TESTING OF THE WEBGIS TOOL FOR DELIVERABLE D.T2.2.1

VIPAVA VALLEY / SLOVENIA

Version 1
01 2021

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Content

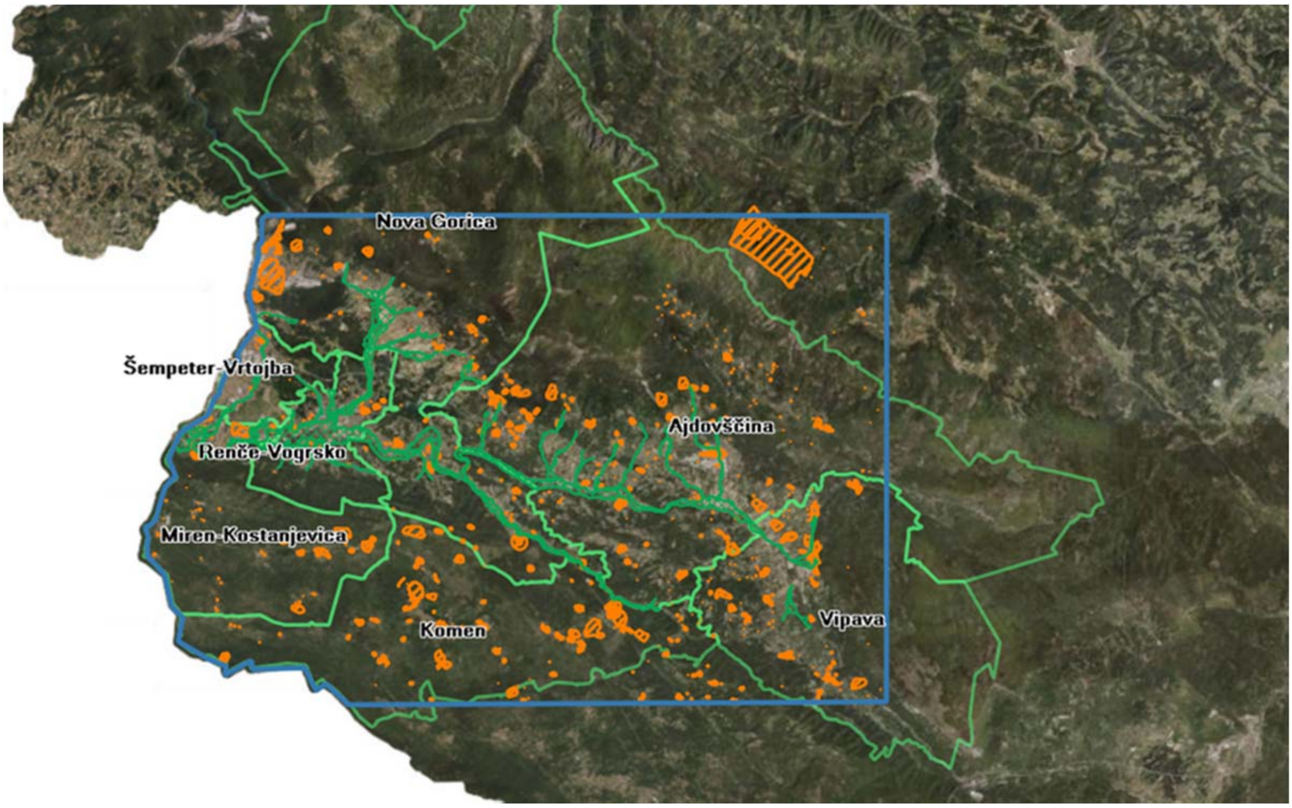
1. Introduction

UIRS evaluated the STRENCH WEBGIS tool for Vipava Valley - the pilot area in Slovenia. The main risks in the pilot area are floods and windstorms. The evaluation followed WGT content and focused on floods.

The goal of evaluation was to get an overview of the potential risk of floods on cultural heritage in Vipava Valley.

2. Site location

The Vipava Valley is located in the south-western part of Slovenia. The valley is surrounded by the mountains Trnovski gozd, Hrušica and Nanos and by the Vipava Hills merging with the Karst.



3. Site description

The Vipava Valley is rich in cultural landscape and cultural heritage: sacred monuments, mostly churches from the Gothic period, and castles constitute an important national heritage from Roman period to the 17th century. The Vipava Valley reflects the history as it has been a passageway between Italy and Danube region for millennia.

4. Tipology of cultural heritage assets

Through the Vipava Valley, there are more than 1200 cultural heritage sites, also with a status of national or local importance. As mentioned above, there are different types of cultural heritage from prehistorical archaeological sites, monuments from the Antique, Gothic, Baroque periods, and other objects from the 19th century.

Vipava Valley landscape

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

5. Main risks impacting the site

The Vipava Valley and its cultural heritage are affected by natural disasters due to geographical, hydrological, and climatic characteristics. Locals are tackling bora wind, floods, and landslides for centuries. Floods, landslides, and the bora wind affected architecture, agriculture, economic activities, and the population. Landslides are common on the steep slopes during heavy rainfall events in the north of the Vipava Valley.

The main risks impacting the Vipava Valley area are floods and windstorms.

Bora wind comes down from the mountain peaks to the valley with high speed and poses a hazard for building structures - roofs and facades, throughout history, this influenced the design of dwellings.

In the Vipava river basin, there are five significant flood risk areas concerning cultural heritage, human health, environment, and economic activity. According to the preliminary Slovenian hazard indication map, there is a likelihood of rare floods. The upper stream of the Vipava River and its tributaries were already regulated in the past. Flood protection is an issue in the lower part of the basin, where floods have become more frequent and several severe floods occurred in past years. These floods are a result of changes in the precipitation regime as a consequence of climate change. Let us also mention the landslides as a potential risk to cultural heritage areas.

5.1. Recorded past events

Floods:

- October 1898, in the 2nd half of October, Vipava was flooded (water up to half a meter high).
- 16-19/10/1992, floods in Vipava lower stream.
- 3-7/12/1992, Vipava near Ajdovščina flooded.
- 28/10/1994, Vipava near Žablje overflowed due to heavy rainfall.
- December 1995, Vipava lower stream flooded at the end of December.
- 2/04/1996, Heavy rainfall caused minor flooding of the Vipava river.
- 29-31/03/2009, the water caused the most damage in the Vipava and Goriška regions. Extensive agricultural areas, fields, vineyards, orchards, as well as dozens of residential and other buildings were flooded.
- 23-27/12/2009, the warning flows on the Vipava in Dolenja and its tributaries, especially the Hubelj flood of the Vipava upstream, were exceeded.
- 17-21/09/2010, extensive floods covered the Vipava.
- 06-10/12/2010, the river Vipava flooded harder. Vipava upper and lower part of the Vipava valley heavier floods.

- 23-27/12/2010, Vipava floods to a lesser extent.
- 27/10/2012, Vipava started flooding to a lesser extent in the morning.
- 05-20/11/2014, three more intense flood events occurred: 6 -11 November, 11-13 November, 18-20 November.
- 14/10/2015, Vipava floods in usual places in the lower part, increased flows in Hubelj, Branica and Lijak floods.
- 01/10/2016, Vipava was the first to rise and spilled to a lesser extent in the areas of frequent floods.
- 08-16/02/2017, with the onset of precipitation, flows began to increase.
- 27-28/04/2017, the first river overflows began on the morning of the 28 of April and in the central flood Vipava spilled along the watercourse.

