CLIMAAX Community of practice

Heavy Rainfall Risk Assessment: Learning from regions

July 16, 2026
14:30-16 CET

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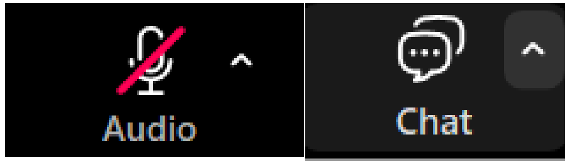
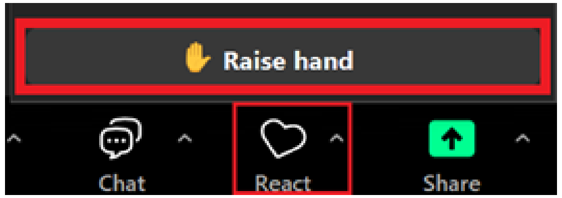
HOUSEKEEPING

- Please note that the meeting is being **recorded**.

- Please, keep your **mic off**.



- Feel free to post your **questions in the chat** (bottom of the screen) or raise your hand to talk



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MEETING AGENDA

- ✓ 14:30-14:35 **Welcome & introduction to the webinar**
- ✓ 14:35-14:45 **Introduction to the *Heavy Rainfall* workflow**
  - Speaker: Erika Melendez (UPC)
- ✓ 14:45-15:15 **Regional experience**
  - Putna river basin, Romania - Speakers: Marius Matreata, Florin Bilbie
  - Košice Region, Slovakia - Speaker: Martin Kuban
- ✓ 15:15-15:45 **Panel discussion and Q&A**
  - Moderators: Fulvio Biddau, Lisa Ferrari and Majid Niazkar (CMCC)
- ✓ 15:55-16:00 **Closing remarks**

Moving forward in CLIMAAX CoP from:

- **Thematic webinars** and workshops connecting science, policy and practice to support CRAs using the CLIMAAX Framework and Toolbox
- **Demo & co-design sessions** for refining and fostering usability of CLIMAAX outcomes

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NEW HAZARD-AND WORKFLOW-FOCUSED SERIES

INTRODUCTION TO *HEAVY RAINFALL* WORKFLOW

Erika Melendez
(UPC)

Are rainfall warnings ready for climate change?

A case study from Catalonia, Spain

Erika Meléndez-Landaverde, Daniel Sempere-Torres, Víctor Gonzales, Carles Corral

Universitat Politècnica de Catalunya

CoP 2026

CRAHI UPC
Centre de Recerca Aplicada en Hidrometeorologia
UNIVERSITAT POLITÈCNICA DE CATALUNYA

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Recent Extreme Rainfall Events

Alcanar, Spain 2021


Terrassa, Spain 2018


Barcelona, Spain 2019


Terrassa, Spain 2023

Recent Extreme Rainfall Events

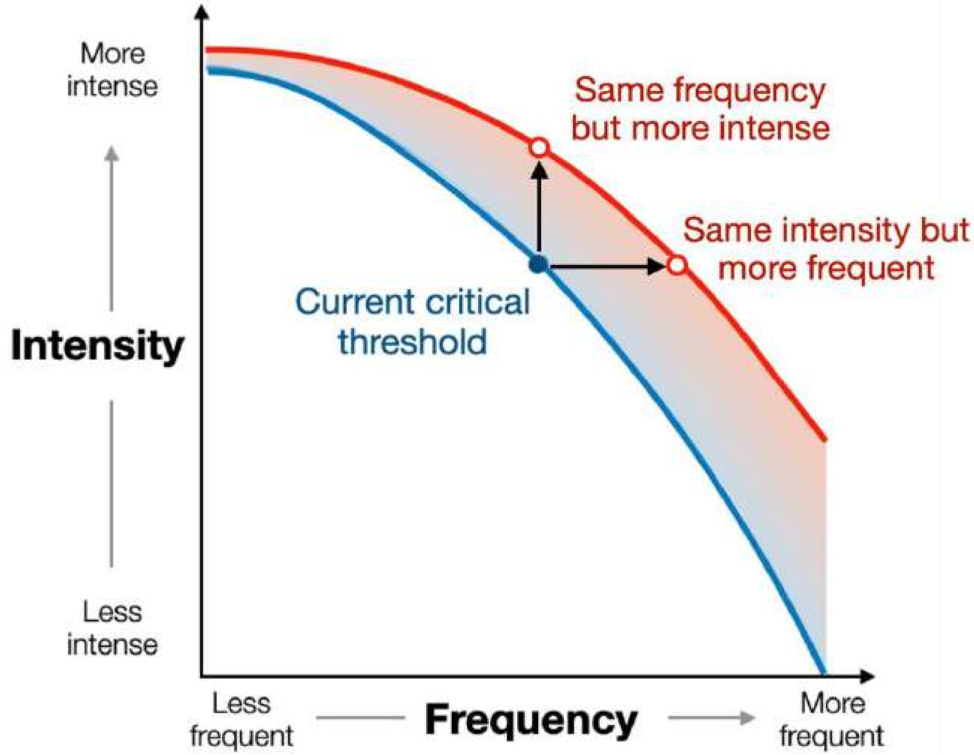
Extreme rainfall workflow: Structure

1. **Guidance on developing critical rainfall thresholds**
   In terms of **M**agnitude (mm), **D**uration (hrs) and **F**requency (T/return period)

2. **Calculating expected precipitation for different durations and frequencies**
   For current and future climate scenarios based on CORDEX

3. **Assessment of threshold changes under climate scenarios**

What will be the new return period (or frequency) for 100mm/24 hours in 2070?



Extreme rainfall workflow: Structure

Online Workflow

Extreme Precipitation: Local data requirements and interpretation for climate risk assessment

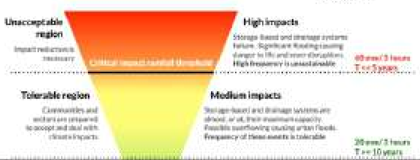
As explained in the introduction section, the frequency and magnitude of extreme precipitation events are likely to vary under the premises of climate change scenarios. These projected changes can translate to an increase in the frequency and magnitude of pluvial floods [urban and flash floods] resulting from the precipitation intensity **exceeding the critical impact rainfall thresholds** of natural and artificial drainage systems capacities.

The extreme precipitation workflow has been constructed to guide users, communities, and regions in understanding how their current critical impact rainfall thresholds will be affected by climate change. The following section will walk you through learning more about what are impact rainfall thresholds, the local knowledge to derive them, and a summary of the basic information needed to start executing the extreme precipitation workflow.

What are critical impact rainfall thresholds?

Impact rainfall thresholds are defined as the precipitation required within a specific timeframe to trigger various impacts, such as urban flooding in vulnerable areas or sites (e.g., low-lying). Additionally, these are commonly used in designing civil works like road drainage systems and flood protection infrastructure and serve as decision support values for early warning systems (Meléndez-Landaverde & Sempere-Torres, 2022). Hence, impact rainfall thresholds serve as key indicators, helping link local potential risk and its consequences to specific rainfall intensity values.

In this context, a **critical impact rainfall threshold** is defined as the precipitation necessary to trigger unsustainable or unacceptable impacts. As seen in figure 1, this concept is closely related to the "**risk-tolerance level**", defined as the maximum amount of loss, impact, or frequency that areas, communities, and regions are prepared to handle due to climate hazards, or in this case, extreme precipitation. Consequently, these naturally vary across communities and sectors (e.g., transportation or agriculture) as risk is not absolute but a social construct that depends on the local context, the coping capacity, and risk perception.



Introduction

Extreme precipitation: Changes under climate scenarios worfklow [Hazard assessment]

- A workflow from the CLIMAAX Handbook and HEAVY RAINFALL GitHub repository.
- See our how to use risk workflows page for information on how to run this notebook.

This section outlines the guidelines for generating rainfall datasets representing current and future climate scenarios. The steps detailed here involve extracting annual maximum precipitation values, fitting various statistical distributions, and calculating return periods for specific durations and scenarios across Europe.

To demonstrate the practical application of hazard data assessment, we provide a specific example focused on the Catalonia region in Spain. In this example, EURO-CORDEX climate projections for precipitation flux at a 12km spatial resolution have been utilised for assessing future climate hazards. The timeframe from 1976-2005 represents historical simulations, while the period from 2041-2070 is used for climate projections.

