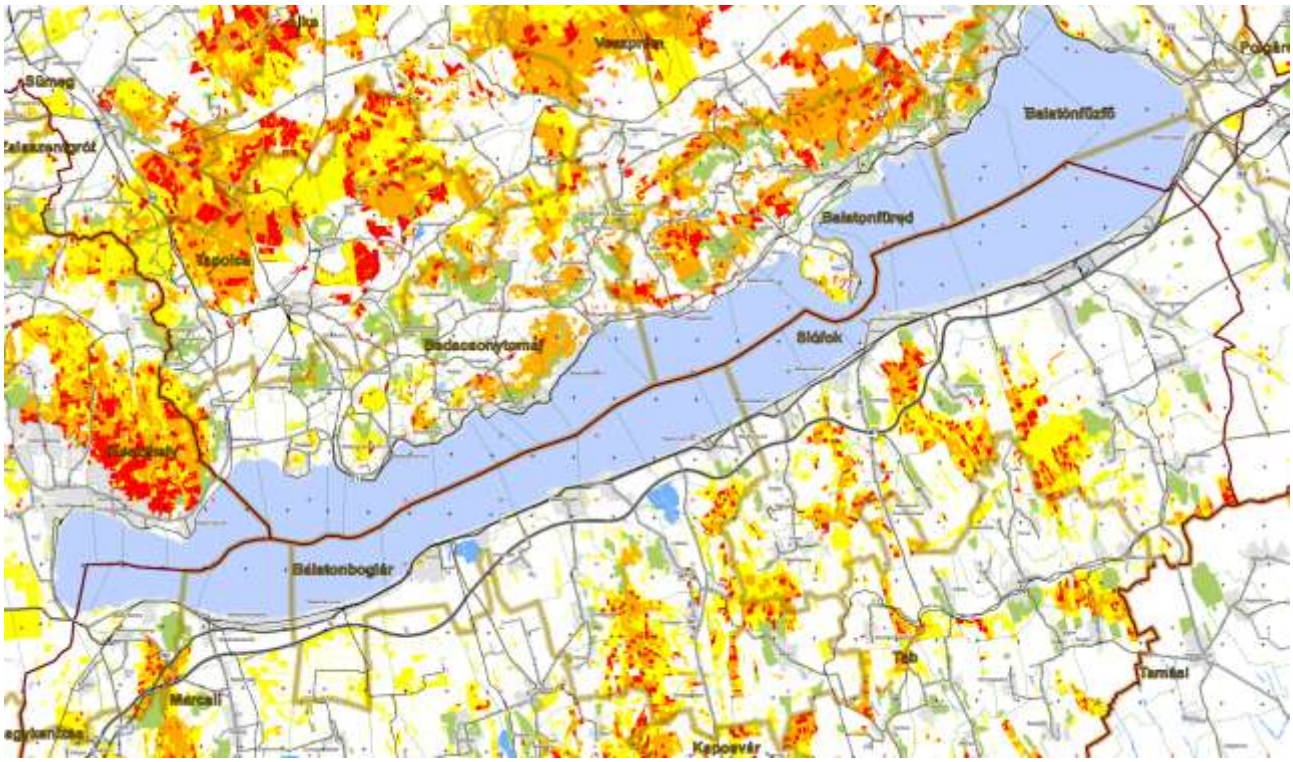
Additionally, there is a creek running only 180 meters from the Zichy Mansion (see picture below). This creek, being a tributary to a larger creek called Kis-Koppány (which was already overflooded in the past, eg. in 2014), could theoretically spill its creek bed and join in the forming of a larger flash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



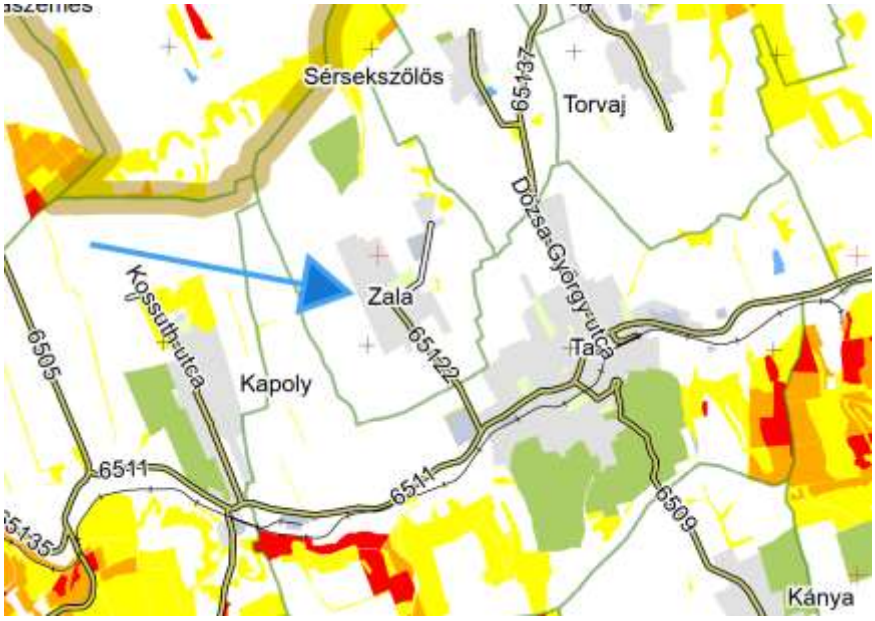
A Google Map cutout and distance measurement between the Zichy Mansion (on the picture marked with a blue icon and the title „Zichy Mihály Emlékház" and the Zala Creek (blue line). The creek itself is running parallel with the road (marked with the title „Zichy Mihály u."). When overflowing, the water and the debris could cross the road itself to 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.