Windstorm:

- 03-07/02/2015, very strong bora wind: the highest half-hour average wind speed was 54 km/h caused road closures.
- 19-23/05/2015, very strong bora wind: the highest half-hour average wind speed was 78 km/h.
- 11/01/2016, bora wind: the highest half-hour average wind speed was 10,5 km/h.
- 05-07/11/2016, bora wind: the highest half-hour average wind speed was 9,2 km/h.
- 16-19/01/2017, strong bora wind: the highest half-hour average wind speed was 17,7 km/h.
- 14-20/09/2017, strong bora wind: the highest half-hour average wind speed was 19,1 km/h.
- 22-23/10/2017, bora wind: the highest half-hour average wind speed was 10 km/h.
- 12-15/11/2017, bora wind: the highest half-hour average wind speed was 13,9 km/h.
- 03/02/2018, bora wind: the highest half-hour average wind speed was 14,5 km/h.
- 22/02/2017, bora wind: the highest half-hour average wind speed was 13,9 km/h.
- 27-30/10/2018, strong bora wind: the highest half-hour average wind speed was 18,7 km/h.
- 02/01/2019, bora wind: the highest half-hour average wind speed was 12,55 km/h.
- 02/02/2019, bora wind: the highest half-hour average wind speed was 9,1 km/h.
- 03/11/2019, bora wind: the highest half-hour average wind speed was 7,6 km/h.
- 21/10/2019, bora wind: the highest half-hour average wind speed was 10,5 km/h.

Vipava, linden avenue, floods in June 2020 (left).

Velike žablje, Vipava flooding in June 2020 (right).

5.2. Adopted measures

In Slovenia, the majority of responsibilities for immovable heritage protection are divided between the Ministry of Culture, municipalities, and the Institute for the Protection of Cultural Heritage of Slovenia. Public and private owners are fully responsible for the maintenance, management, and strategic development of cultural assets.

Cultural Heritage Protection Act requires that cultural heritage is taken into consideration in the preparation of all spatial plans and that spatial plans must include heritage protection measures. That means that monuments of local and of national importance registered archaeological sites and heritage protection areas are included and taken into consideration as obligatory components of spatial (zoning) plans at the national and local levels.

The Environmental Protection Act sets a strategic environmental impact assessment procedure. An assessment of the impact on the heritage of the potential development is an important part of the SEIA. SEIA is prepared for all categories: monuments, registered archaeological sites, and heritage protection areas. A strategic impact assessment on heritage is also mandatory for interventions to areas without heritage if such interventions could have a direct or indirect impact on heritage.

The protection of Slovenian cultural heritage is also regulated by the Act on Protection Against Natural and Other Disasters. This act defines the general framework for the prevention and elimination of threats to cultural heritage and establishes principles for other heritage protection regulations, acts, and guidelines. The system of protection against natural and other disasters includes the protection of cultural heritage, with a view of reducing the number of disasters and preventing or reducing the number of casualties and other consequences of such disasters. Legislation on emergency preparedness is strict; however, these regulations do not apply specifically to cultural heritage.

Natural disasters as floods and wind are present in Vipava Valley for centuries hence are well tackled in national and local documents. The Vipava river basin is managed with the Vipava River Basin Management Plan and its Program of Measures according to the EU Water Framework Directive that has been completely integrated into Slovenian legislation through the Waters Act. There are also other sectorial strategic plans related to water management, as The Flood Risk Management Plan, Natura 2000 Management Programme, and other sectorial documents in agriculture and forestry.

6. WEBGIS tool evaluation for Vipava Valley

The main risks affecting the Vipava Valley area are floods and windstorms. We evaluated 2 extreme events: heavy rain and flooding. Furthermore, we also evaluated all Climate variables.

In the evaluation of the WGT tool, we collected maps of the area with past (1951–2016), near future (2021–2050), and far future (2071–2100) projections (Model ensemble statistics / Maximum / RCP 4.5). Due to the scale available in the Web GIS tool, UIRS evaluated the whole Vipava Valley.

We found that the robust visualization tool of the WGT tool is better suited for comparison of past with future scenarios than raw datasets.

The goal of this evaluation was to get an overview of the potential risk of floods and hot weather on cultural heritage in Vipava Valley.

Extreme events	Indexes	Description
Heavy rain	Very heavy precipitation days (R20mm)	Number of days in a year with precipitation larger or equal 20 mm/day.
Heavy rain	Precipitation due to extremely wet days (R95pTOT)	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.
Flooding	Highest 5-day precipitation amount (Rx5day)	Yearly maximum of cumulated precipitation over consecutive 5 day periods.
Flooding	Consecutive wet days (CWD)[1]	Seasonal maximum number of consecutive days with RR>=1mm.

[1] During evaluating STRENCH WGT fture simulations were not available.