Note

To simplify your climate risk assessment of extreme precipitation, CRAHI-UPC has already prepared datasets for the European region for different Global/Regional chains, accessible at link. These datasets are ready to be used directly in your risk assessment. You can find detailed instructions on how to use these datasets in the "Extreme precipitation: Changes under climate scenarios workflow [Risk assessment]"

If you are following Path A, **you do not need to execute the steps outlined on this page to begin your risk assessment**. However, depending on your specific research needs, we encourage you to adapt the code for your local area and explore how critical impact rainfall thresholds may be affected under different climate change scenarios (refer to the previous section on critical thresholds for more details).

Prepare your workspace

In this notebook we will use the following Python libraries: Click to show

Load libraries

```
# Libraries to download data and manage files
import os
import cdsapi
import zipfile
import datetime
```

Hazard assessment

For the entire region of Catalonia

We can create some visualisations to better understand the changes in Magnitude and Frequency of our critical thresholds for the period of 2041-2070.

```
# Convert projection so matplotlib understands it.
proj_rp_map = ccrs.epsg(proj_rp_th.to_epsg())
# Path of rasters to plot.
r1 = path_rp_th
r2 = glob.glob(os.path.join(results_dir, 'RP_shift*.tiff'))[0]
# Define colorbar.
cmap_ret_per = mpl.cm.RdYlGn_r
# bounds_ret_per = [1, 2, 3, 4, 5, 10, 25, 50, 100, 200]
bounds_ret_per = [1, 5, 10, 20, 35, 50, 75, 100, 150, 200]
norm_ret_per = mpl.colors.BoundaryNorm(bounds_ret_per, cmap_ret_per.N)
fig_rp, ax_rp = plt.subplots(1,2, figsize = (18,11), subplot_kw = {'projection': proj_rp_map
for i, file in enumerate([r1, r2]):
    ds_i = rio.open_rasterio(file, masked =True)
    im = ds_i.plot(ax = ax_rp[i], add_colorbar=False, norm = norm_ret_per, cmap=cmap_ret_per
    ctx.add_basemap(ax=ax_rp[i], crs=proj_rp_map, source=ctx.providers.OpenStreetMap.Mapnik,
                    attribution = False)

ax_rp[0].set_title('Current return period')
ax_rp[1].set_title(f'Expected return period under {RCP}')
cb_rp = fig_rp.colorbar(im, ax = ax_rp[:], location='bottom', shrink = 0.7)
cb_rp.set_label( 'RP (years)', fontsize = 14)
fig_rp.suptitle(f"Shift of frequency for 100mm/24h threshold between in {TIME_FRAMES[RCP]}",
plt.show()

fig_rp.savefig(os.path.join(plots_dir, f'RP_shift_threshold_{TIME_FRAMES[RCP]}.png'))
```

Risk assessment

Extreme rainfall: Catalonia Spain

The Meteorological Service of Catalonia (SMC) **issues warnings for Dangerous meteorological Situations** due to rainfall using critical thresholds:

100 mm/24 hours

How will this critical rainfall threshold change in frequency and magnitude in the context of climate scenarios?

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Extreme rainfall: Catalonia Spain

How will this critical rainfall threshold change in frequency and magnitude in the context of climate scenarios?

- Critical Rainfall Threshold: **100 mm/24 hours**
- Analysis Objective: Current vs future return periods and rainfall magnitudes
- Climate Projections: EURO-CORDEX historical, RCP 4.5 and RCP 8.5 (12 km resolution)
- Analisis Setup: Multi-model ensemble for mid-century (2041-2070) and end-century (2071-2100)

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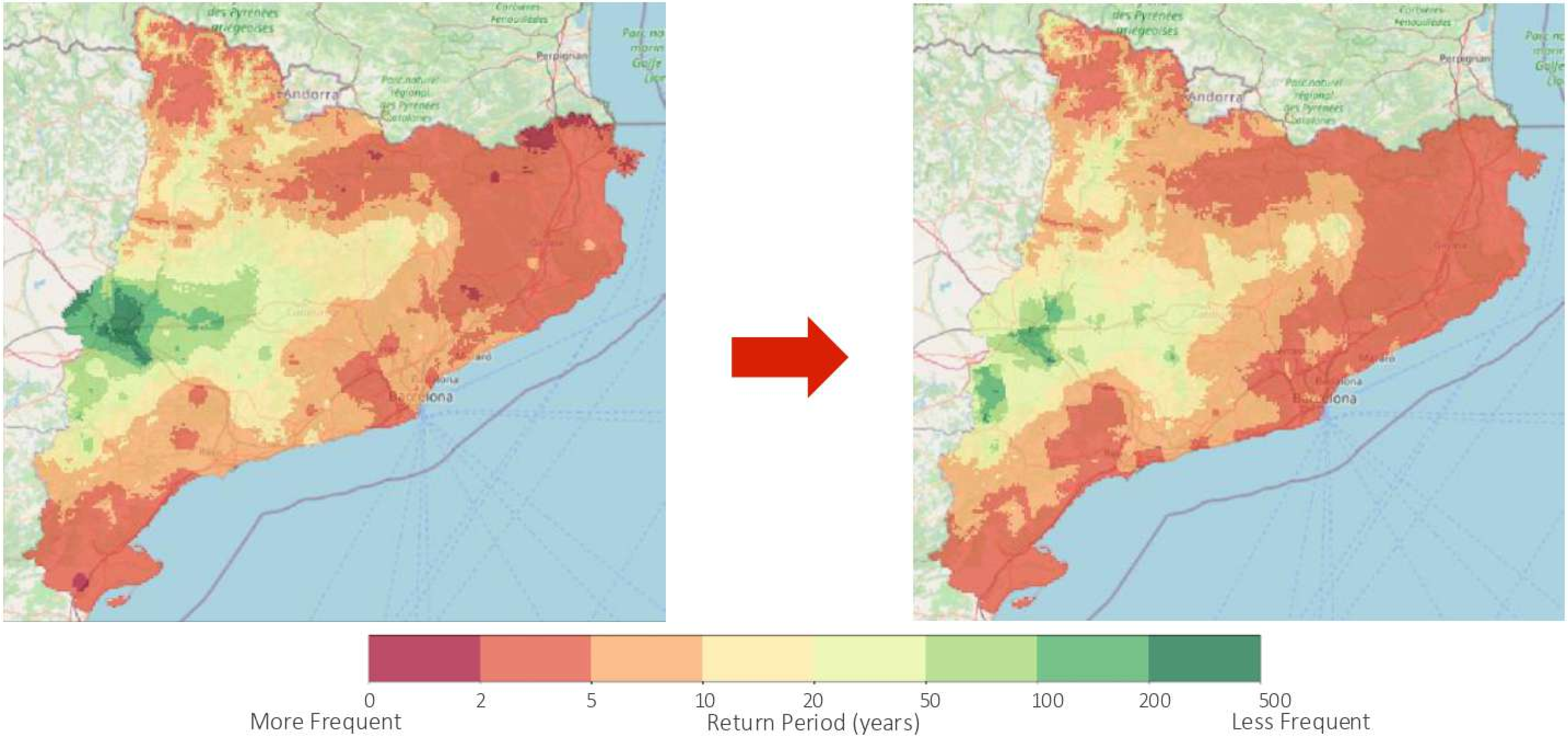
1 Projected Changes in Return Periods for 100 mm/24 hours Events in Catalonia: Ensamble mean

Model Chain: ICHEC-EC-Earth/RACMO22E | mohc-hadgem2-es/RACMO22E | mpi-m-mpi-esm-lr/SMHI-RCA4

Current return period [**1976-2005**]

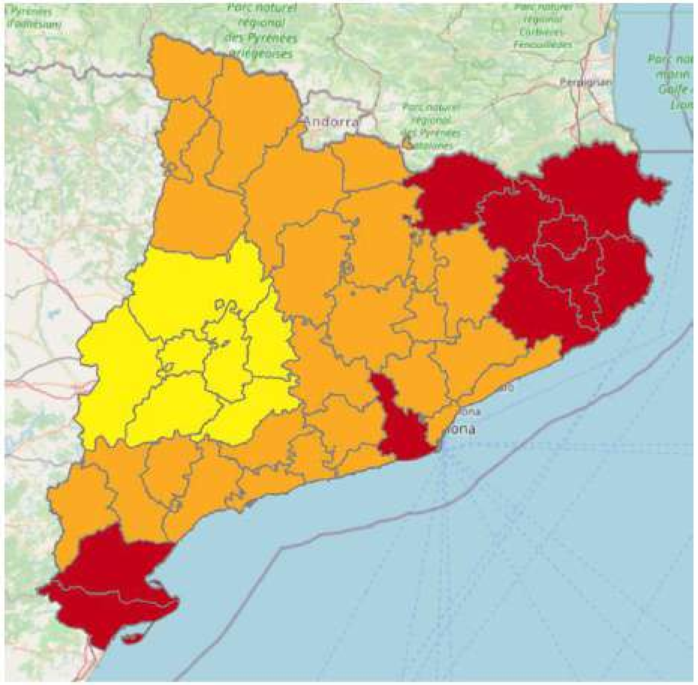
Projected return periods under RCP 8.5 [**2041-2070**]