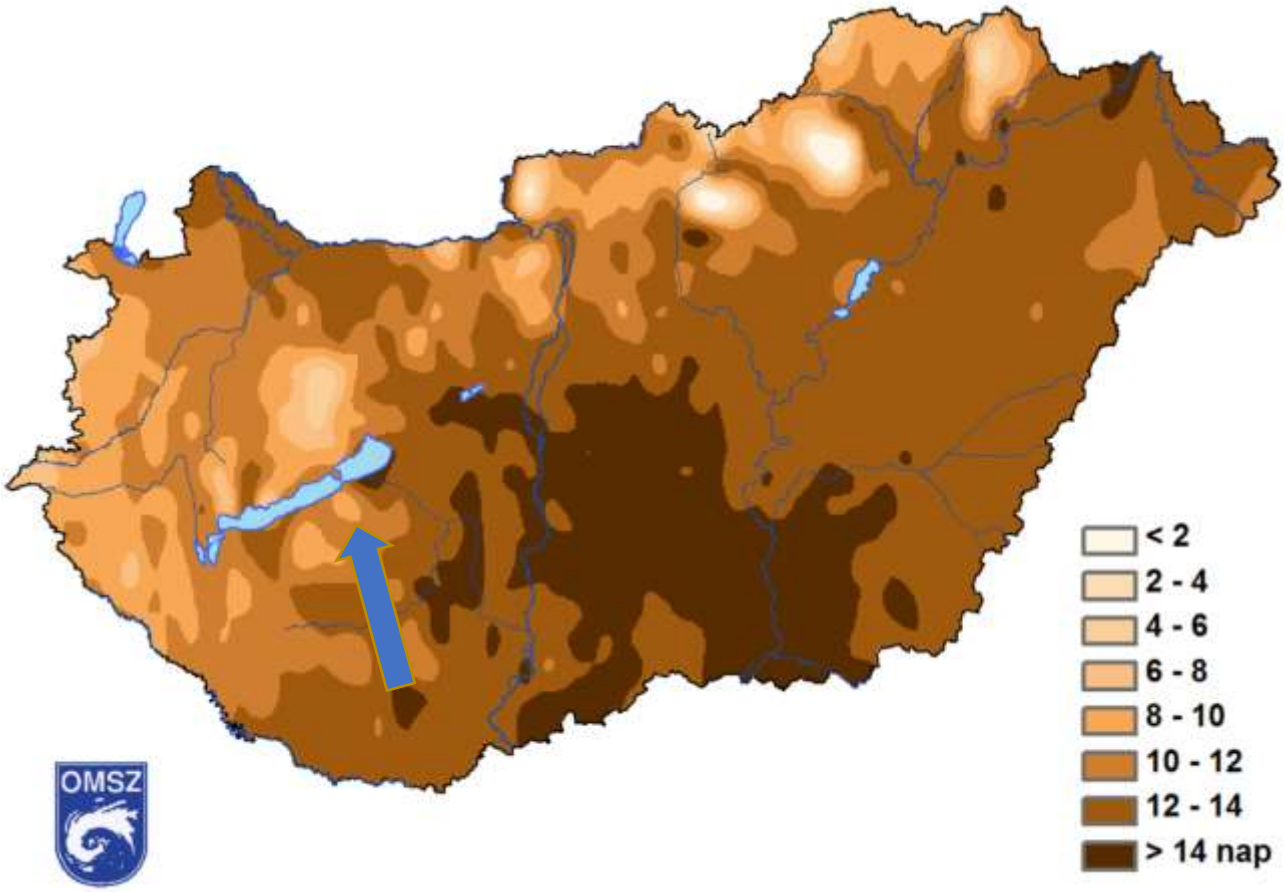


Cutout from the map above, Zichy Mansion marked with a blue arrow.

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.

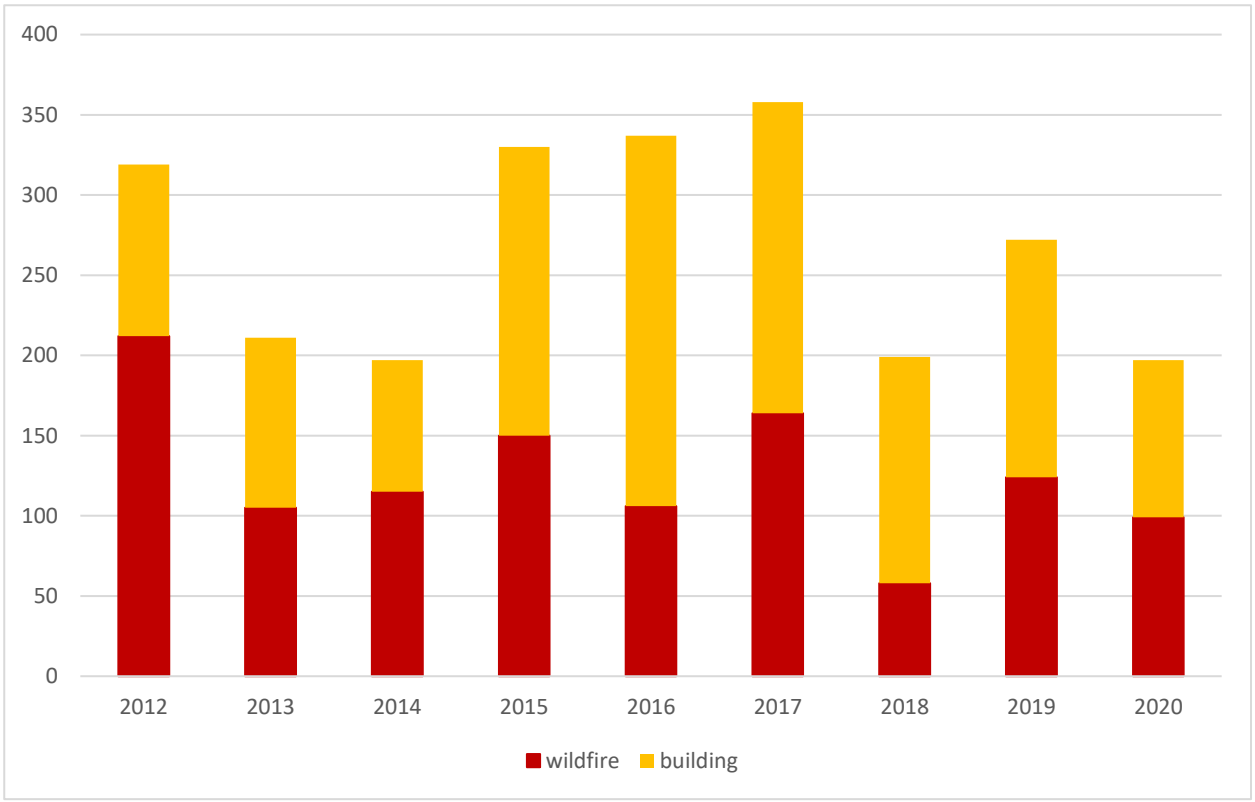


Days with a heatwave (daily avg. temp. 25+ °C) in a 36 years period in Hungary.

