

CLIMAAX Handbook overview

Handbook webinar
4 July 2024



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CLIMAAX
climate ready regions

Housekeeping



This session is recorded



Raise your hand to ask a question during
dedicated Q&A moment or write in the
chat



Agenda

TIME	SPEAKER	TOPICS
10:00 - 10:05	Dana Stuparu (Deltares)	Welcome
10:05 - 10:10	Erika Meléndez (UPC)	Contractual process (setting up)
10:10 - 10:25	Michaela Bachmann (IIASA)	Framework presentation
	Anna Pirani (CMCC)	Use of climate change data
10:25 - 10:45	Christopher Polster (ECMWF)	Toolbox presentation
	Erika Meléndez (UPC)	Example demonstration with an example
10:45 - 11:00	Dana Stuparu (Deltares)	Q&A



CLIMAAX Framework

Michaela Bachmann, Reinhard Mechler, Oscar Higuera-Roa
International Institute for Applied Systems Analysis (IIASA)

Handbook Webinar
4th of July 2024

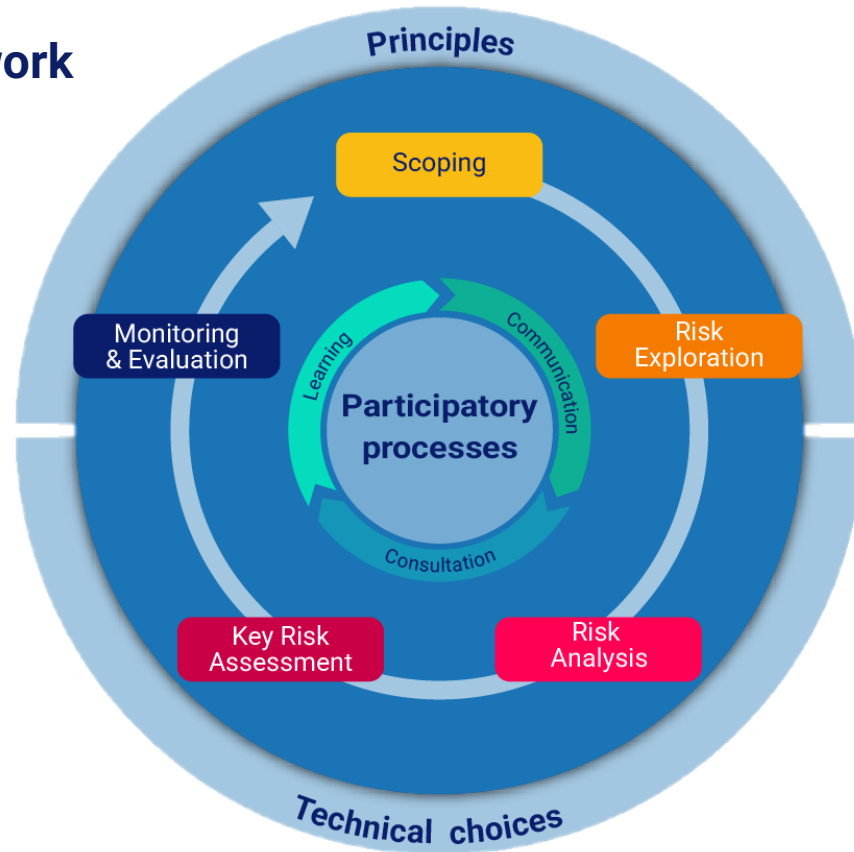


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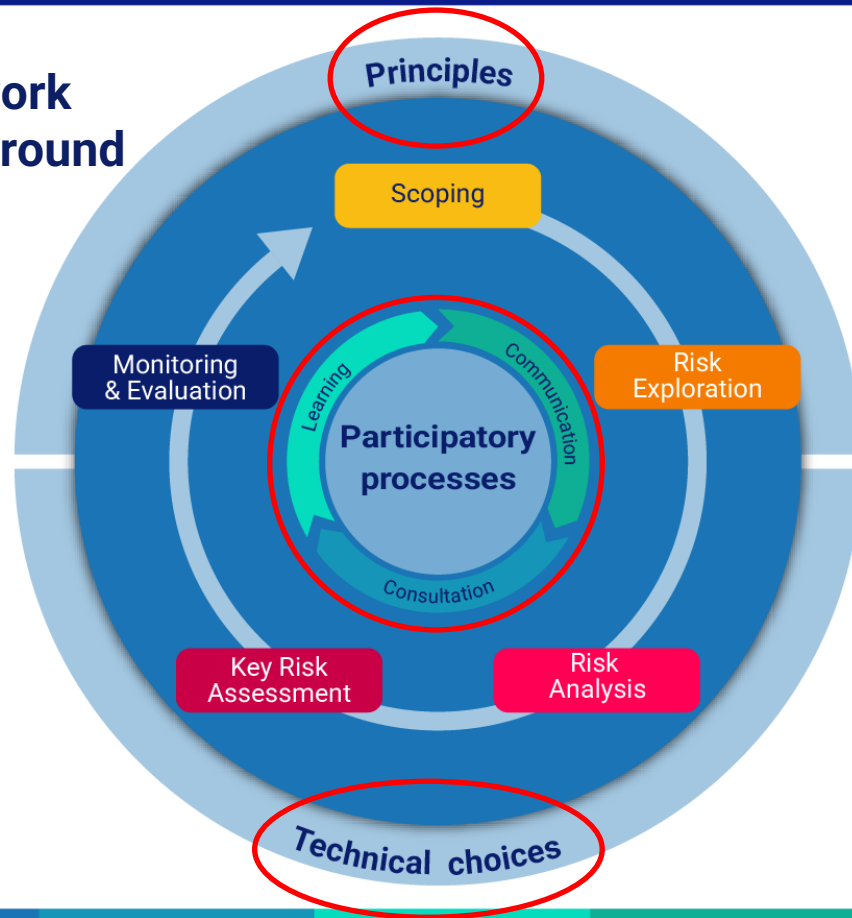
CLIMAAX Framework