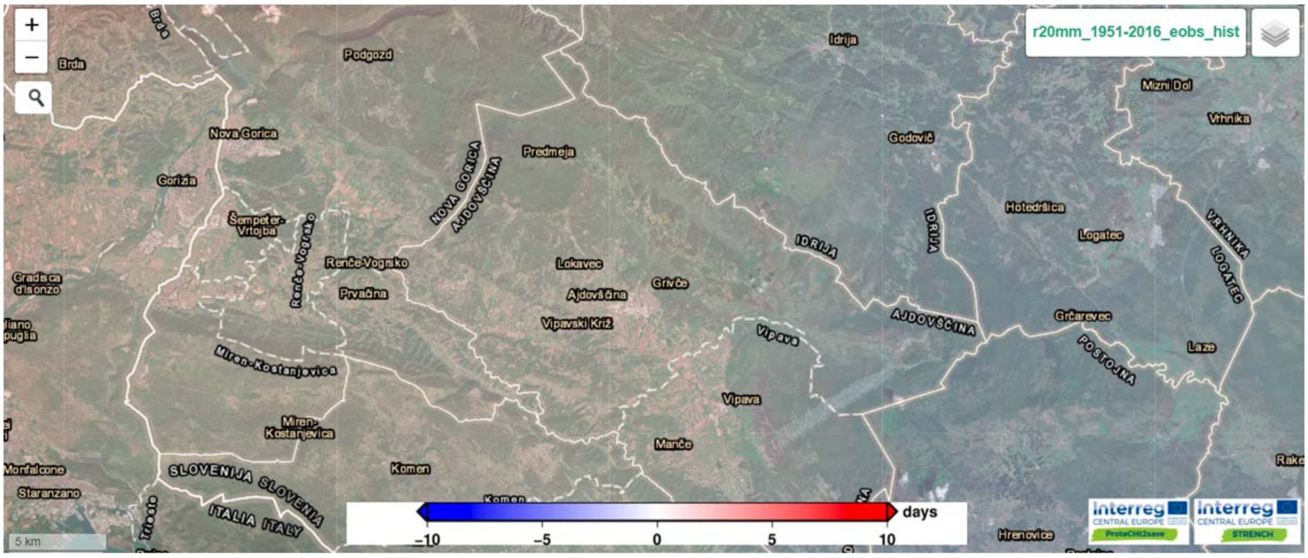
Extreme event: Heavy rain

Very heavy precipitation days

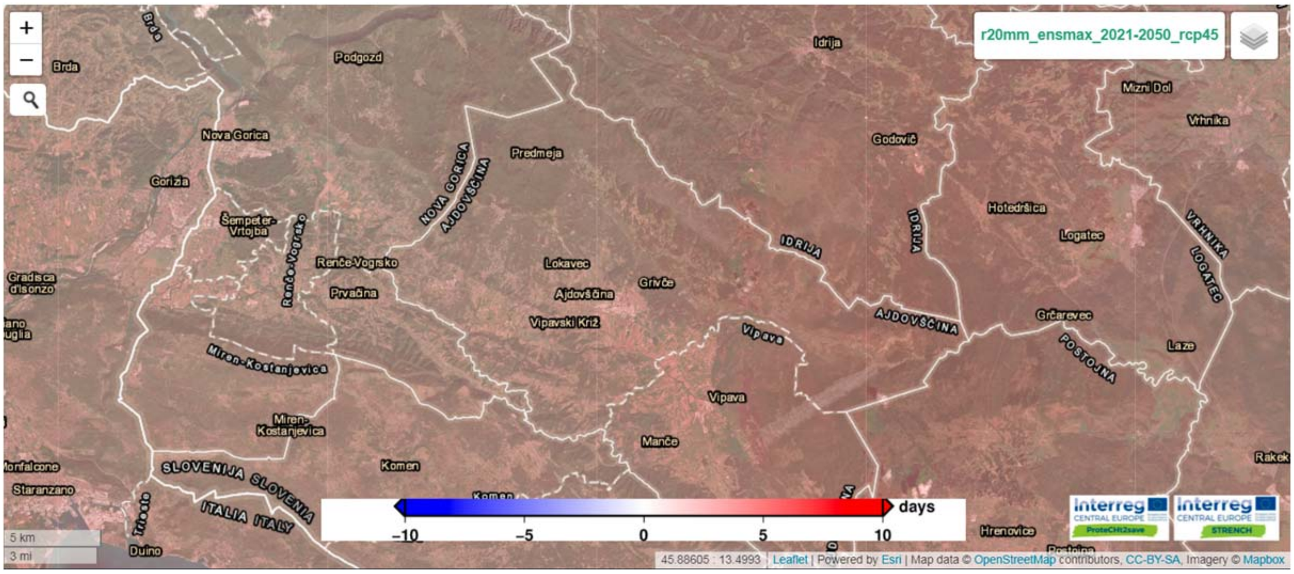
Index: R20mm

Number of days in a year with precipitation larger or equal 20 mm/day.

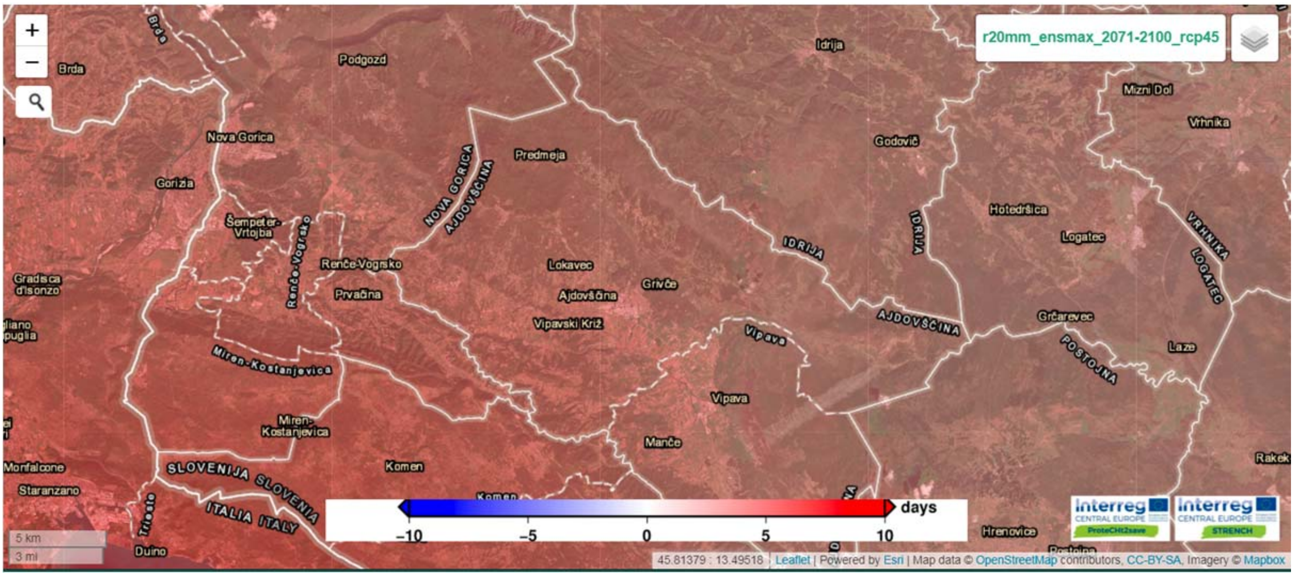
Map: Historical observations: r20mm_1951-2016_eobs_hist



Map: Model ensemble statistics: Mean / near future / RCP 4.5: r20mm_ensmax_2021-2050_rcp45



Map: Model ensemble statistics: Mean / far future / RCP 4.5: r20mm_ensmean_2071-2100_rcp45



The near and far future projections show an increase in the number of days in a year with precipitation larger or equal to 20 mm/day.