4. Risk matrix from a disaster management perspective

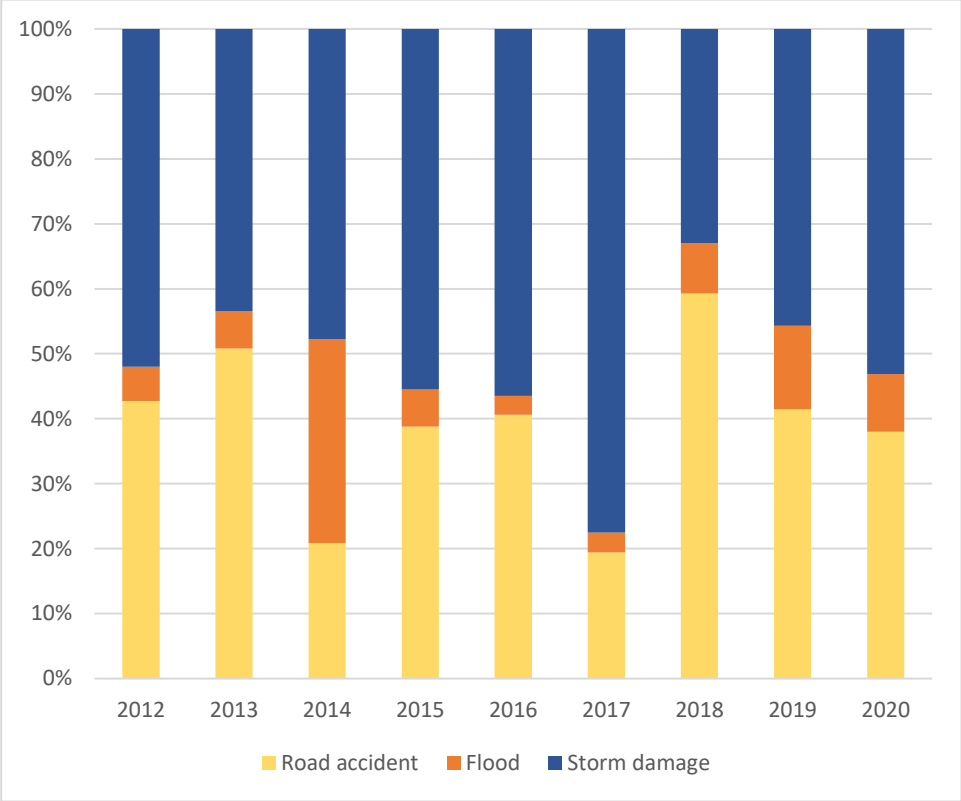
Considering all of the above it should be possible to establish a risk matrix for the mansion and the surrounding area, focusing on the disaster management aspects.

As to some disaster management background, see the diagrams below.



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 document 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.



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 document 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.

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 document.

	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 of this document 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.

5. Evaluated site: Zichy Mansion

WebGIS indices used:

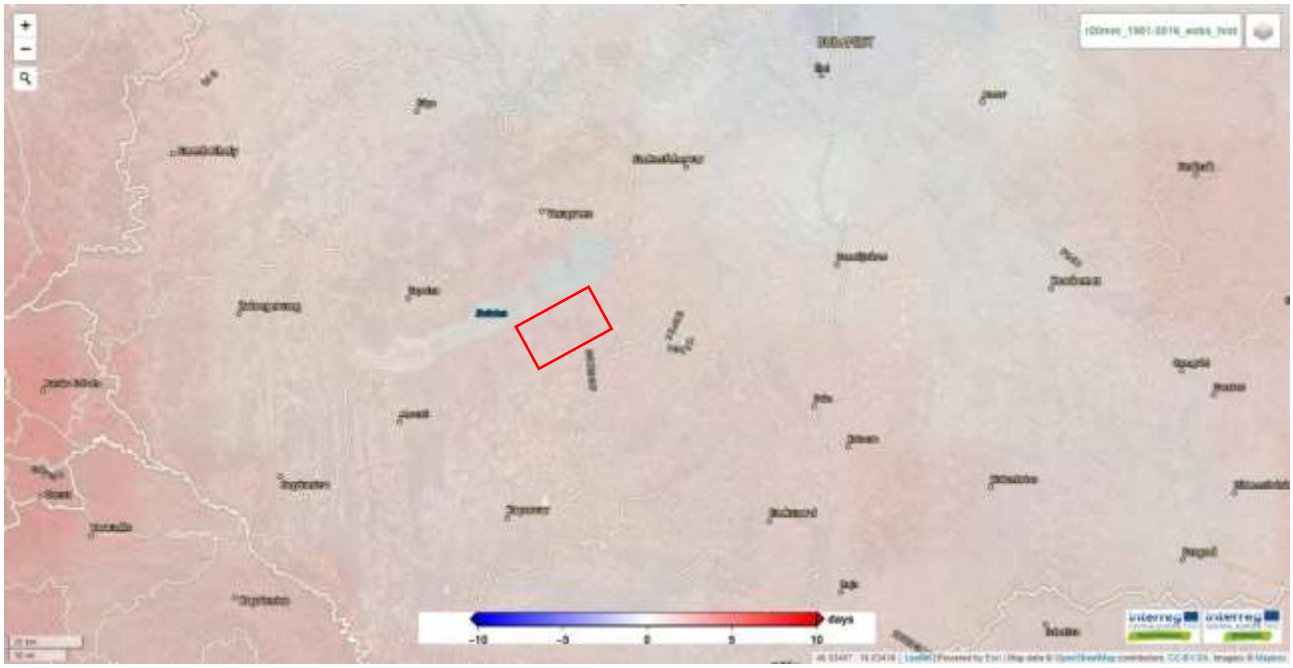
Index	Definition / description	Reason
R20mm	Very heavy precipitation days Number of days in a year with precipitation larger or equal 20 mm/day.	slow erosion, possible flash floods
R95pTOT	Precipitation due to extremely wet days The total precipitation in a year cumulated over all days when daily precipitation 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 in the area, possibility of 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