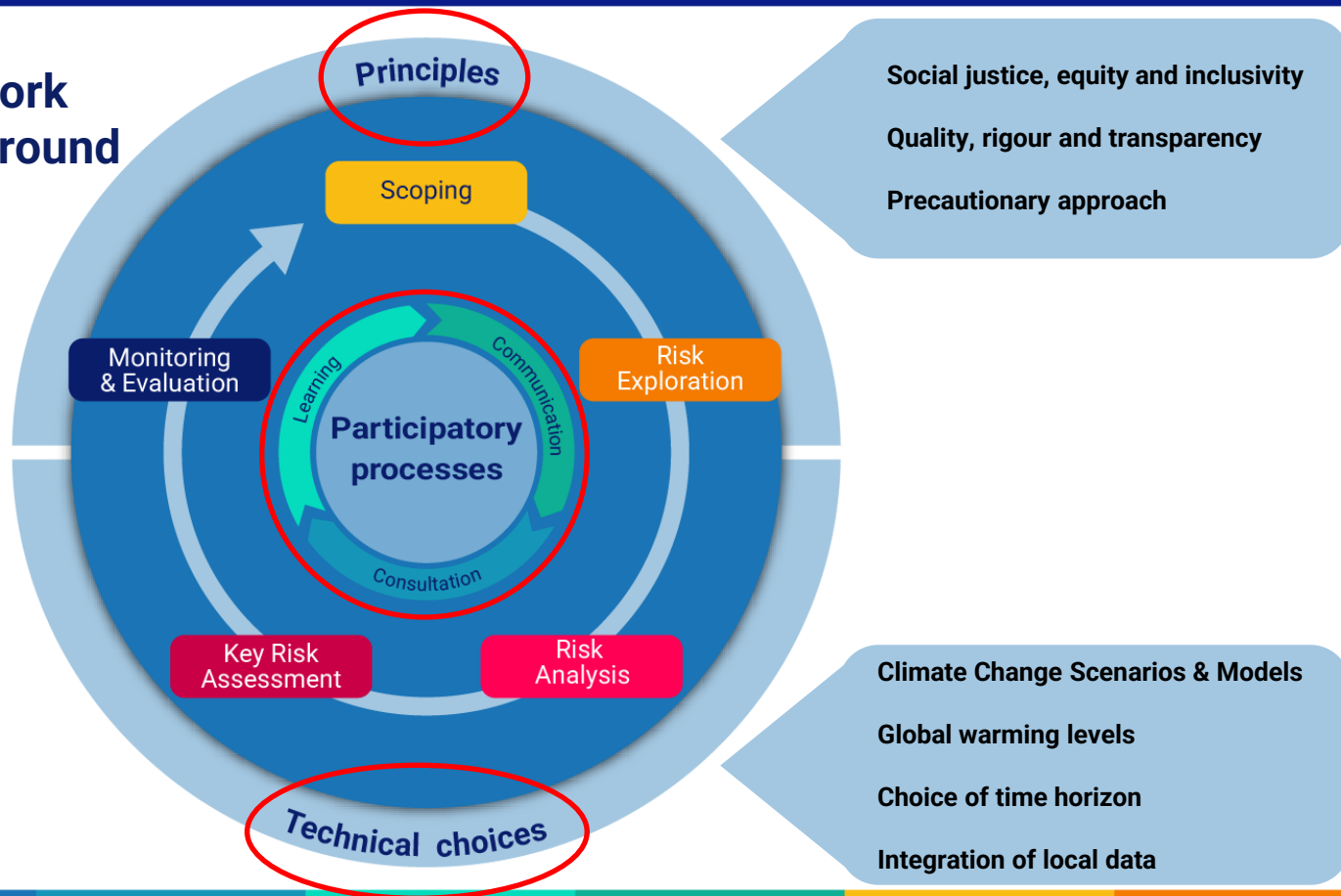
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