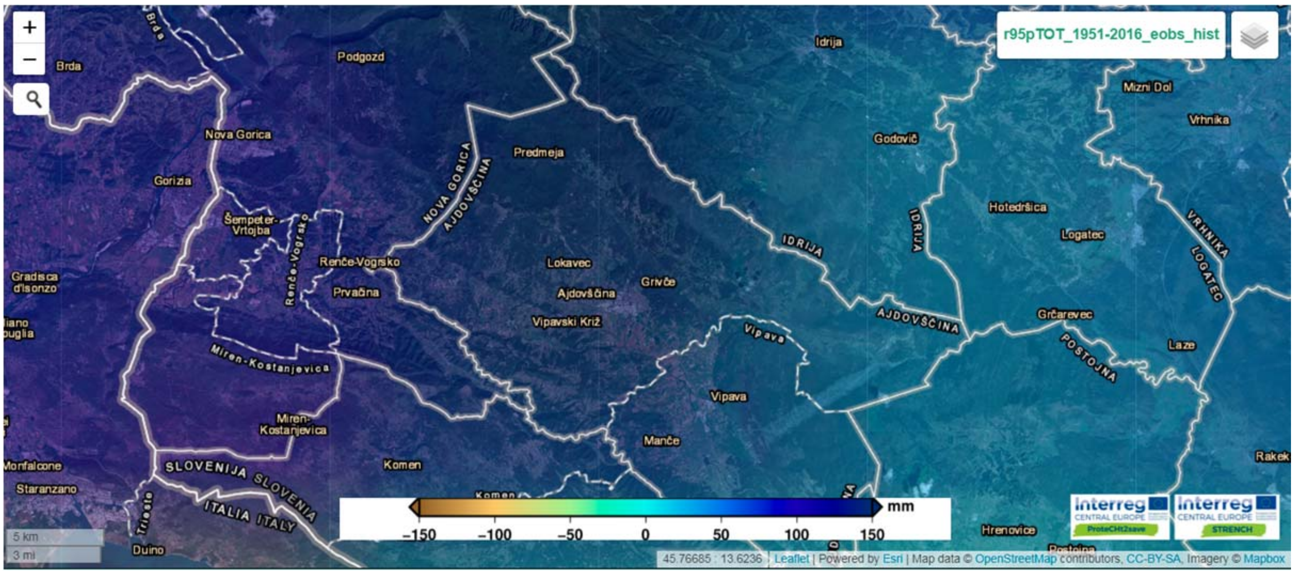
Extreme event: Heavy rain

Precipitation due to extremely wet days

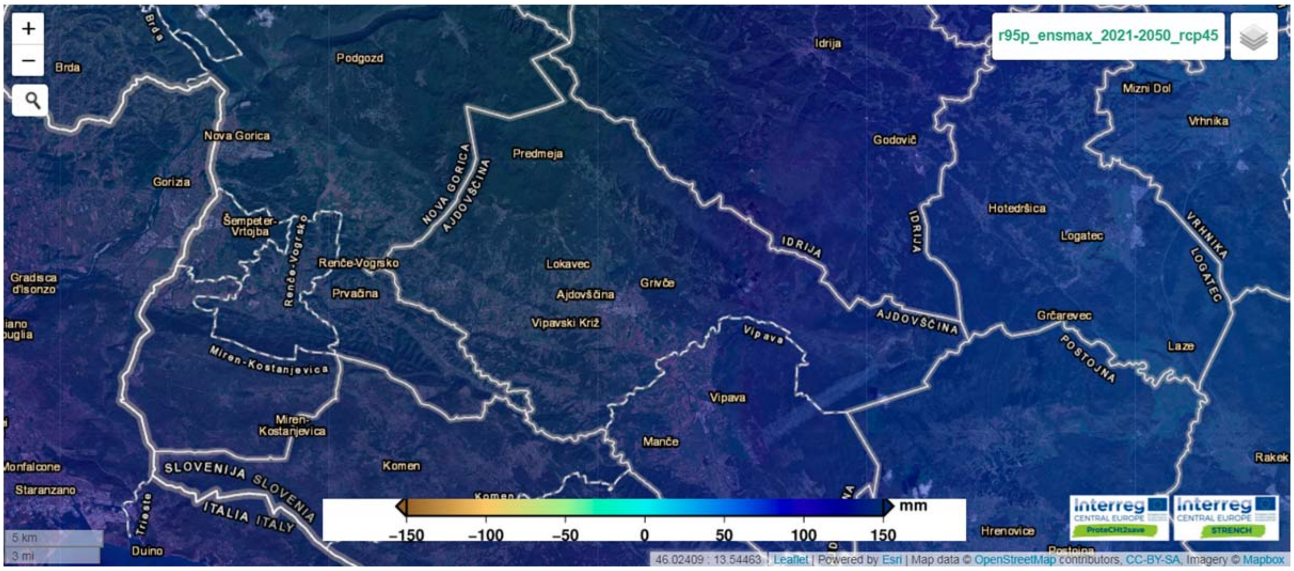
Index: R95pTOT

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.

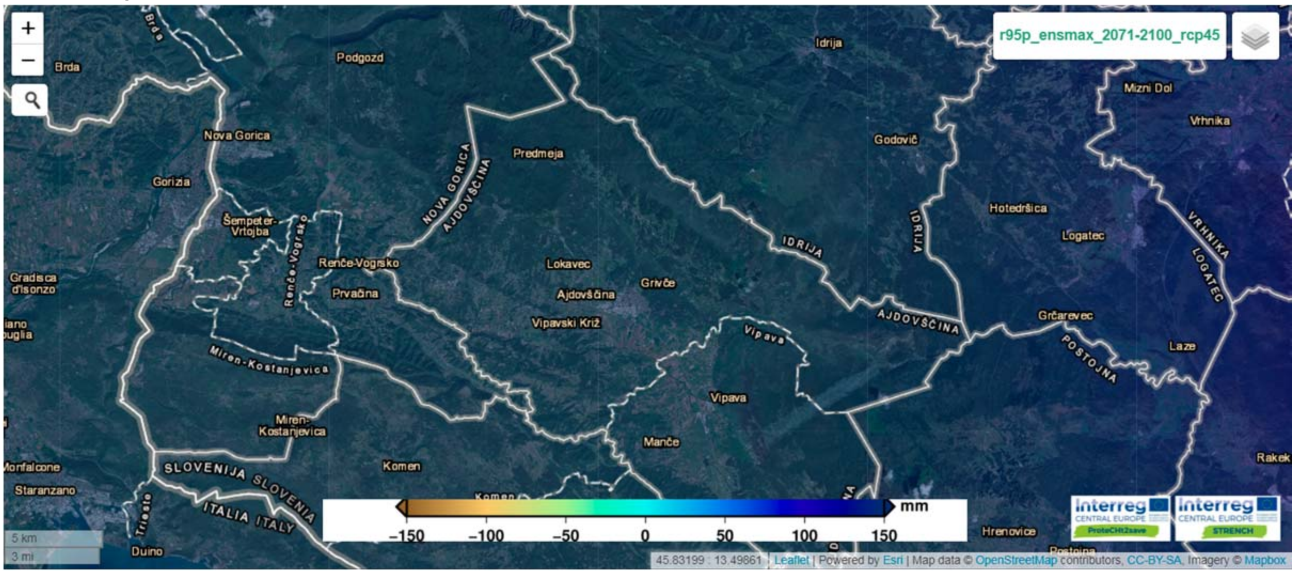
Map: Historical observations: r95pTOT_1951-2016_eobs_hist



Map: Model ensemble statistics: Mean / near future / RCP 4.5: r95p_ensmax_2021-2050_rcp45



Map: Model ensemble statistics: Mean / far future / RCP 4.5: r95p_ensmax_2071-2100_rcp45



The near and far future simulations show an increase of total precipitation in a year cumulated over all days when daily precipitation is larger than the 95th percentile of daily precipitation on wet days.