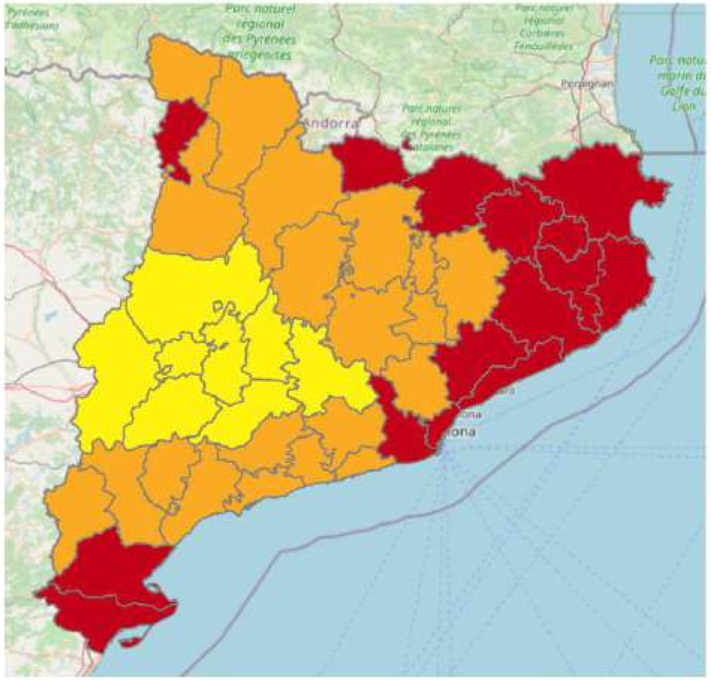
1 Projected Changes in Return Periods for 100 mm/24 hours Events in Catalonia: Ensamble mean

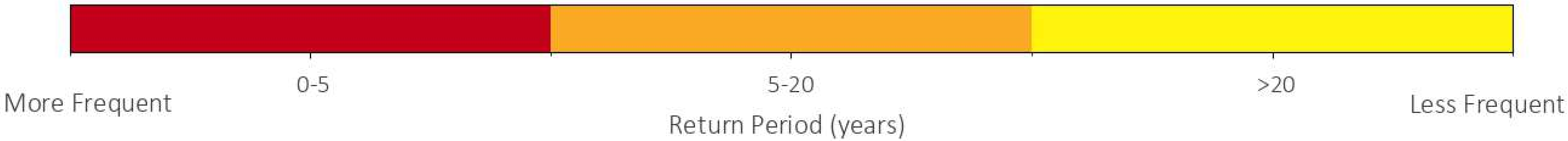
Model Chain: ICHEC-EC-Earth/RACMO22E | mohc-hadgem2-es/RACMO22E | mpi-m-mpi-esm-lr/SMHI-RCA4

Current return period
[**1976-2005**]



Projected return periods under
RCP 4.5 [**2041-2070**]





REGIONAL EXPERIENCES

PUTNA RIVER BASIN

Marius Matreata

Florin Bilbie

KOŠICE REGION

Martin Kuban

CARERoPutna

CLIMAAX Community of Practice webinar on Heavy Rainfall

Florin BILBIE, NIHWM
Marius MATREATA, NIHWM

National Institute of Hydrology and Water Management (NIHWM), Romania
Online, 16, July, 2026

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Who are we?

- National Institute of Hydrology and Water Management (NIHWM), Romania

- National authority responsible for hydrological monitoring, forecasting and warning, flood hazard and flood risk assessment, and technical support for the implementation of the EU Floods Directive.

- CARE-ROPutna is one of the CLIMAAX First Call Cascade Funding projects implementing the Climate Risk Assessment Framework.

- The NIHWM expertise is in combining climate projections, hydrological modelling, hydraulic simulations and exposure analysis to support flood related climate adaptation.

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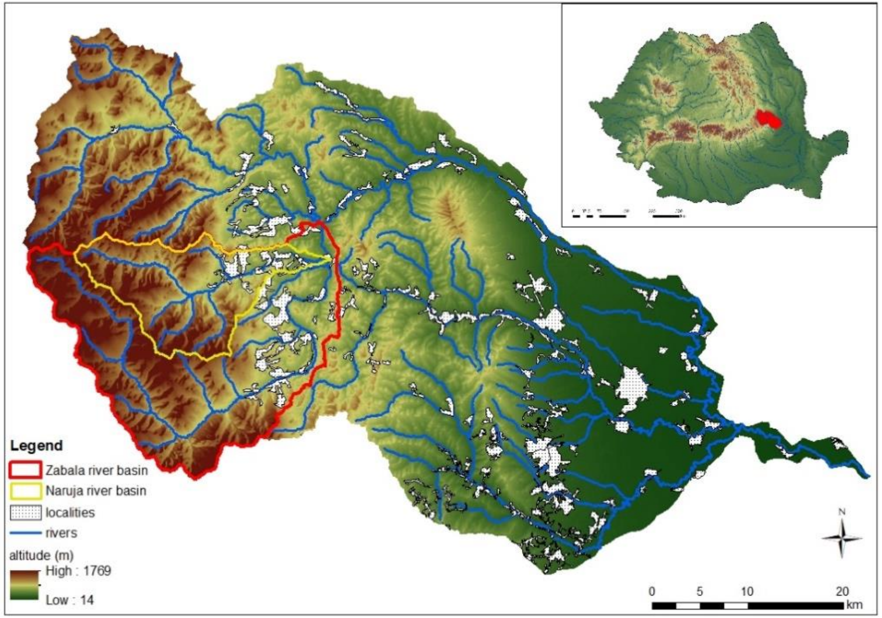
Regional Profile and Context

- Putna River Basin is located in south-eastern Romania, within the Siret River Basin District. Economy is based on agriculture, forestry, small industries and local services. Settlements and transport infrastructure are concentrated along river corridors.
- Main climate-related hazards and vulnerabilities are river floods and flash floods generated by heavy rainfall. Exposure of residential areas, roads, agricultural land and public infrastructure.



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Regional Profile and Context

- Notable extreme events: several major flood events triggered by intense rainfall, particularly in 2005, 2012, 2016, 2021 and 2022, causing significant socio-economic damage and, in some cases, loss of life.
- Existing adaptation and risk management framework are: Flood Risk Management Plan, River Basin Management Plan, National Climate Change Adaptation Strategy, Local emergency management plans.
- Context-specific challenges: limited financial resources identified by stakeholders as the main barrier to implementing adaptation measures, legal constraints, land ownership issues and public acceptance affecting the implementation of flood protection measures.

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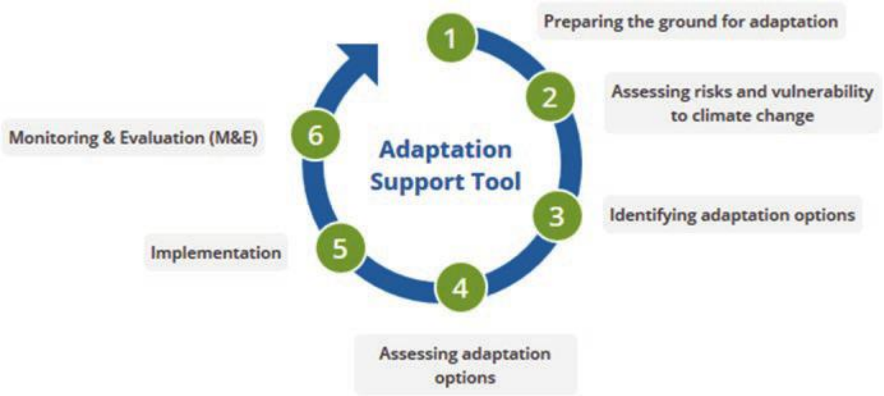
Climate Risk Assessment Framework experience

- Local data matter: higher-resolution datasets substantially improved the CRA.
- Stakeholder participation strengthened the credibility and usability of the results.
- National operational tools can successfully complement the CLIMAAX Toolbox.
- Data availability and uncertainty remain key challenges.
- Flexible, locally adapted workflows generate more actionable climate risk assessments.