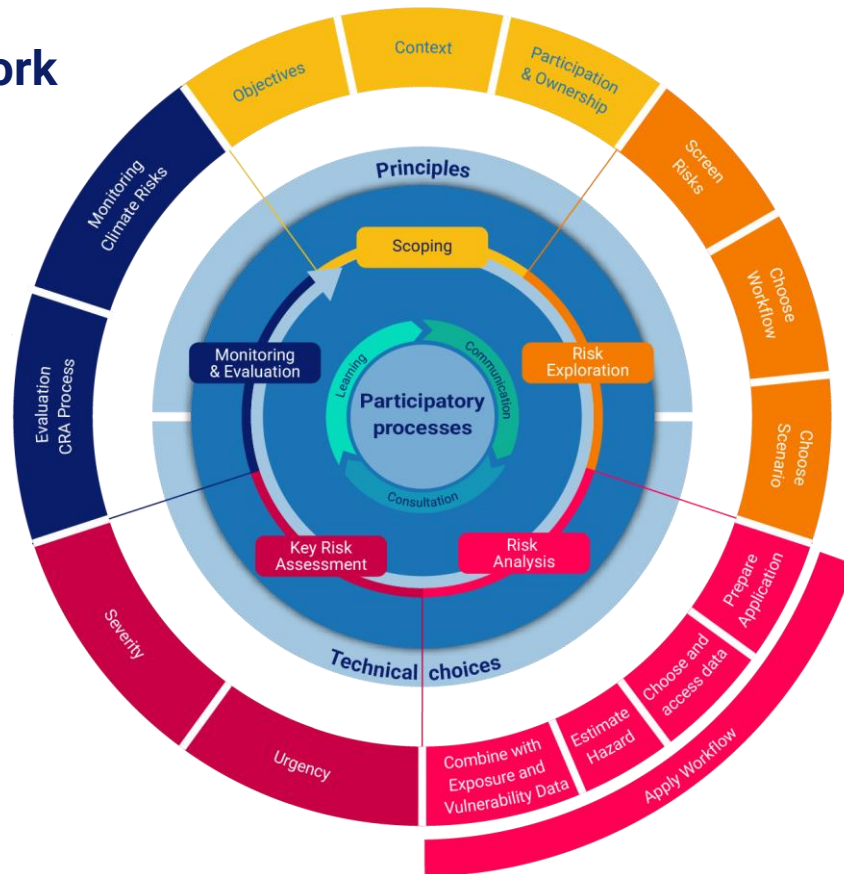
CLIMAAX Framework Conceptual Background