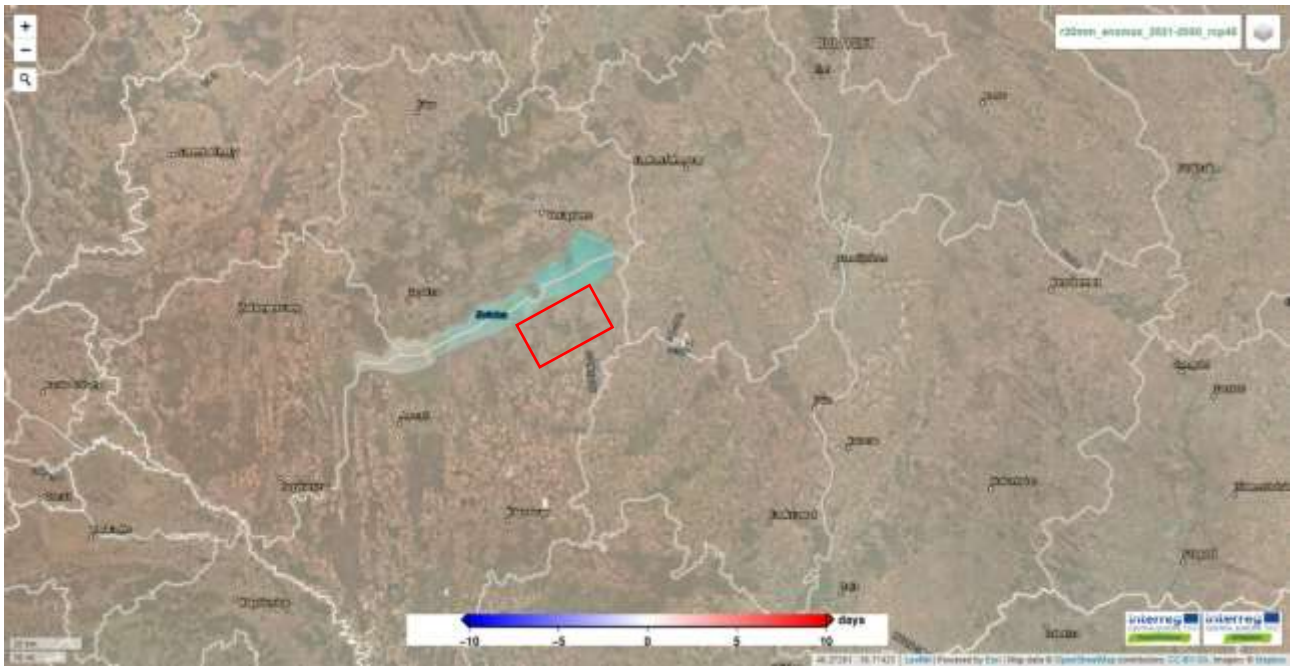
The approach was to collect maps of the area from the WebGIS application with past (1951–2016), near future (2021–2050) and far future (2071–2100) projections (Model ensemble statistics / Maximum / RCP 4.5). We found that the robust visualization tool of the WebGIS application is better suited for comparison (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.

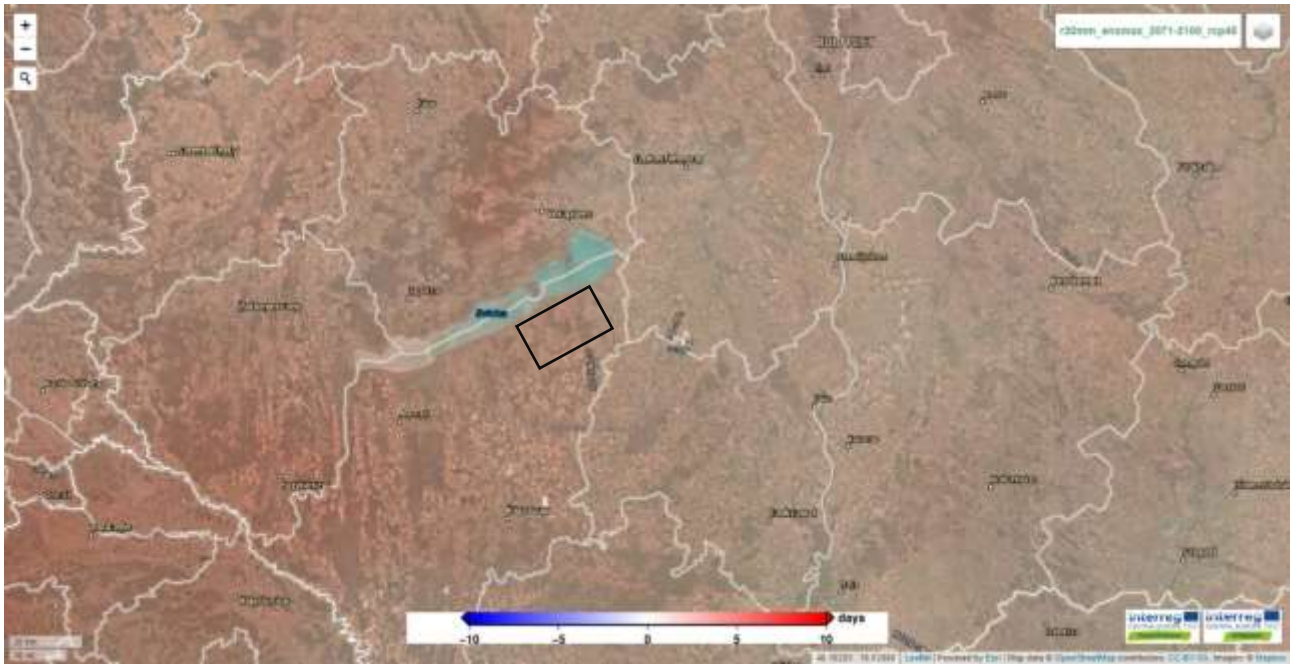
5.1. Very heavy precipitation days



Map for the past dataset on r20mm



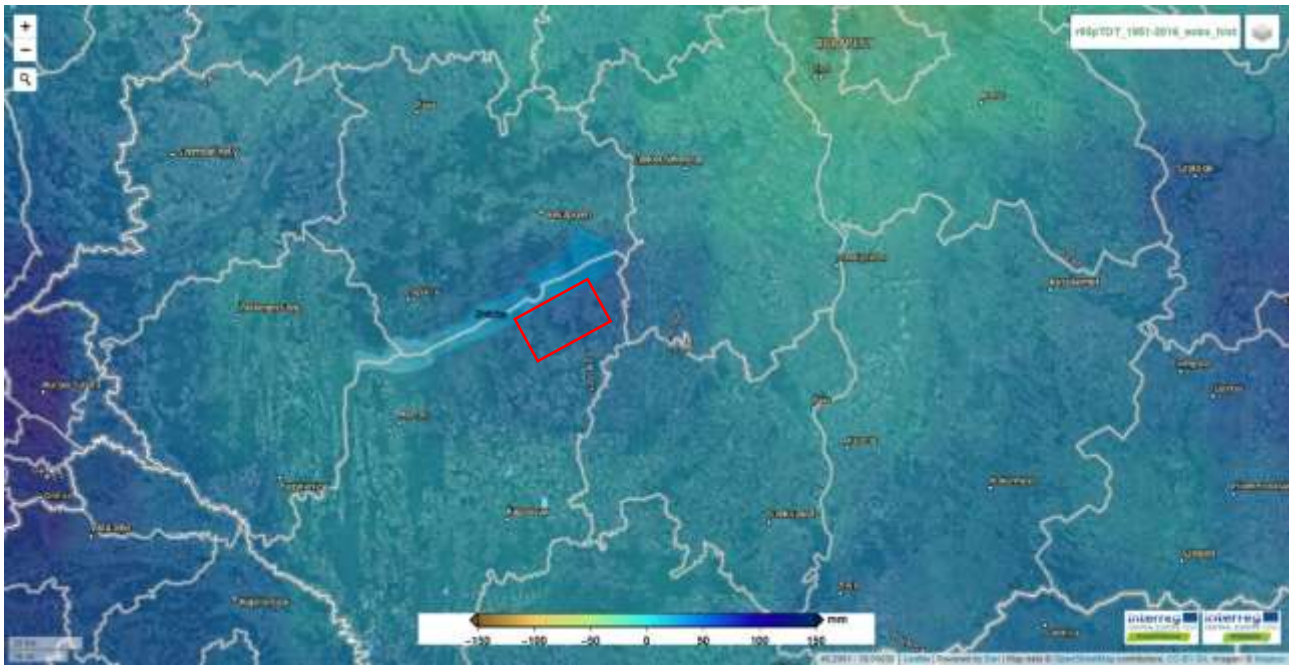
Map for the near future dataset on r20mm