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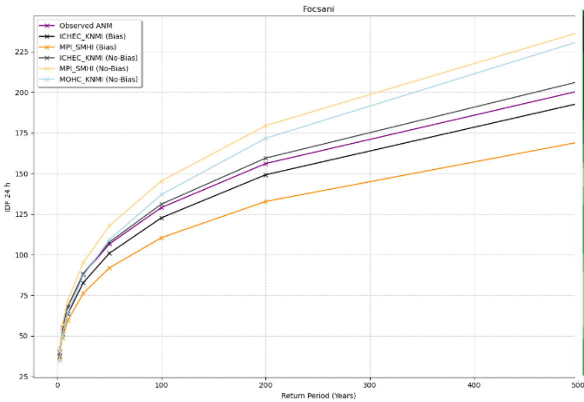
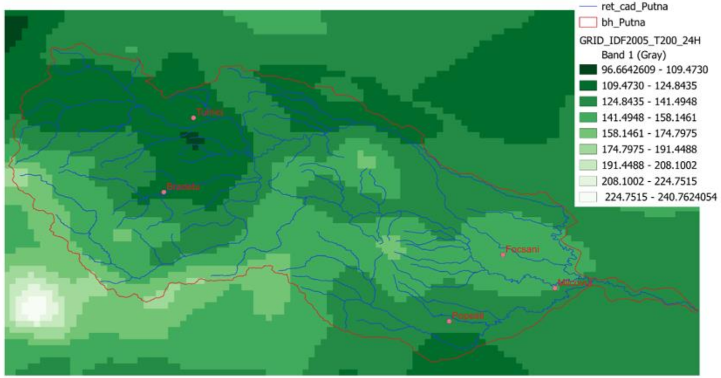
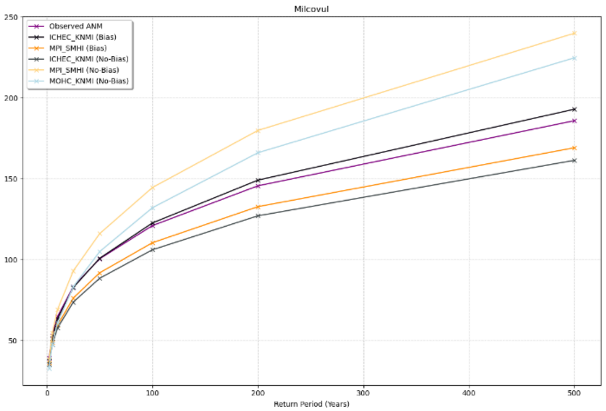
Hazard analysis using the CLIMAAX Toolbox

- For conducting the analyses we mainly used two new local precipitation datasets:
- Daily gridded precipitation dataset for Romania, derived from the observations within the National Netowrk of Meteorological stations
- RoCliB - Bias corrected CORDEX RCM dataset over Romania







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Risk analysis using the CLIMAAX Toolbox

Attribute	Bias corrected datasets
Global and Regional Climate Model Chains	ichec-ec-earth/knmi-racmo22e mpi-m-mpi-esm-lr/smhi-rca4
Representative Concentration Pathway (RCP)	RCP 4.5 RCP 8.5
Historical Time-frames	1976-2005
Future Time-frames	2011-2040 2041-2070 2071-2100
Durations	24h

- The updated risk assessment started with estimation of new relevant spatially variable critical impact-based rainfall thresholds for 3h duration, which were derived mainly from the configuration of ROFFG System, as well as the experience of the NIHWM forecasters from using this system for real time flash flood warnings.
- The Romanian Flash Flood Guidance system (ROFFG) is an adaptation of the San Diego Hydrologic Research Center's (http://www.hrc-lab.org) Flash Flood Guidance System used in various regions of the world to help forecasters cope effectively with flash flood warnings.

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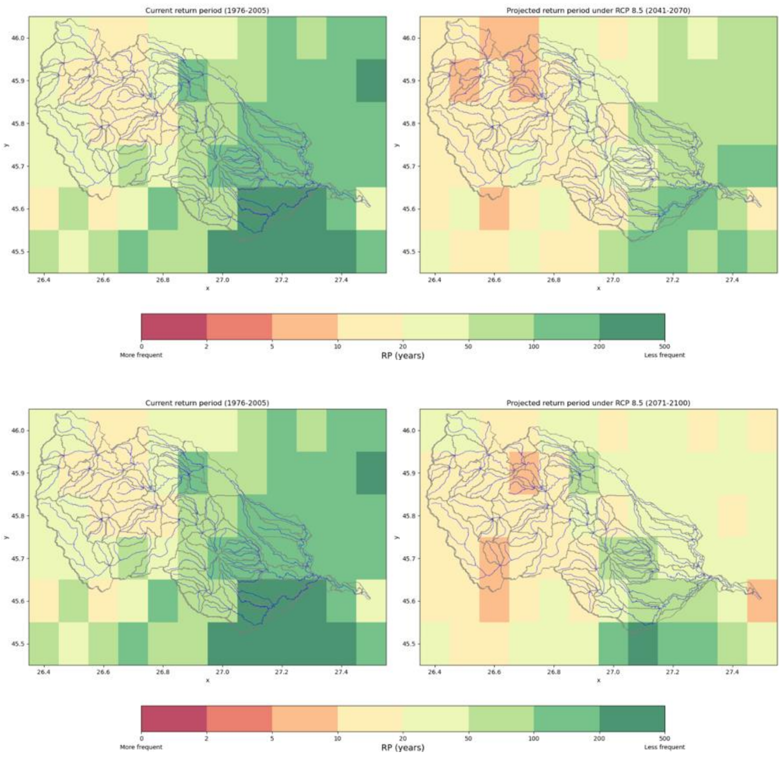
Our CRA results



- Regionalizing the workflow makes the outputs much more useful for adaptation planning and preparedness activities.
- The assessment helps shift the discussion from historical events to future climate-driven heavy rainfall risk.
- Best practices at workshop with stakeholders
  - Present Heavy Rainfall results in a simple and practical way. Maps showing hotspots and future changes are much easier for stakeholders to understand than technical indicators.
  - Use the results to stimulate discussions about preparedness, rather than focusing only on climate projections.
  - Stakeholder feedback can help identify priority areas where further analyses may be needed.

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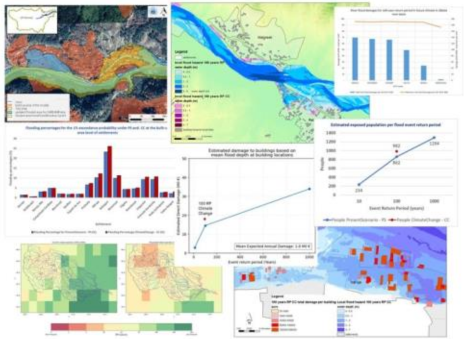
Risk evaluation and management

- Climate Risk Assessment results were progressively translated into a Key Risk Assessment through stakeholder engagement.
- 3 stakeholder workshops were organised throughout the project. Representatives from local authorities, water management institutions, emergency services and local communities participated.

- Implications for action: Strengthening early warning systems, priority for combined grey-green infrastructure, increased community awareness and education, improved spatial planning and restrictions on development in flood-prone areas, continued stakeholder engagement during implementation.



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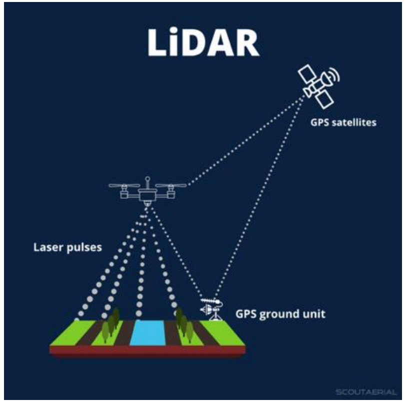
Reflections on using CLIMAAX toolbox and next steps

- Whenever available, complement the CLIMAAX Toolbox with local high-resolution datasets, models and national methodologies - Use locally derived rainfall thresholds whenever available. In our case, runoff thresholds for 3 hours duration and for the small river basins within Putna River Basin, from the configuration of Romanian ROFFG forecasting system significantly improved the relevance of the assessment for flash flood conditions.
- Combine climate datasets with national expertise. The workflow becomes much more meaningful when climate projections are interpreted together with local forecasting experience and regional knowledge.
- Validate CRA outputs through field observations and expert knowledge before using them for adaptation planning - Compare the results with local operational experience and historical heavy rainfall events before drawing conclusions.
- Engage stakeholders from the earliest stages of the assessment and maintain continuous interaction throughout the project - Their knowledge helps explain why some hotspots appear in the assessment and increases confidence in the results.