CLIMAAX Framework Conceptual Background



CLIMAAX Framework and substeps



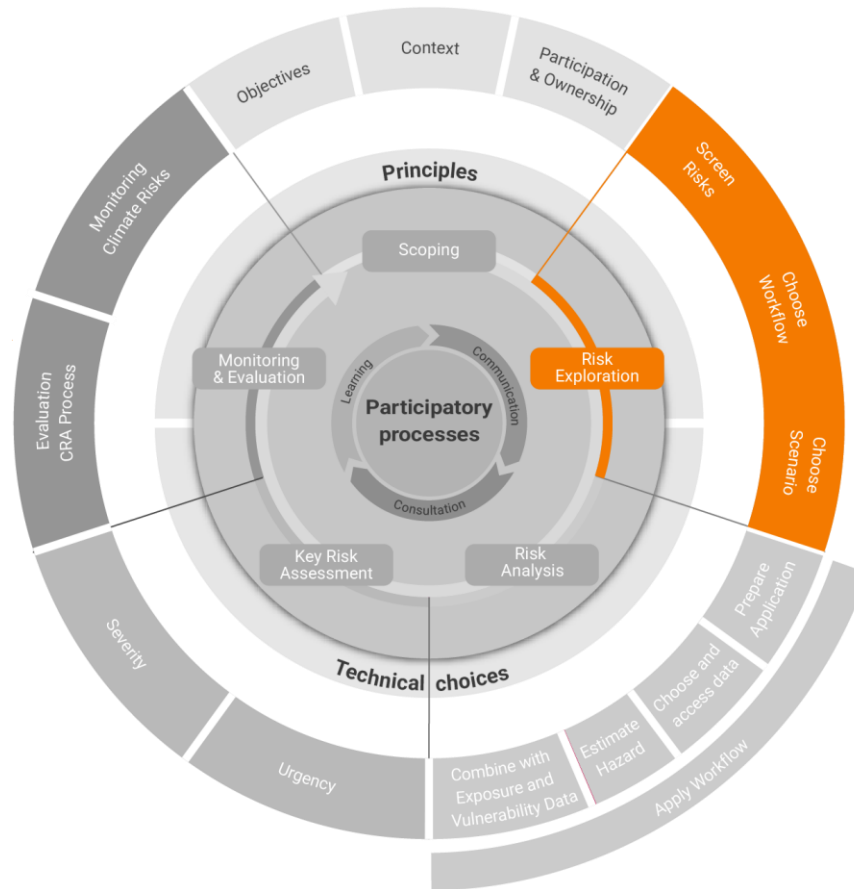
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