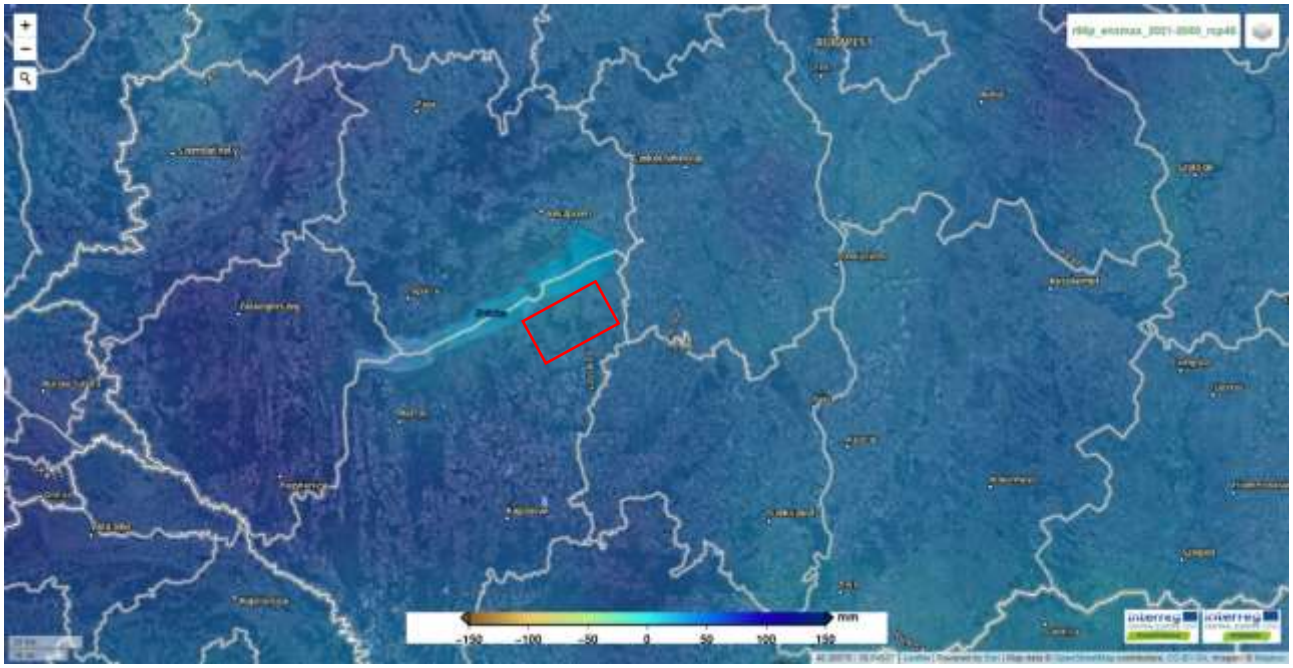
Map for the far future dataset on r20mm

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 future projections have the real dramatic effect: it shows 4-5+ values.

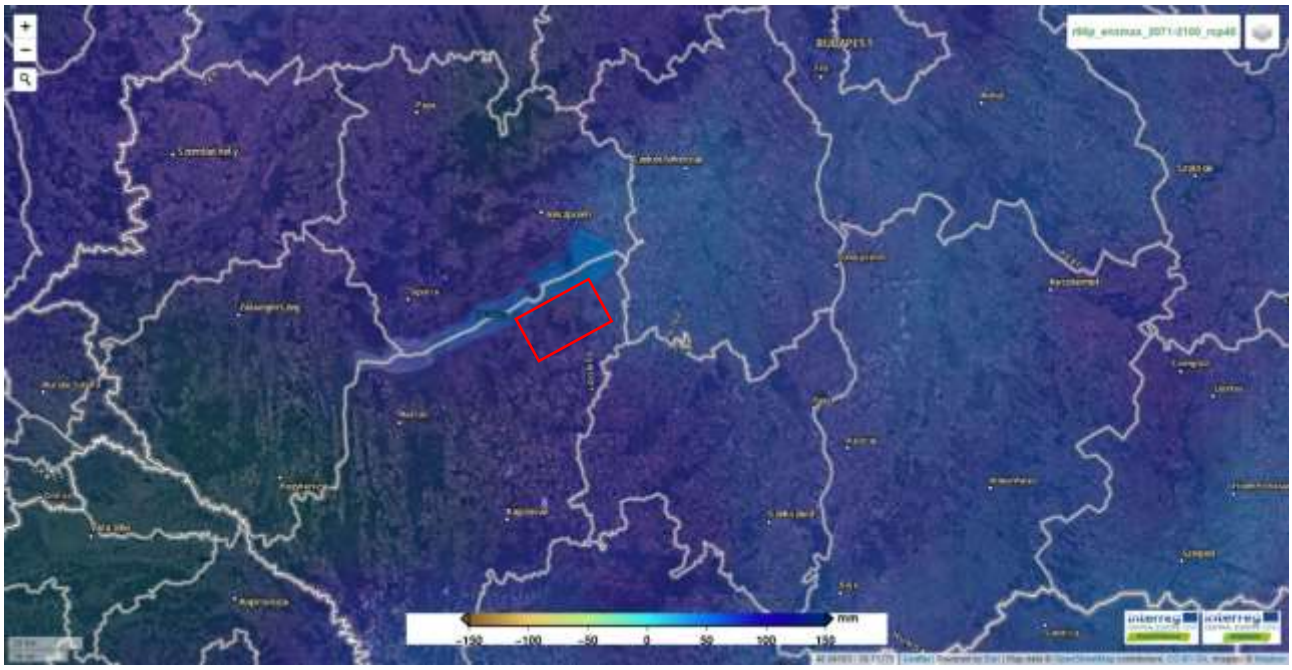
5.2. Precipitation due to extremely wet days