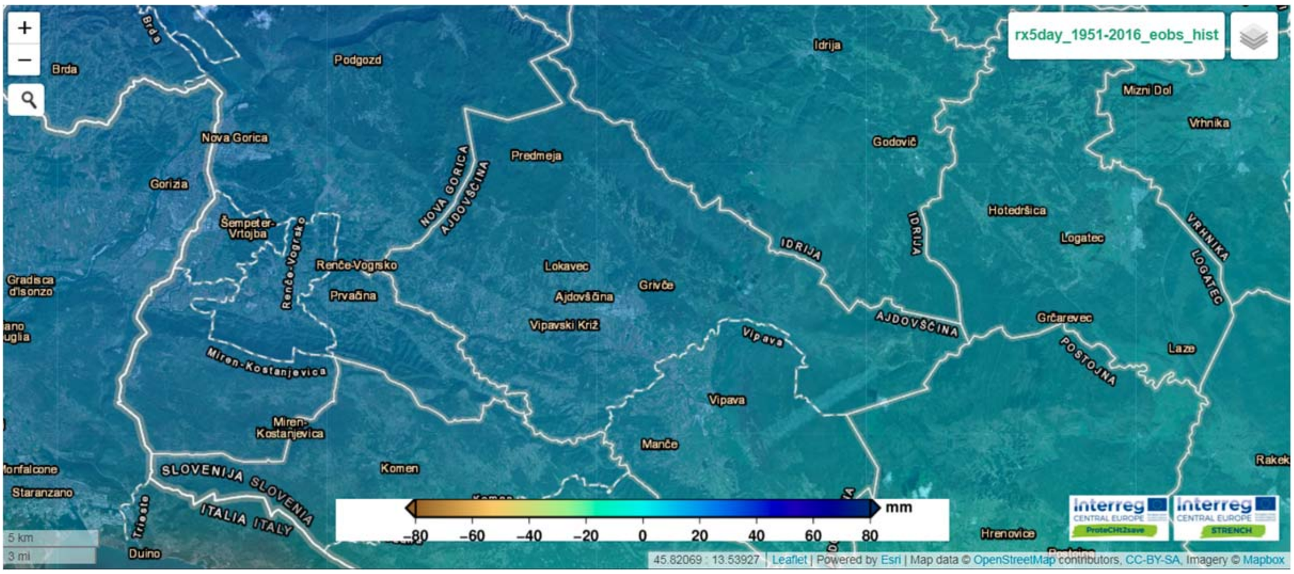
Extreme event: Flooding

Highest 5-day precipitation amount

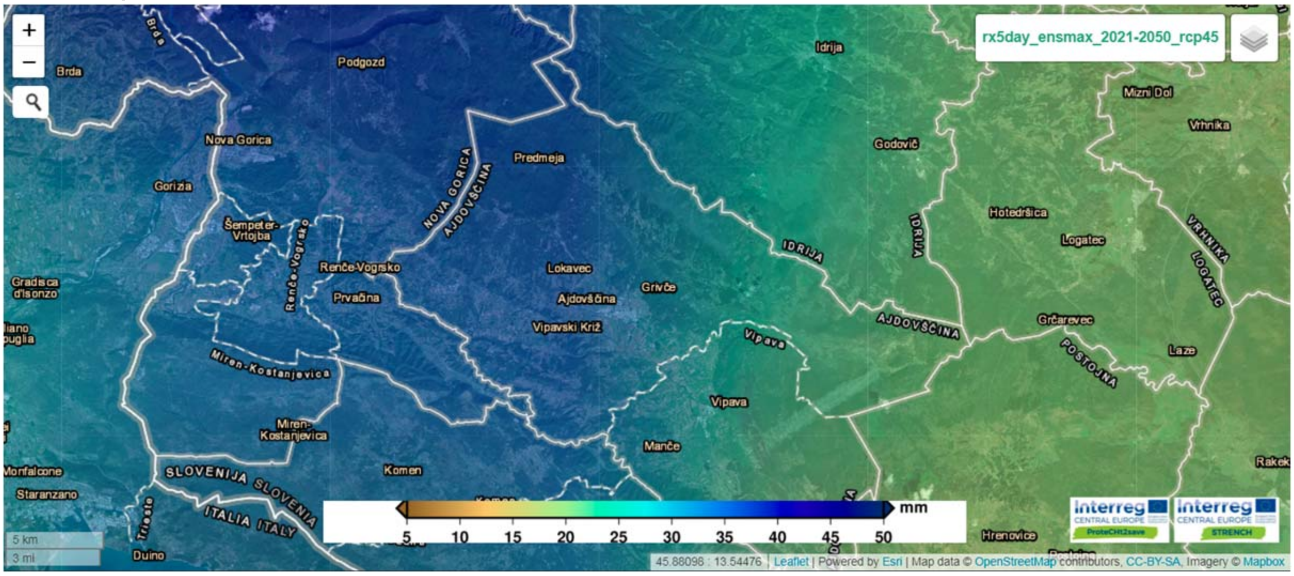
Index: Rx5day

Yearly maximum of cumulated precipitation over consecutive 5 day periods.

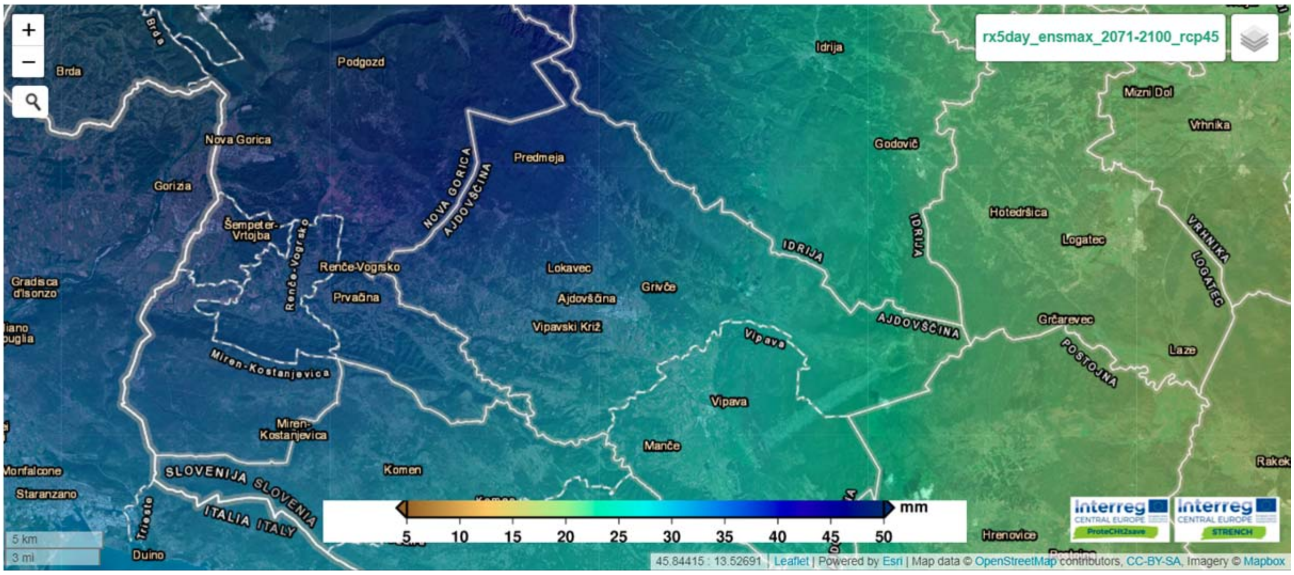
Map: Historical observations: rx5day_1951-2016_eobs_hist



Map: Model ensemble statistics: Mean / near future / RCP 4.5: rx5day_ensmax_2021-2050_rcp45



Map: Model ensemble statistics: Mean / far future / RCP 4.5: rx5day_ensmax_2071-2100_rcp45



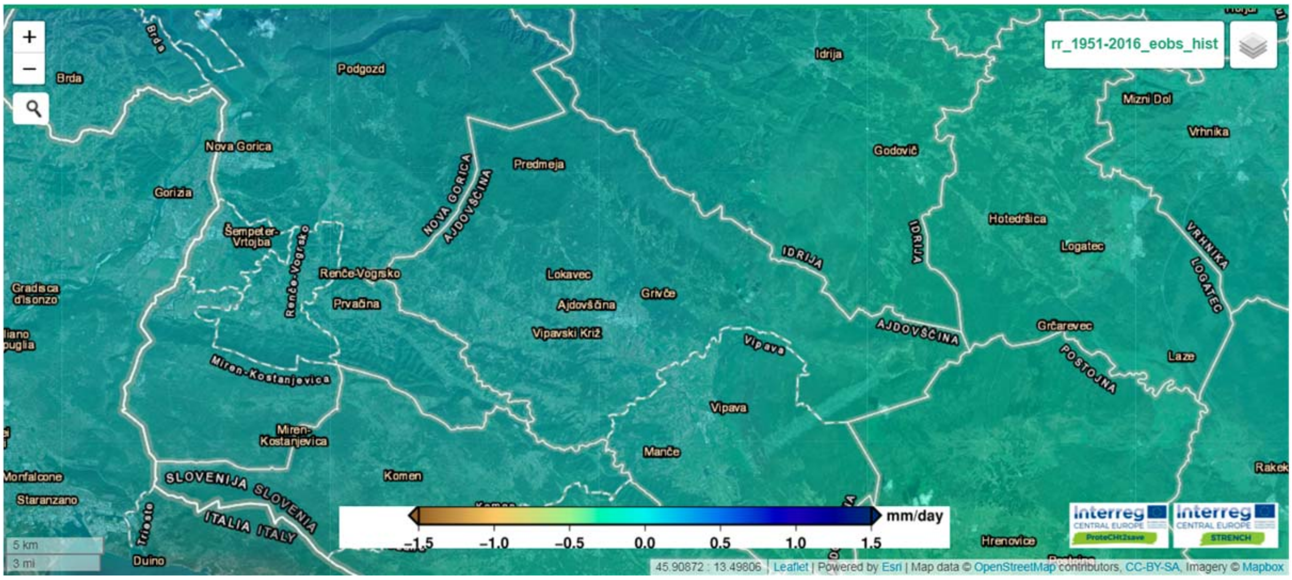
The near and far future projections show a decrease of a yearly maximum of cumulated precipitation over consecutive 5 day periods.