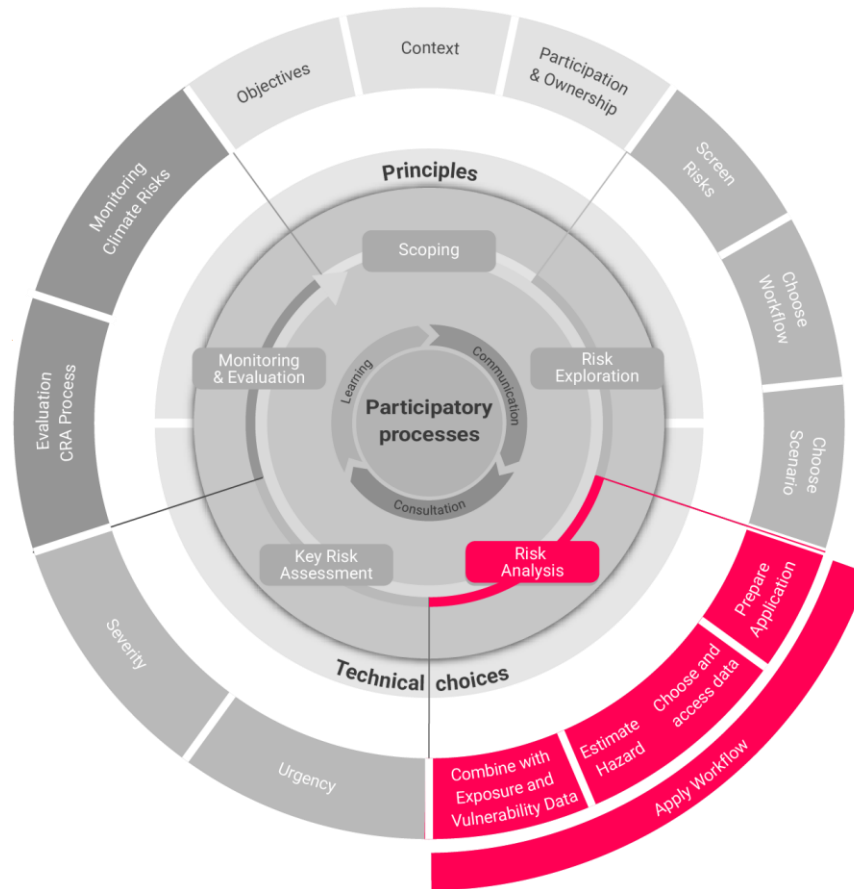
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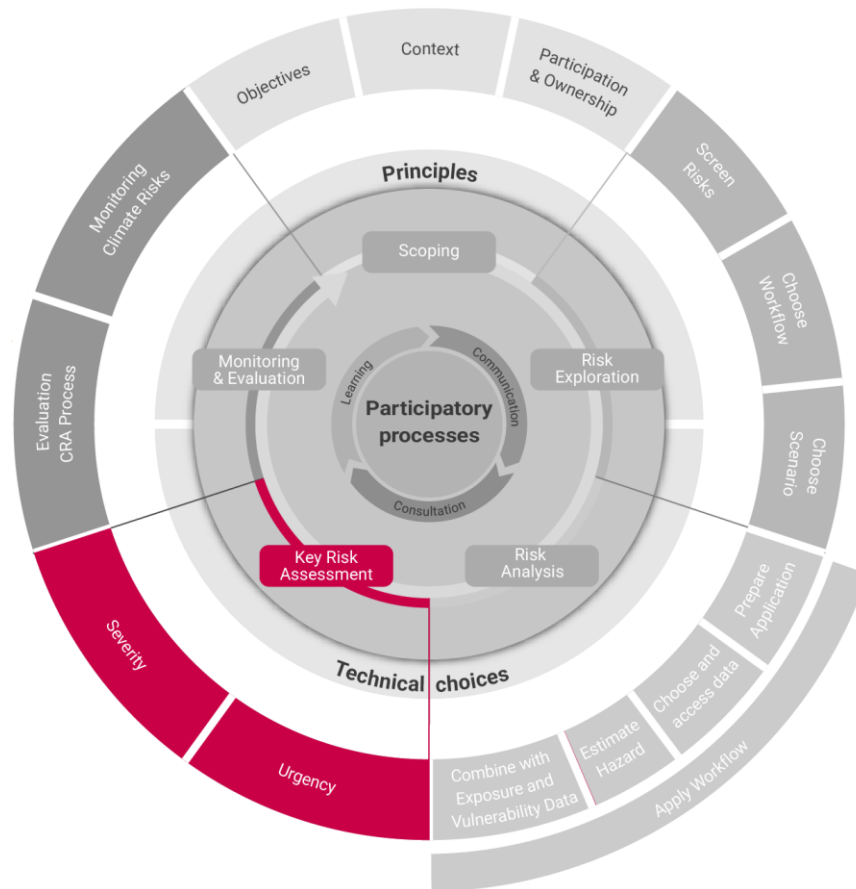