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Košice Urban Development area – Heavy rainfall

Presented by Martin Kuban (KAJO, STU)

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Kosice heavy rainfall workflow: key steps

- Registered heavy rainfall events – understanding past occurrences
- Assigning rainfall intensities to the registered events
- Estimating the impacts
- Identifying critical rainfall thresholds
- Assessing the impacts of climate change
- Identifying the potential problematic locations and catchments

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Registered heavy rainfall events – hazard impact database

- Flood reports (SHMU)
- News (dnes24, tvkosice, pravda)

source:https://kosice.dnes24.sk/https://www.tvkosice.sk/tag/povodne

***source:** https://kosice.dnes24.sk/povodne-dorazili-na-vychod-cesty-a-obce-v-okoli-kosic-zaplavila-voda-foto-390149*

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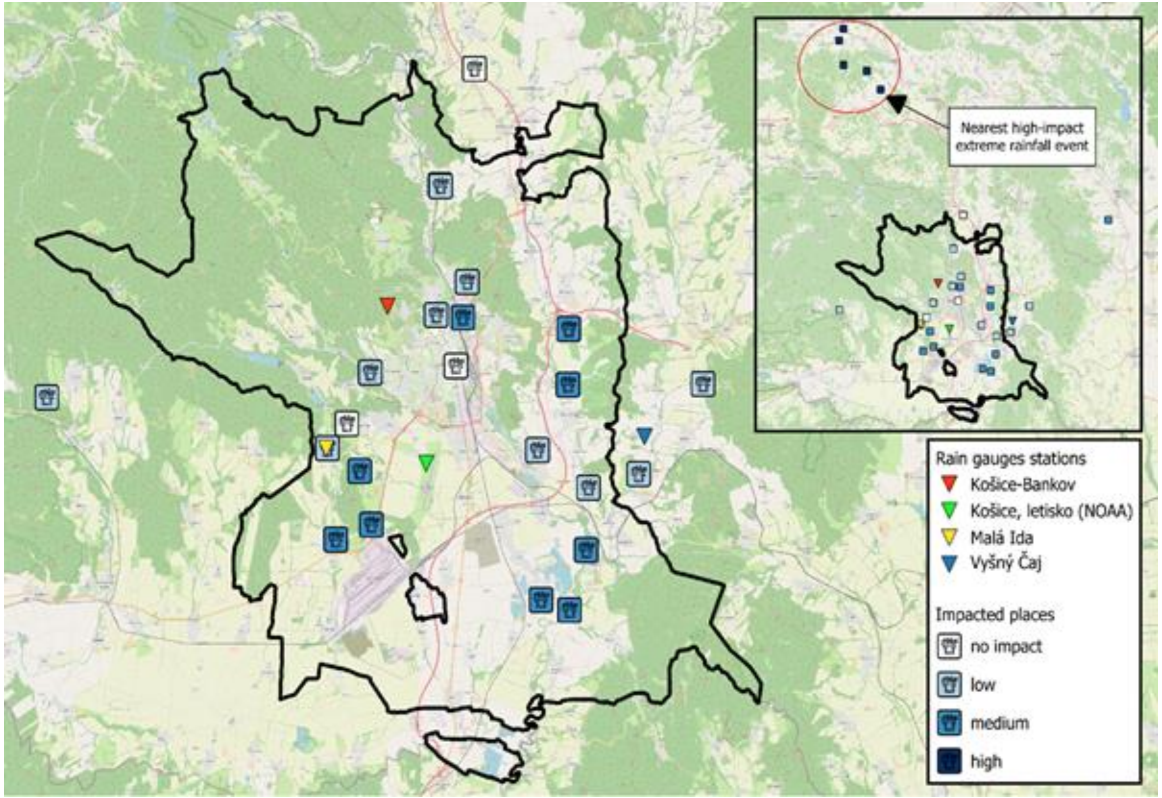
Assigning rainfall intensities to the registered events

- Flood reports and news – usually missed the measured intensities information
- Purchased intensities from SHMU
- From 4 recommended rainfall gauges (SHMU)



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Assigning rainfall intensities to the registered events

- Selection of the highest registred accumulations

Date	*Online sources mm/24h mm/days*	*Bankov mm/24h mm/days*	*Mala Ida mm/24h mm/days*	*Vysny Caj mm/24h mm/days*	*KE letisko (NOAA) mm/24h mm/days*	*RP ichec (1976-2005)*	*RP mohc (1976-2005)*	*Impact severity scale*
7/20/1998	100	(NA)	(NA)	(NA)	(NA)	500	275	High impact (3)
8/19/2003	NA	69	33	18	37	100	54	Medium impact (2)
5/6/2010	50	50 166 6d	38 119 6d	36 111 6d	32 74 6d	25	15	Medium impact (2)
5/6/2013	(NA)	19 33 5d	14 29 5d	45 62 5d	26 43 5d	12	10	Medium impact (2)
5/27/2014	(NA)	17 27 5d	19 24 5d	36 38 5d	38 41 5d	6	5	Low impact (1)
7/8/2015	(NA)	66 71 2d	28 40 2d	24 29 2d	26 31 2d	80	45	Medium impact (2)
8/21/2016	(NA)	62	36	40	32	59	35	Medium impact (2)
6/13/2018	(NA)	68	25	13	38	95	50	Medium impact (2)
9/3/2018	(NA)	18	40	19	19	8	6	Low impact (1)

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Estimating the impacts and thresholds

- Using the CLIMAAX heavy rainfall methodology
- **Low impact:** Minor, isolated flooding of land and flood-prone areas
- **Medium impact:** Local flooding of land and roads, with travel disruption and possible danger to life
- **High impact:** Widespread flooding, serious danger to life, and possible evacuations or rescue operations

- SHMU threshold of 40mm/24h for the possible impact

Location	Low impact	Medium impact	High impact
	Threshold	Threshold	Threshold
Košice UMR	**30mm/24h**	**45mm/24h**	**70mm/24h**

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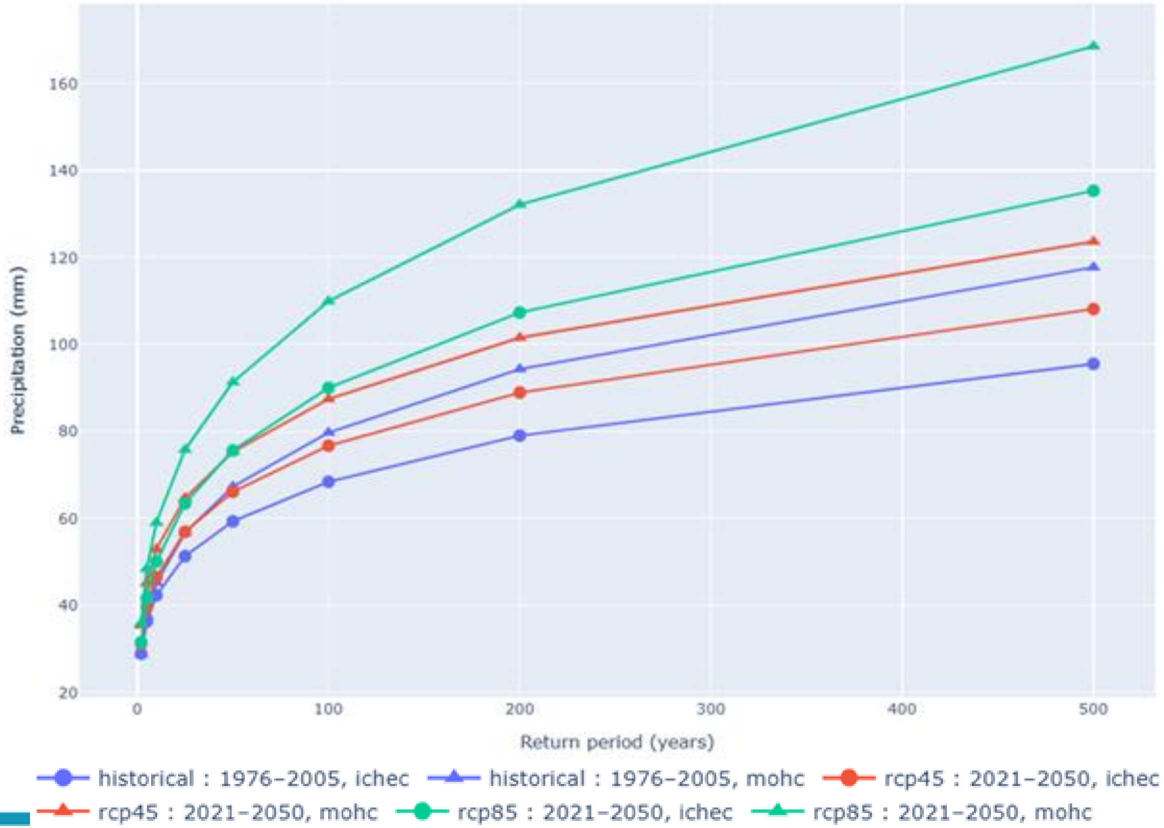
Assessing the impacts of climate change