Evaluation of climate variables

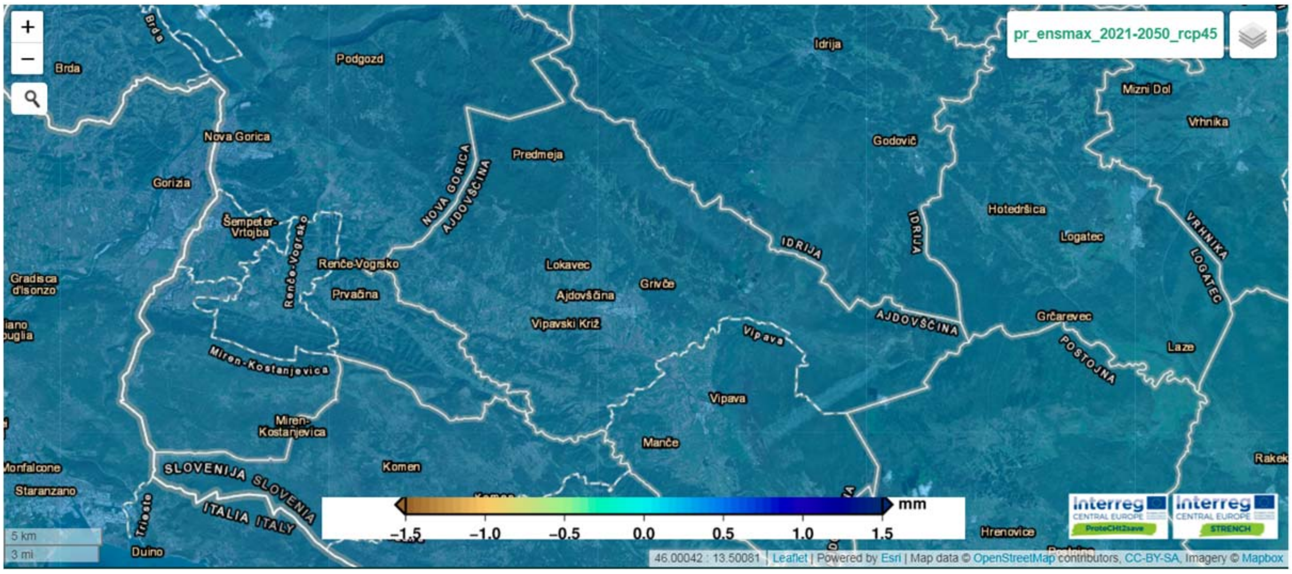
Precipitation	RR	daily cumulated precipitation
Tmax	Tx	daily maximum temperature
Tmin	Tn	daily minimum temperature

Precipitation: RR: daily cumulated precipitation

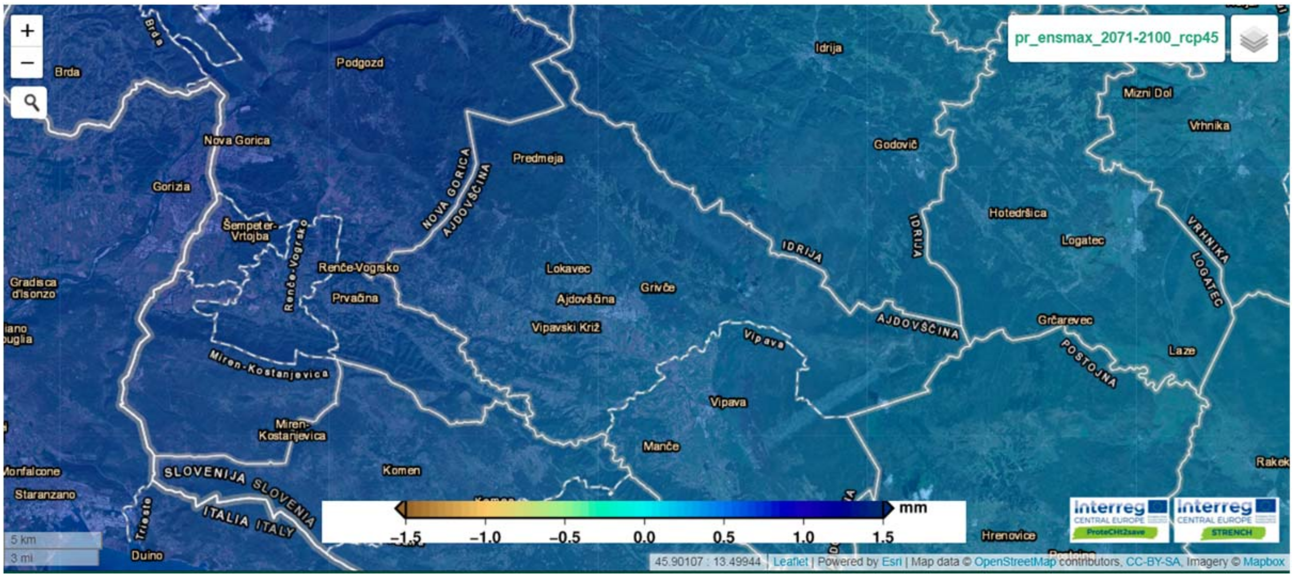
Map: Historical observations: rr_1951-2016_eobs_hist



Map: Model ensemble statistics: Mean / near future / RCP 4.5: pr_ensmax_2021-2050_rcp45



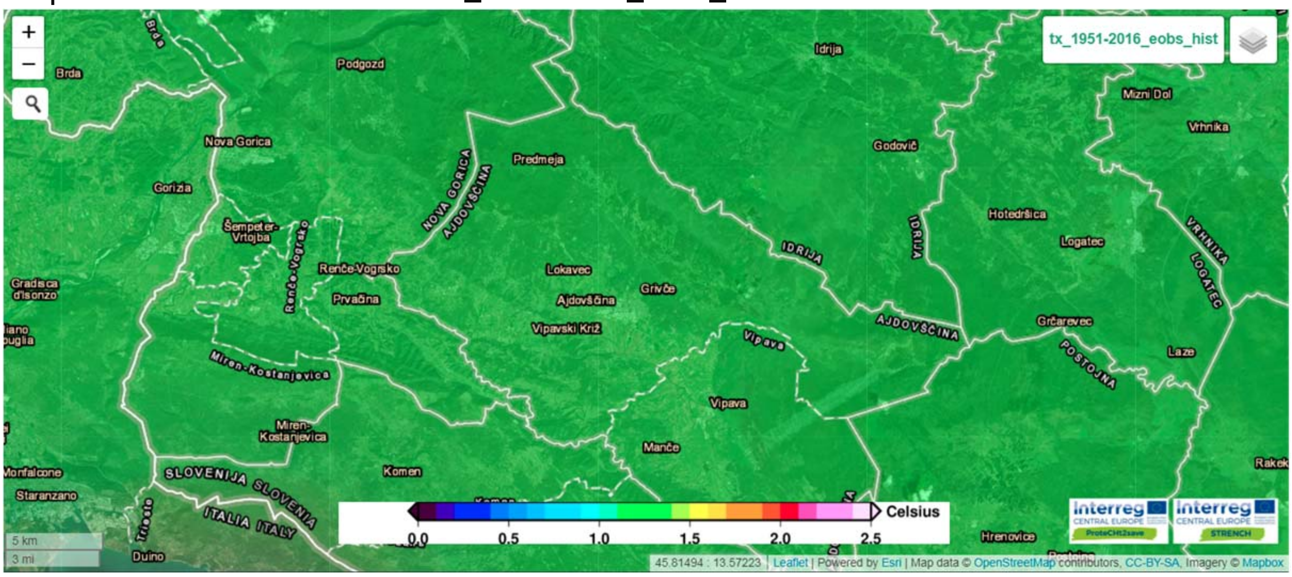
Map: Model ensemble statistics: Mean / far future / RCP 4.5: pr_ensmax_2071-2100_rcp45