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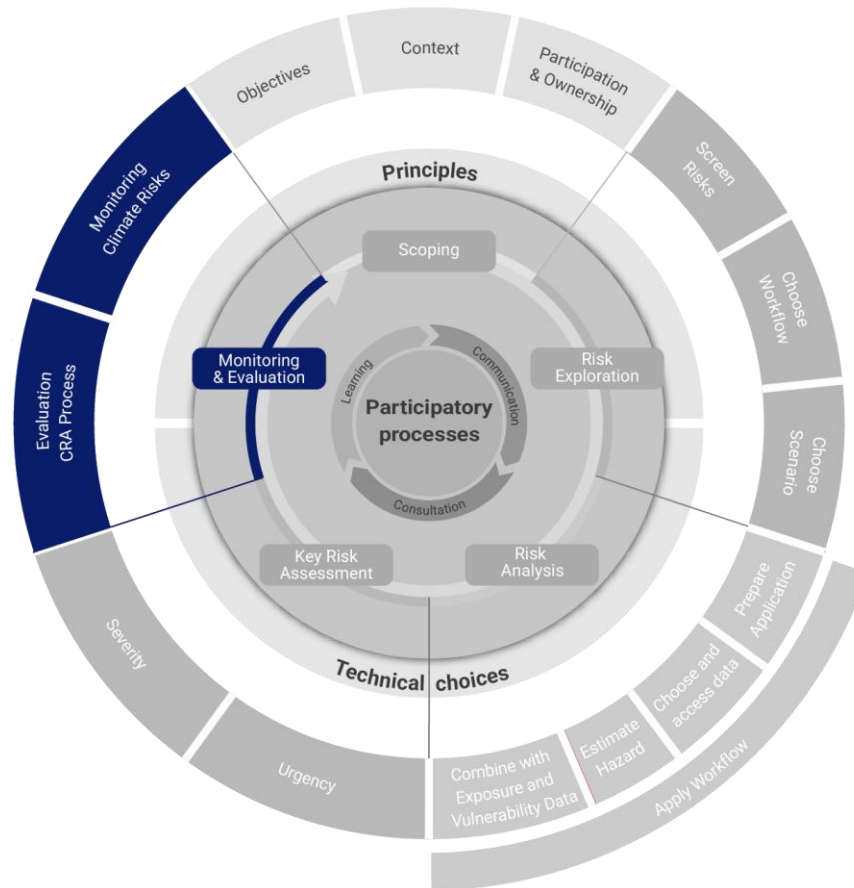
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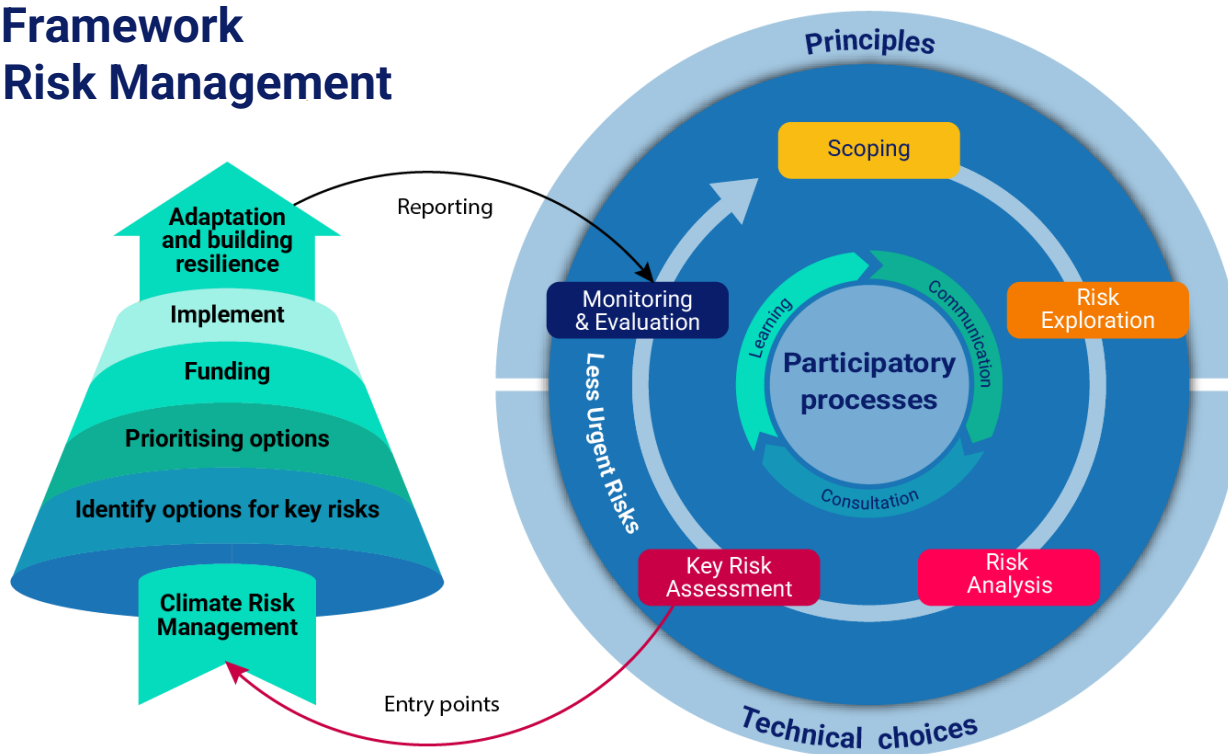