- Selecting the two best-performing **EURO-CORDEX GCM–RCM** combinations using the **CLIMAAX Bias and Uncertainty Tool**.
- Applying the **CLIMAAX hazard and risk workflows** to estimate changes in rainfall intensity and frequency
- Using **SHMÚ** heavy rainfall scenarios



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Assessing the impacts of climate change

- Estimated potential increase of the magnitude and frequency of the heavy rainfall events based on the EURO-CORDEX GCM=*MOHC-HADGEM2-ES* , RCM=*KNMI-RACMO22E*

Rainfall	Historical RP 1976–2005	RCP4.5 RP 2021–2050	Relative change	RCP8.5 RP 2021–2050	Relative change
30 mm/24 h	2.3 years	<2 years	≤−12%	<2 years	≤−12%
45 mm/24 h	9.8 years	5.0 years	−49.5%	3.9 years	−60.3%
70 mm/24 h	58.1 years	35.4 years	−39.2%	18.2 years	−68.7%

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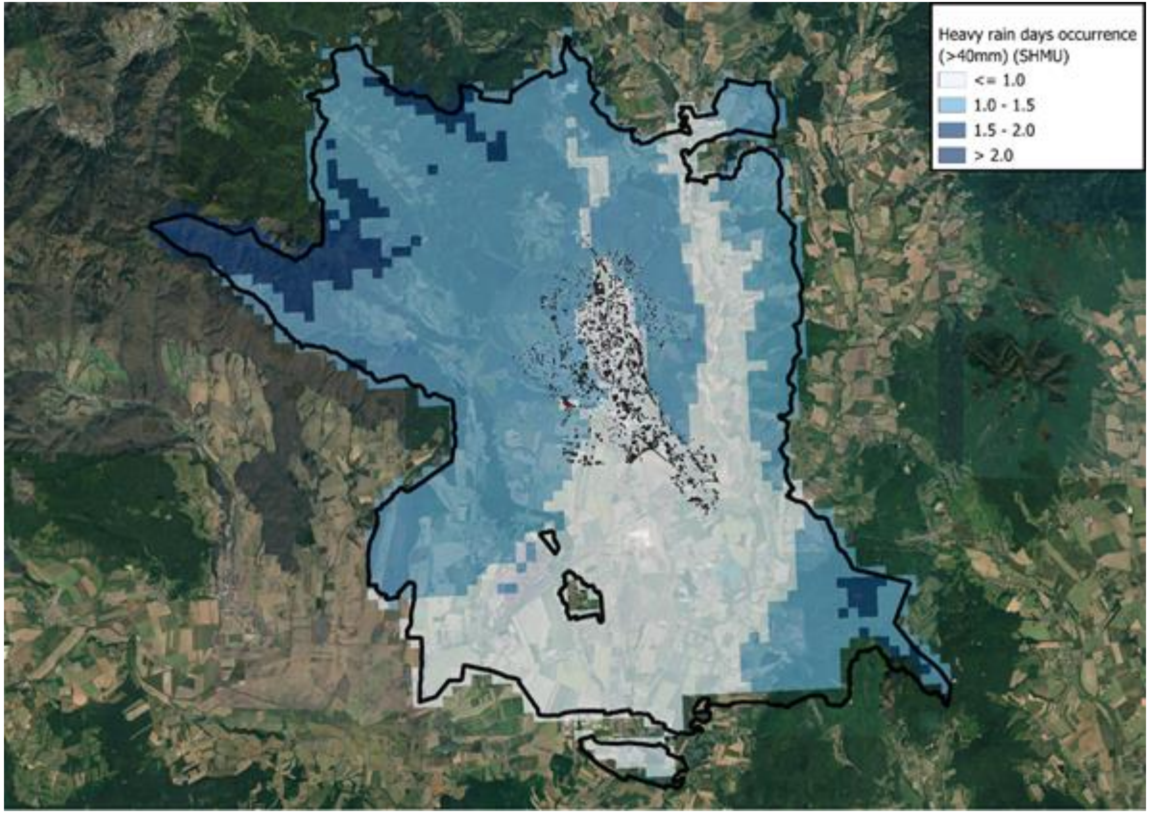
Assessing the impacts of climate change

- SHMU climate scenarios

Days with precipitation > 40 mm/24h			
Scenario	Period	Mean	Relative change vs. historical
Historical	1991–2020	0.75	0.0%
RCP 4.5	2021–2050	1.12	+49.0%
RCP 4.5	2071–2100	1.26	+66.8%
RCP 8.5	2021–2050	1.20	+58.9%
RCP 8.5	2071–2100	1.55	+105.5%



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Where should adaptation and mitigation measures be implemented?

- Susceptible areas based on multiple criteria inside and outside the build up area

source: https://www.asb.sk/zelena-obnova/v-kosiciach-pribudaju-zelene-projekty-od-zelenych-striech-az-po-dazdove-zahrady/attachment/zelena-infrastruktura-1

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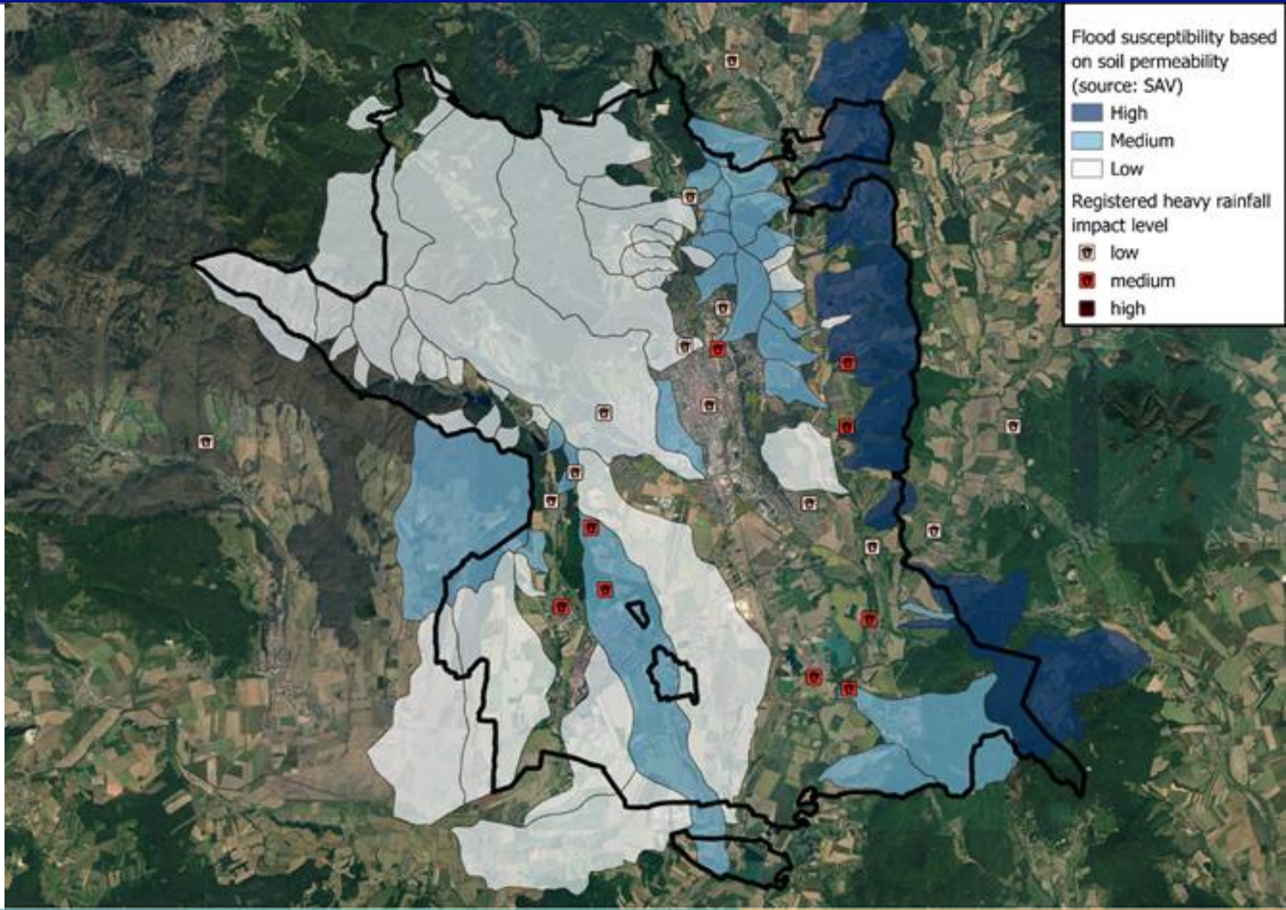
Flood susceptibility outside build-up areas