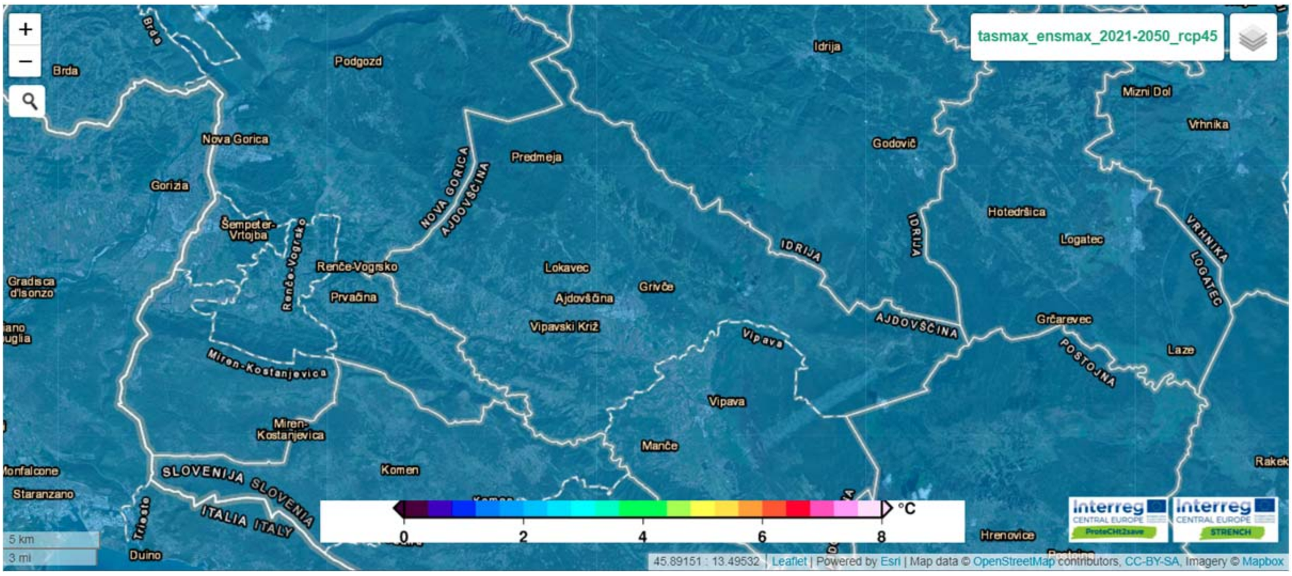
The future projections show an increase in daily cumulated precipitation in Vipava Valley in the near and far future.

Tmax: tx: daily maximum temperature

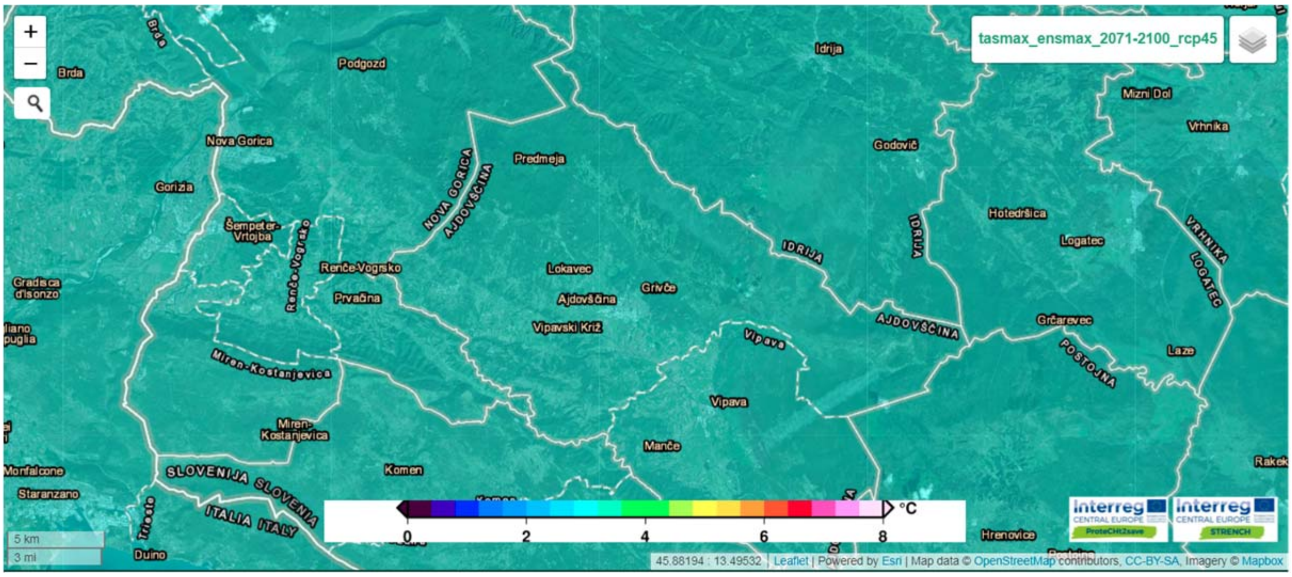
Map: Historical observations: tx_1951-2016_eobs_hist



Map: Model ensemble statistics: Mean / near future / RCP 4.5: tasmax_ensmax_2021-2050_rcp45



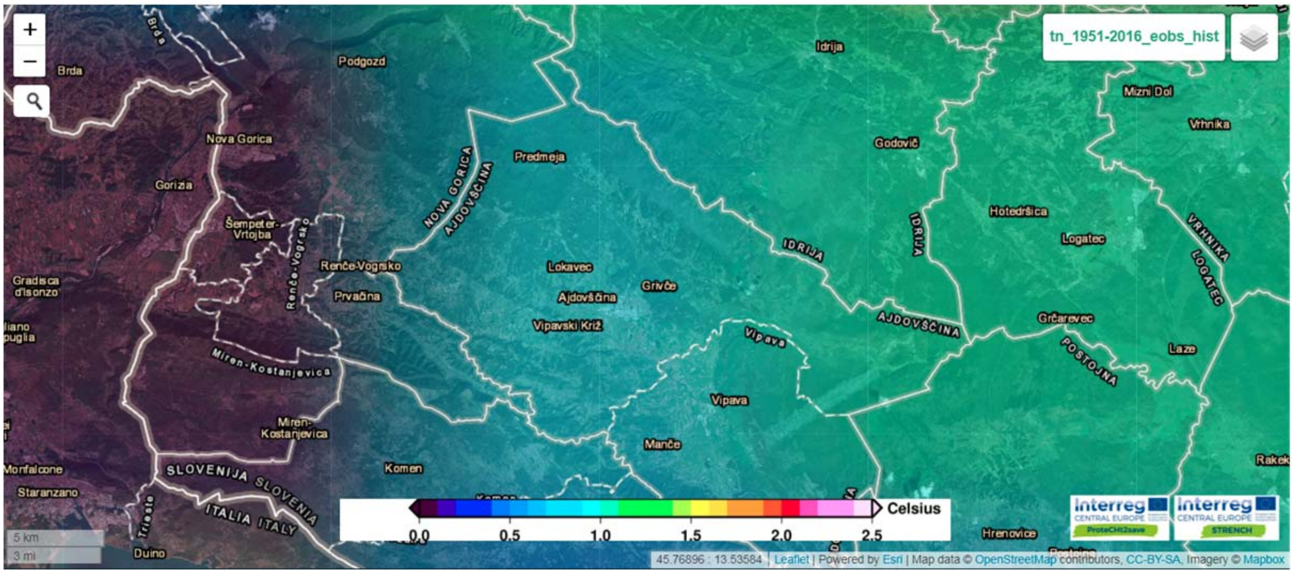
Map: Model ensemble statistics: Mean / far future / RCP 4.5: tasmax_ensmax_2071-2100_rcp45