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CLIMAAX Framework & Climate Risk Management



Assessing climate future information

Anna Pirani, Jeremy Pal, Gloria Mozzi, Davide Serrao, Majid Niazkar
CMCC @Ca'Foscari (Venice)

Handbook webinar
4 July 2024



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Treatment of climate risk in the context of climate change



Larger magnitude



Increased frequency



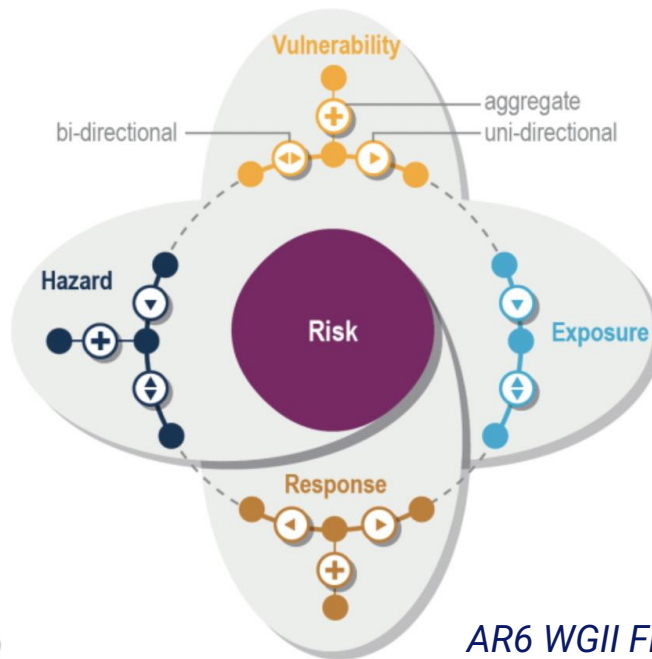
New locations



Different timing



New combinations (compound)