- Flood susceptibility based on the soil permeability (SAV) for catchments outside of buildup areas.
- 70% of the registered events were in the catchments with medium or high flood susceptibility



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Urban Flooding simulation within build-up areas

- Flood susceptibility based on the surface permeability, slopes of the terrain (DHI).
- Flood depth (m) simulated for a critical rainfall event of 30 mm in 1 hour

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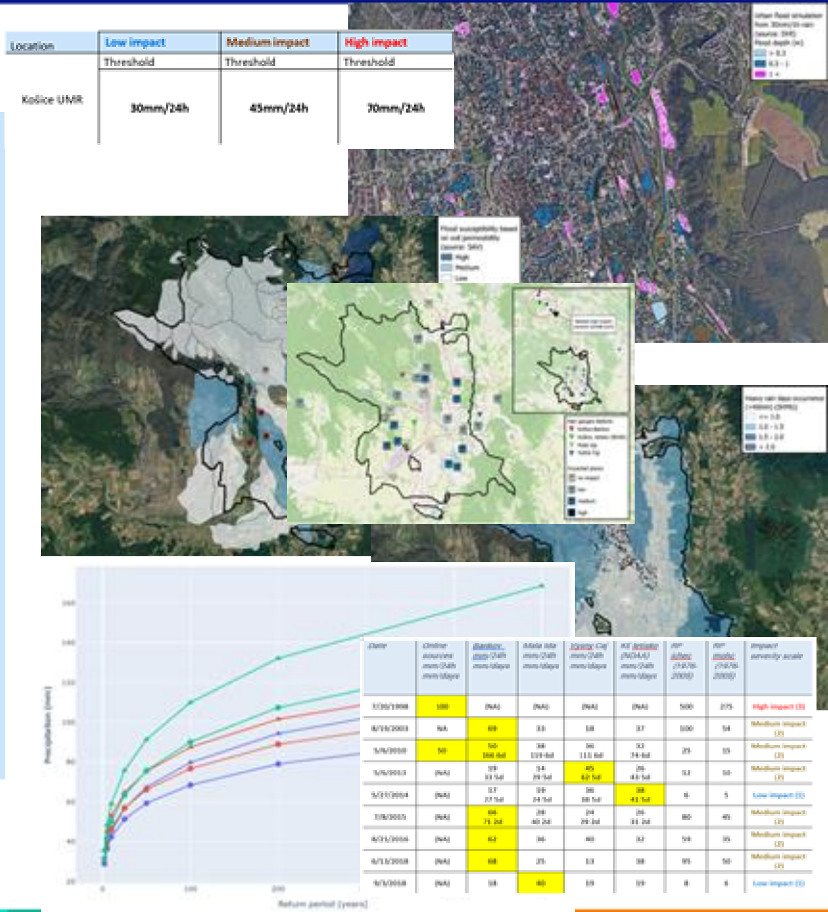
Conclusion:

- The hazard impact database were used for the estimation of the impact and critical thresholds based on registered evidence
- The potential impact of the climate change was estimated based on the EURO-CORDEX and national SHMU climate scenarios.
- The most suitable places for the adaptation and mitigation measures were estimated based on the registred evidence (hazard impact database), flood susceptibility maps and flash flood simulations



Location	Low impact	Medium impact	High impact
	Threshold	Threshold	Threshold
Košice UMR	30mm/24h	45mm/24h	70mm/24h

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Thank you for your attention !

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PANEL DISCUSSION AND Q&A SESSION

UPC

Erika Melendez

PUTNA RIVER BASIN

Marius Matreata

KOŠICE REGION

Martin Kuban

Florin Bilbie

UPCOMING EVENTS

- **16 September 2026 | 14.30-16 CET**
  In collaboration with CARMINE project

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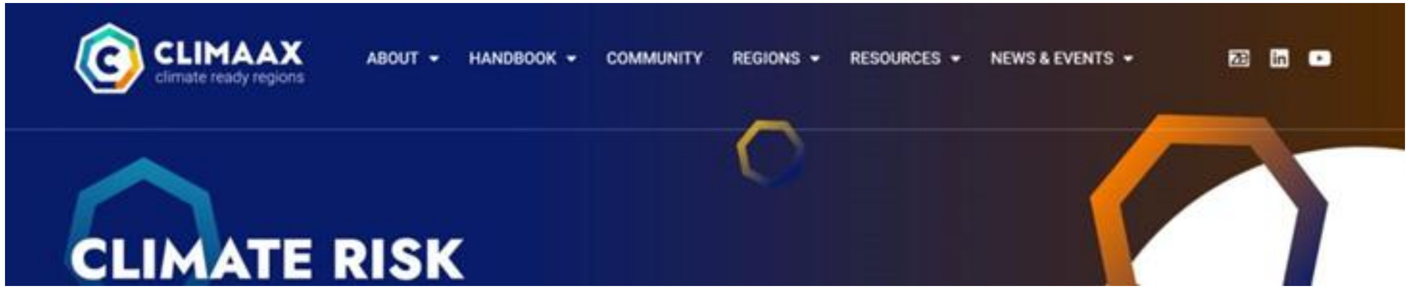
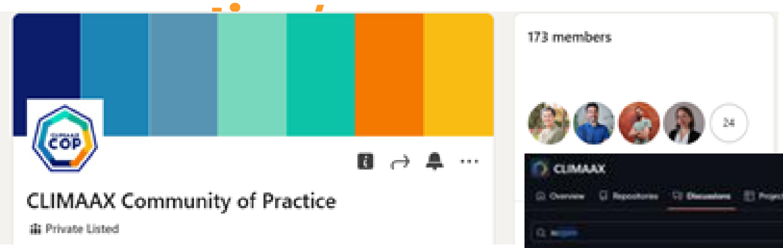
HOW TO ENGAGE IN THE COMMUNITY OF PRACTICE

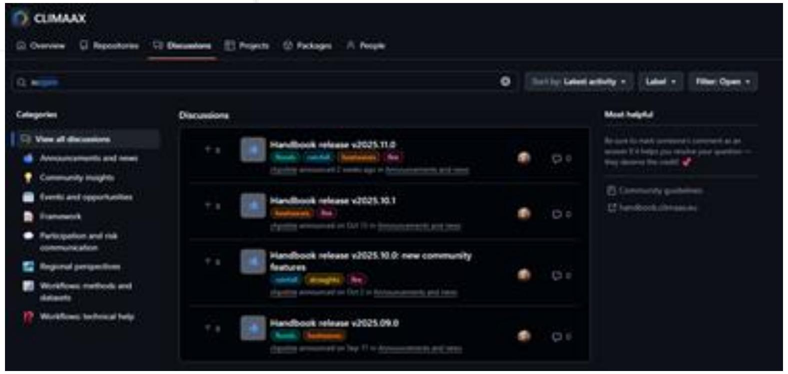


- Join our LinkedIn group and community forum
- Take our surveys
- Subscribe to the CoP to receive communication of further updates

https://www.climaax.eu/community-of-

!! Scan this !!