Map for the past dataset on R95pTOT



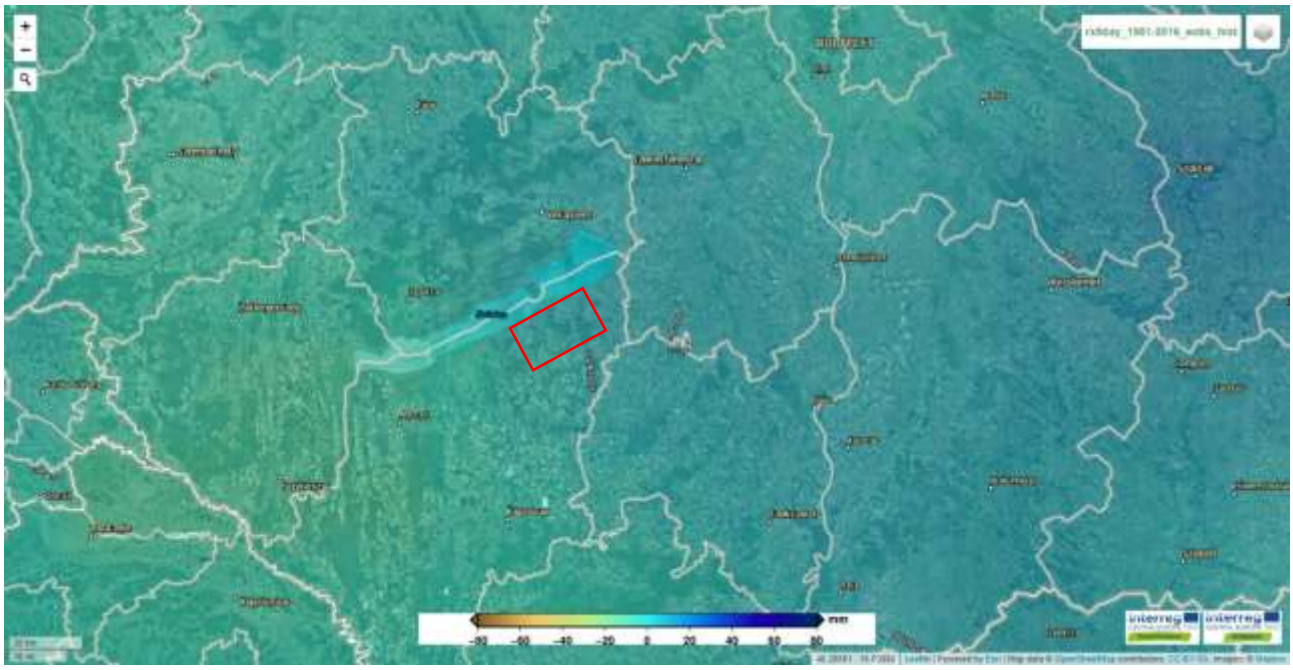
Map for the near future dataset on R95pTOT



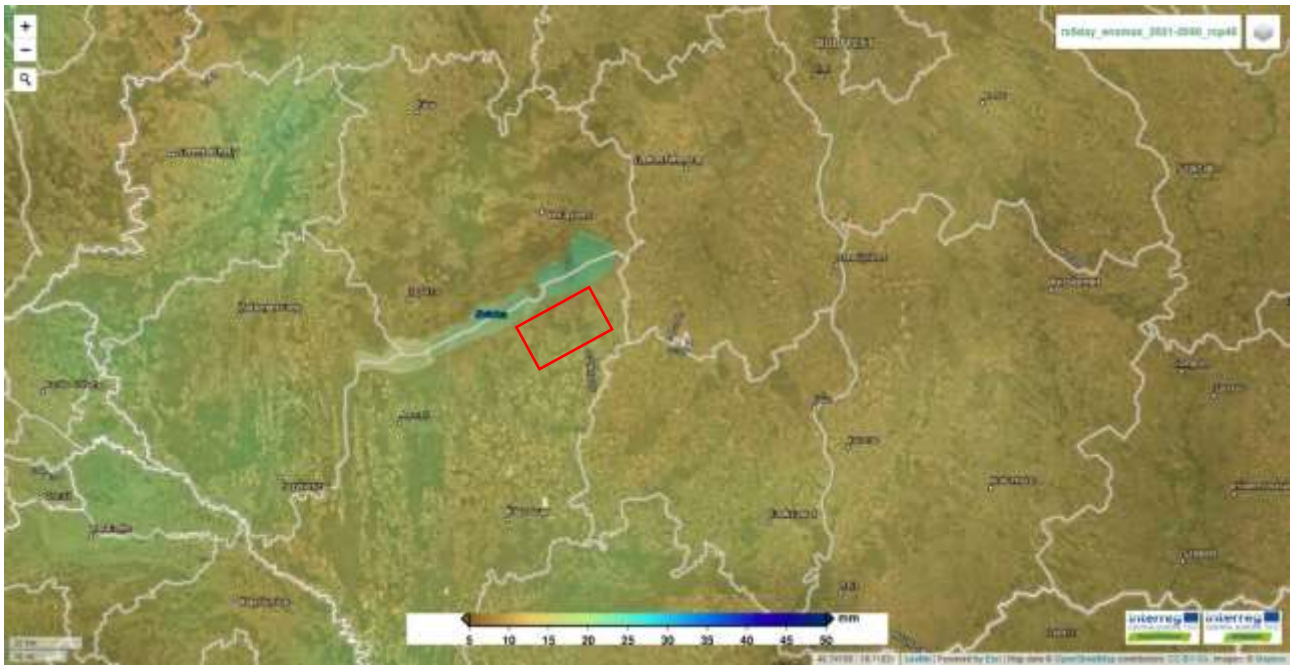
Map for the far future dataset on R95pTOT

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).