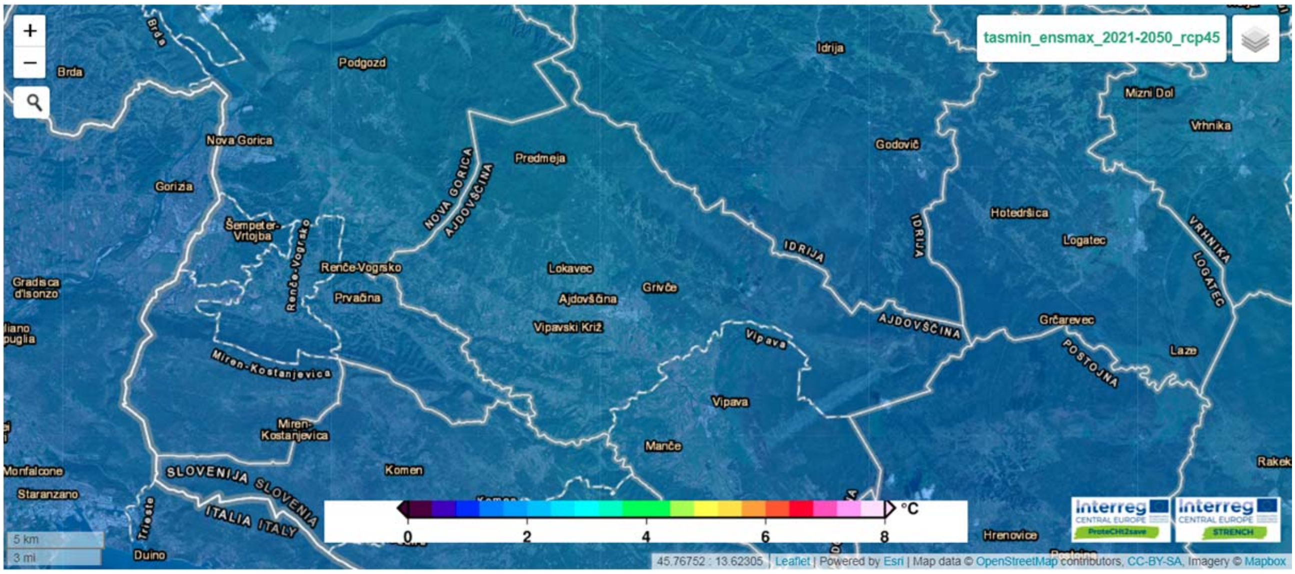
The near and far future projections show a decrease in a daily maximum temperature in Vipava Valley.

Tmin: Tn: daily minimum temperature

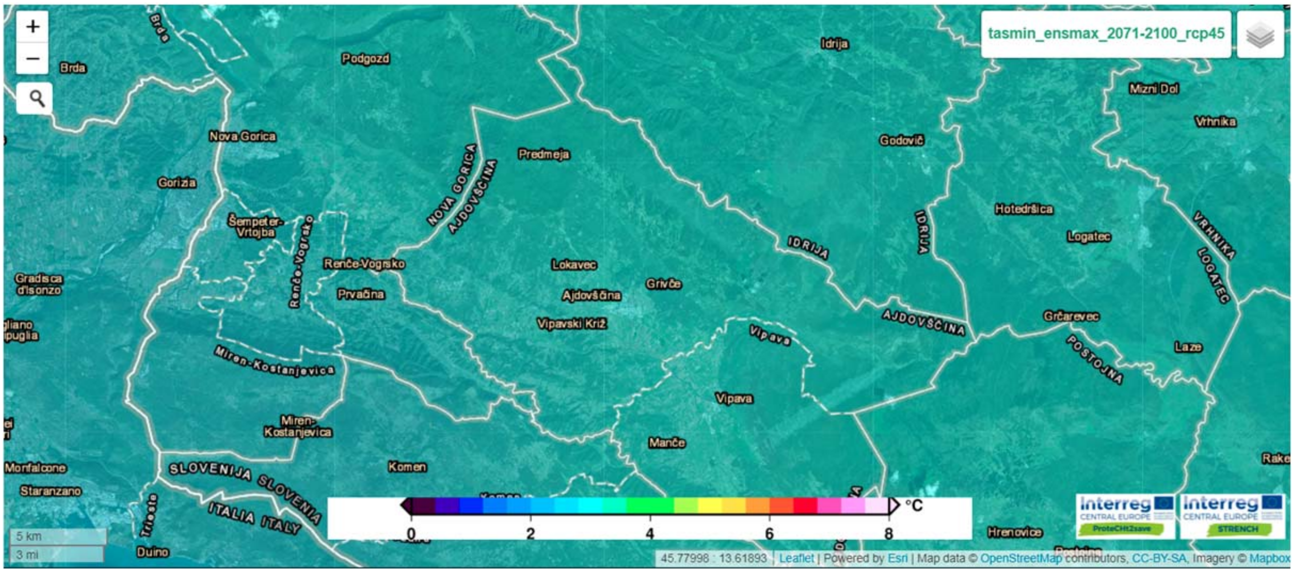
Map: Historical observations: tn_1951-2016_eobs_hist



Map: Model ensemble statistics: Mean / near future / RCP 4.5: tasmin_ensmax_2021-2050_rcp45



Map: Model ensemble statistics: Mean / far future / RCP 4.5: tasmin_ensmax_2071-2100_rcp45



The future projections show a decrease in daily minimum temperature in Vipava Valley in the near and far future.

7. Conclusions

Evaluation of STRENCH Web GIS tool focused on topics tackled in Vipavska Valley pilot site. Due to the scale available in the Web GIS tool, UIRS evaluated the whole Vipava Valley. Evaluation considered extreme events heavy rain, flooding, and climate change variables. In the evaluation of the WGT tool, we collected maps of the area 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 WGT tool is better suited for comparison of past with future scenarios than raw datasets.

The goal of this evaluation was to get an overview of the potential risk of floods on cultural heritage in Vipava Valley.

- Heavy rain will remain to be a problem for the protection of cultural heritage sites. The projection for index R20mm shows that the number of days in a year with precipitation larger or equal to 20 mm/day will increase. That means a potential of flash floods, erosion, etc. Near and far future projections show an increase for index R95pTOT values. That also calls for attention regarding the protection of cultural heritage.

- Flooding is an issue for Vipavska Valley for centuries, hence quite well tackled in strategies and on the field. It was interesting to evaluate STRENCH future projections. The near and far future projections for index Rx5day show a slight decrease of a yearly maximum of cumulated precipitation over consecutive 5 day periods.

- Climate variables daily minimum and maximum temperature and daily-cumulated precipitation were also evaluated. The future projections show an increase of daily-cumulated precipitation in Vipava Valley in the near and far future. The future projections show a decrease of daily maximum and minimum temperature in the near and far future.

Results of The STRENCH WebGIS tool evaluation showed that it can be interesting for analysing climate change effects on cultural heritage.