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CLIMAAX
climate ready regions

www.climaax.eu

Thank you and see you next time!

cop@climaax.eu

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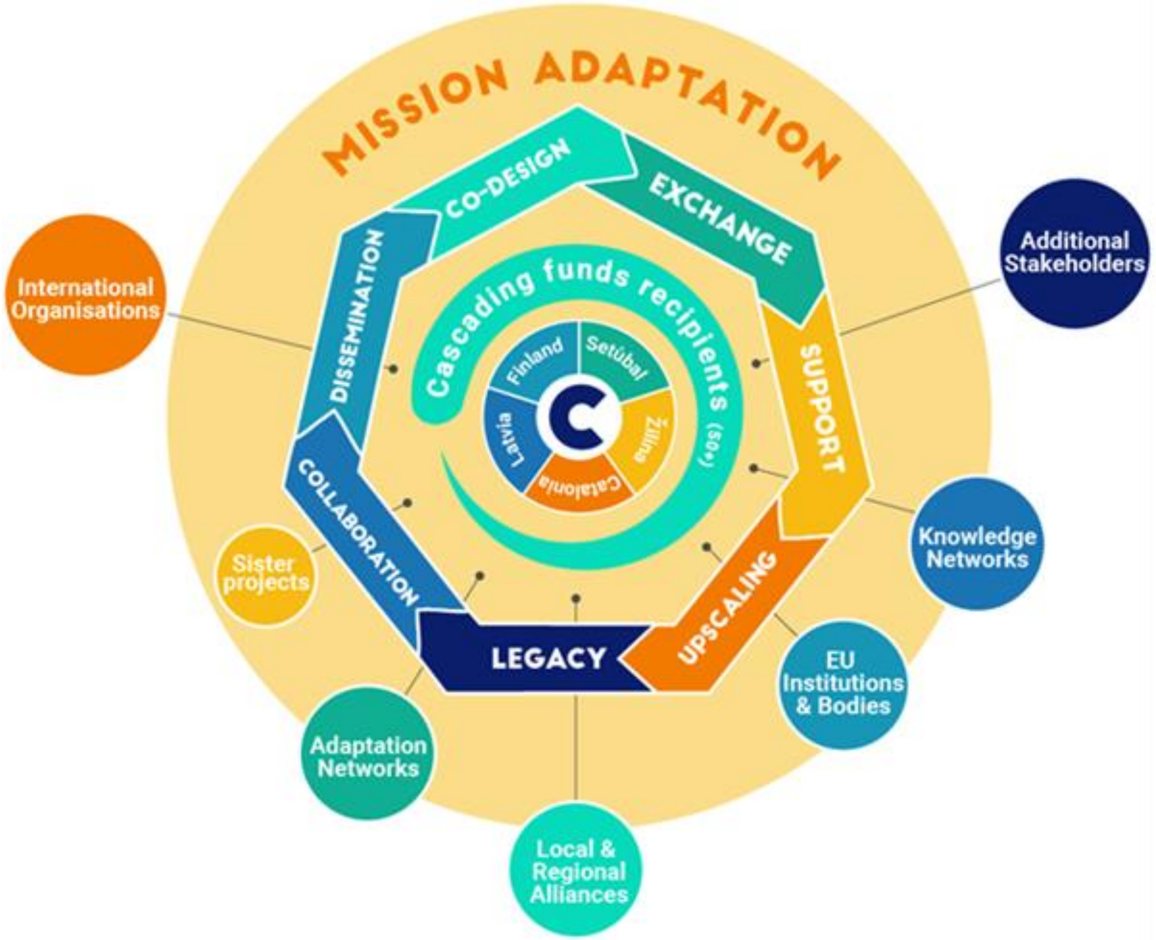
CLIMAAX Community of practice

- *Space for* **collaboration and knowledge exchange** *between practitioners across regions and sectors interested in climate risk assessment (CRA).*

- *It aims to* **foster learning, co-design and improve the climate risk assessment** *(CRA)* practice at local and regional levels.



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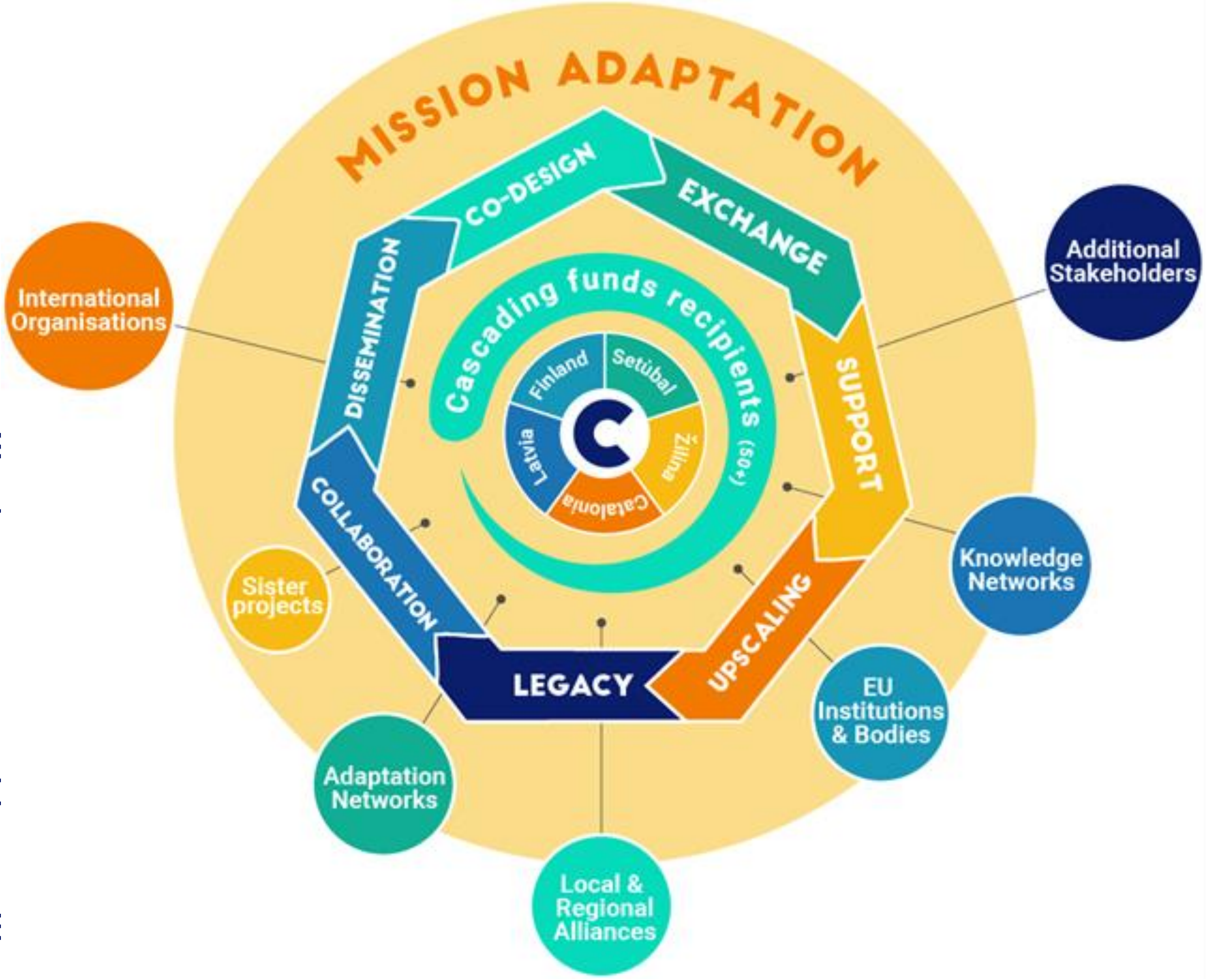
Why joining the CLIMAAX Cop

- **Engage** with peers to share insights and learn from each other's experience
- **Receive advice** from fellow practitioners
- **Share your knowledge** contributing to the identification of best practices, bottlenecks
- **Contribute** to inform CLIMAAX activities ar shape its outcomes
- **Connect** with regions and leverage their experience for mutual benefit
- **Collaborate** with groups of peers in areas c interest and specific applications
- **Participate** in webinars, workshops, or othe that respond to your interests and needs



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