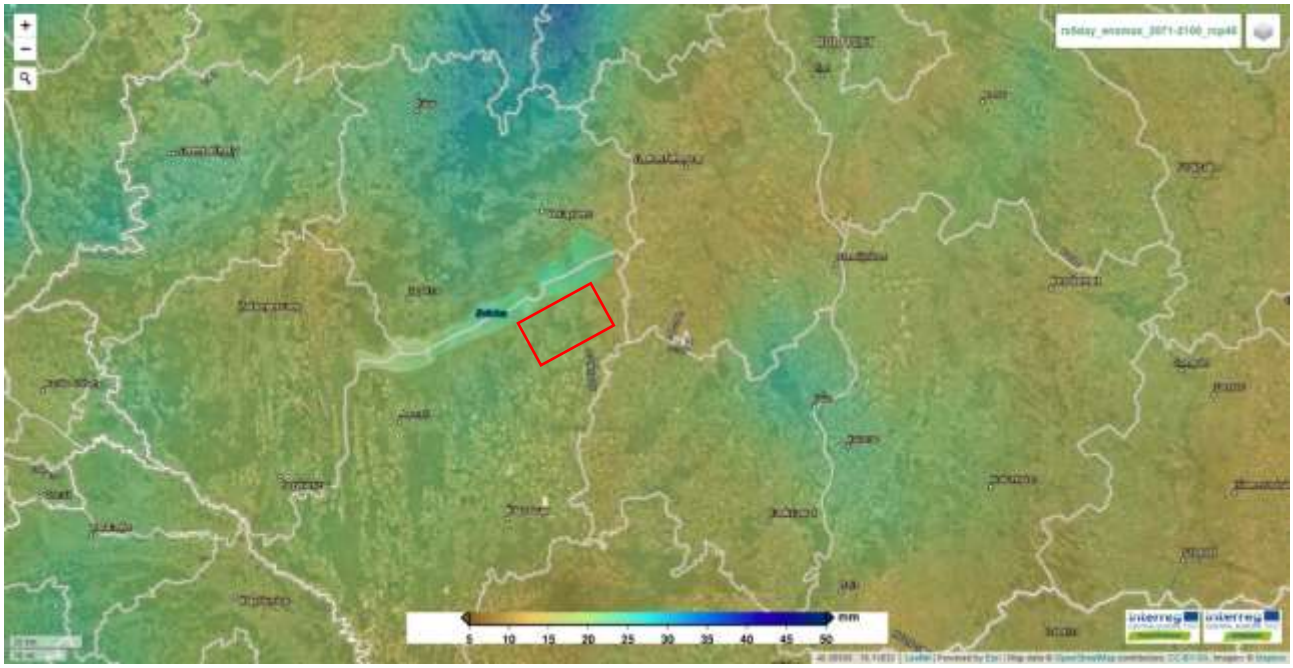
5.3. Highest 5-day precipitation amount



Map for the past dataset on Rx5day



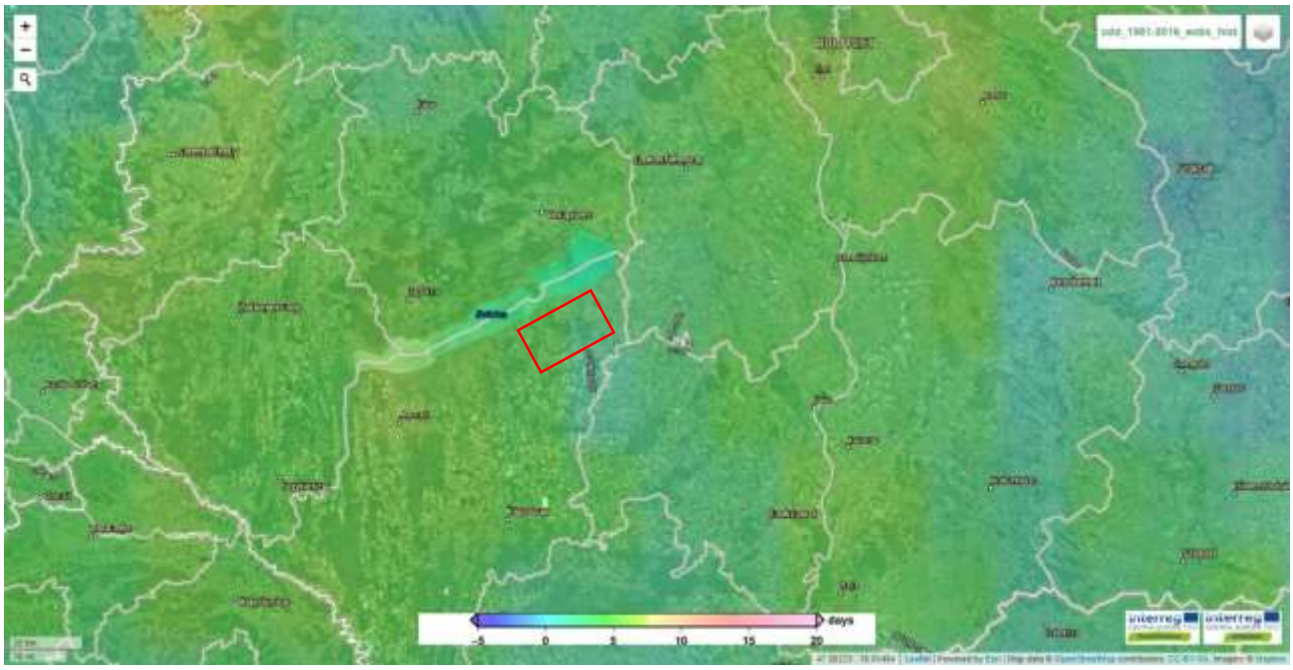
Map for the near future dataset on Rx5day



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



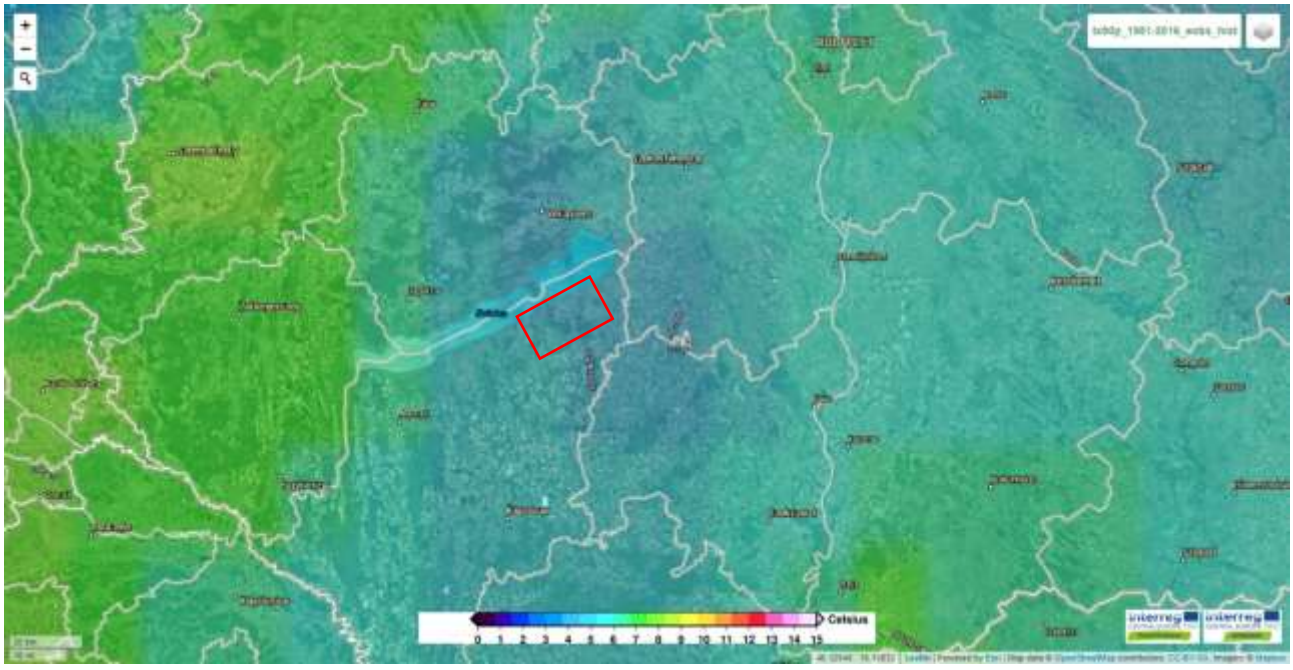
Map for the past dataset on CDD

Map for the near future dataset on CDD

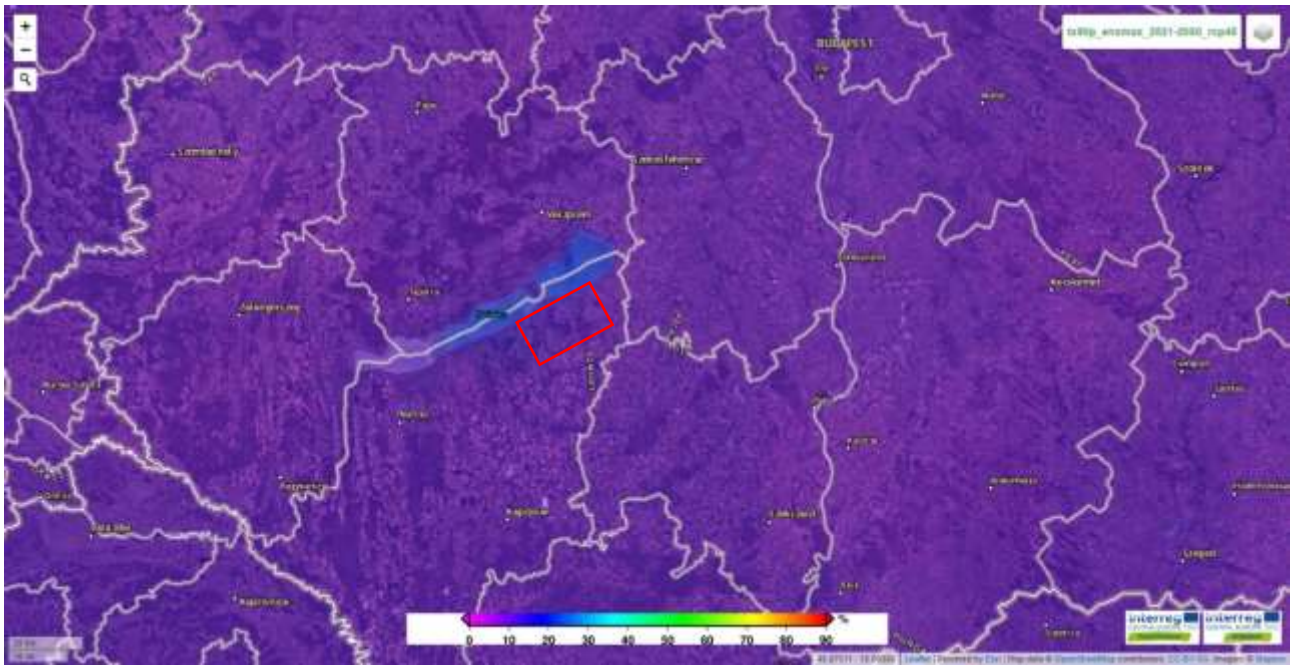
Map for the far future dataset on CDD

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).

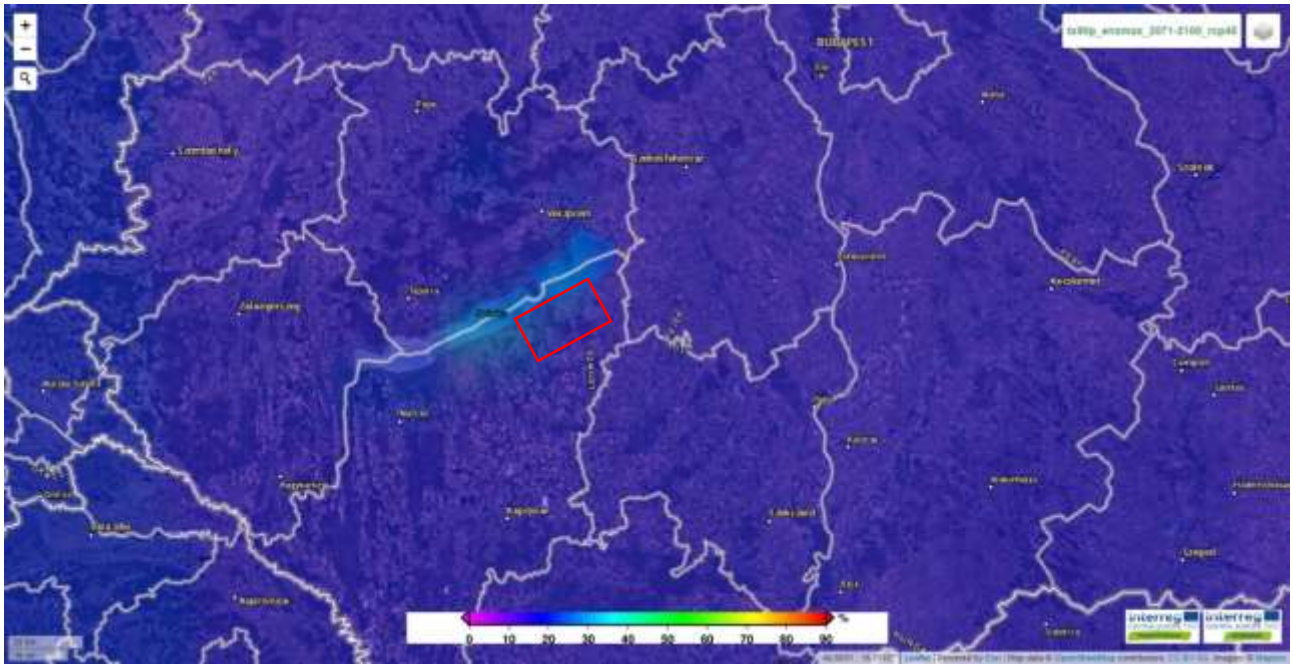
5.5. Extremely warm days



Map for the past dataset on Tx90p



Map for the near future dataset on Tx90p



Map for the far future dataset on Tx90p

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).

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.

7. Addendum

We feel that 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.