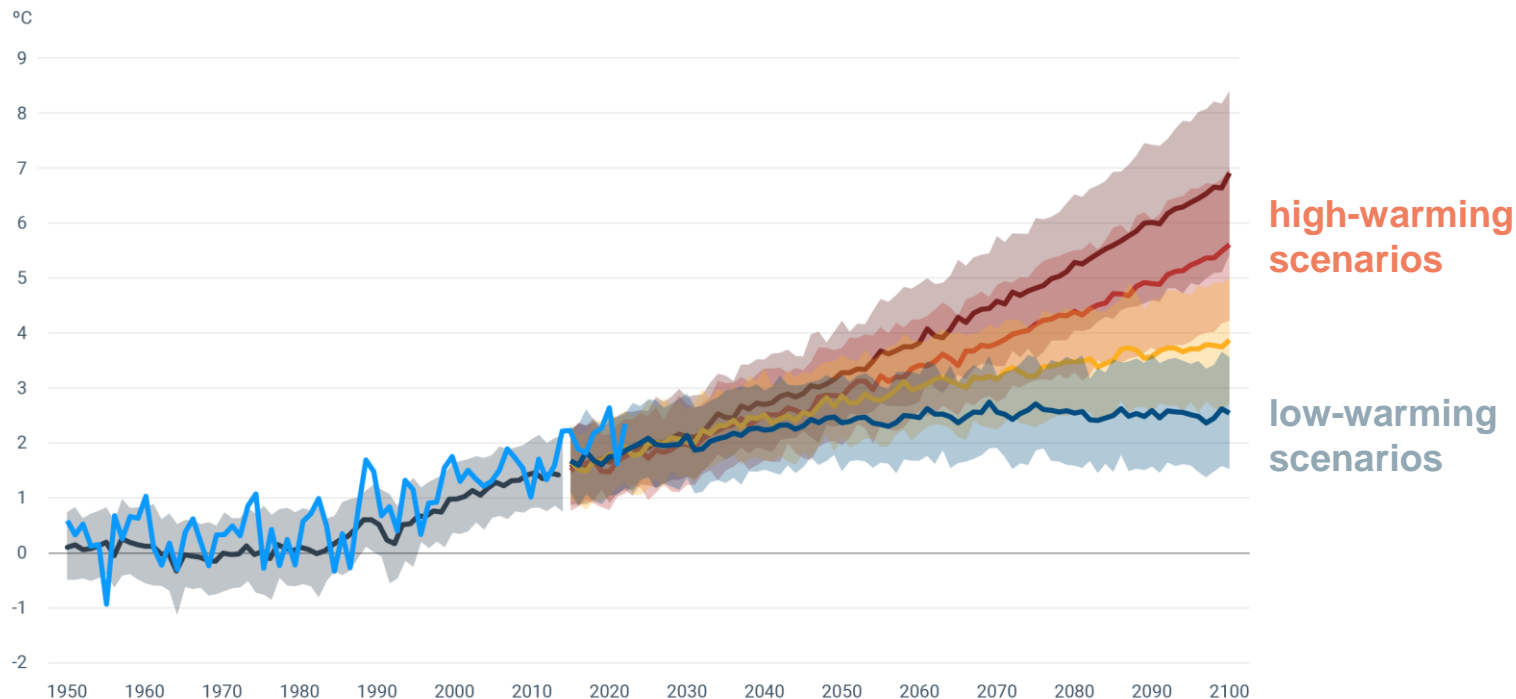
Linking

- multiple climatic impact-drivers,
- societal and ecosystem vulnerabilities and exposure,
- consequences of responses to climate change.

AR6 WGII Figure 1.5b, IPCC AR6 risk framework (Reisinger et al., 2020)



Which scenario? How much will Europe warm in this century?



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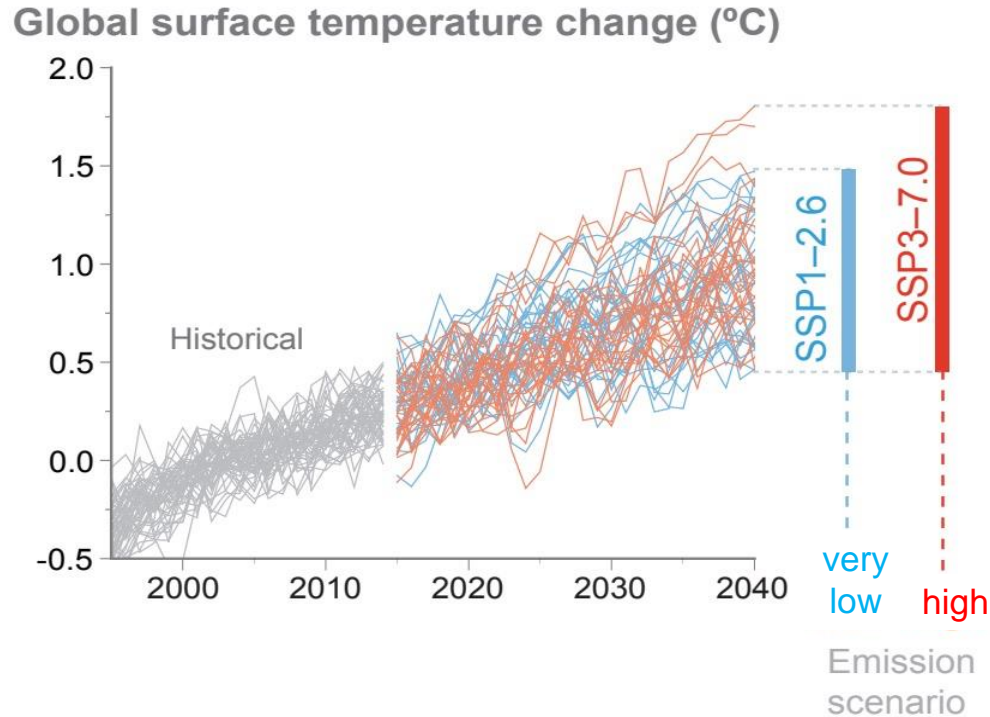


What to consider when choosing climate change scenarios?

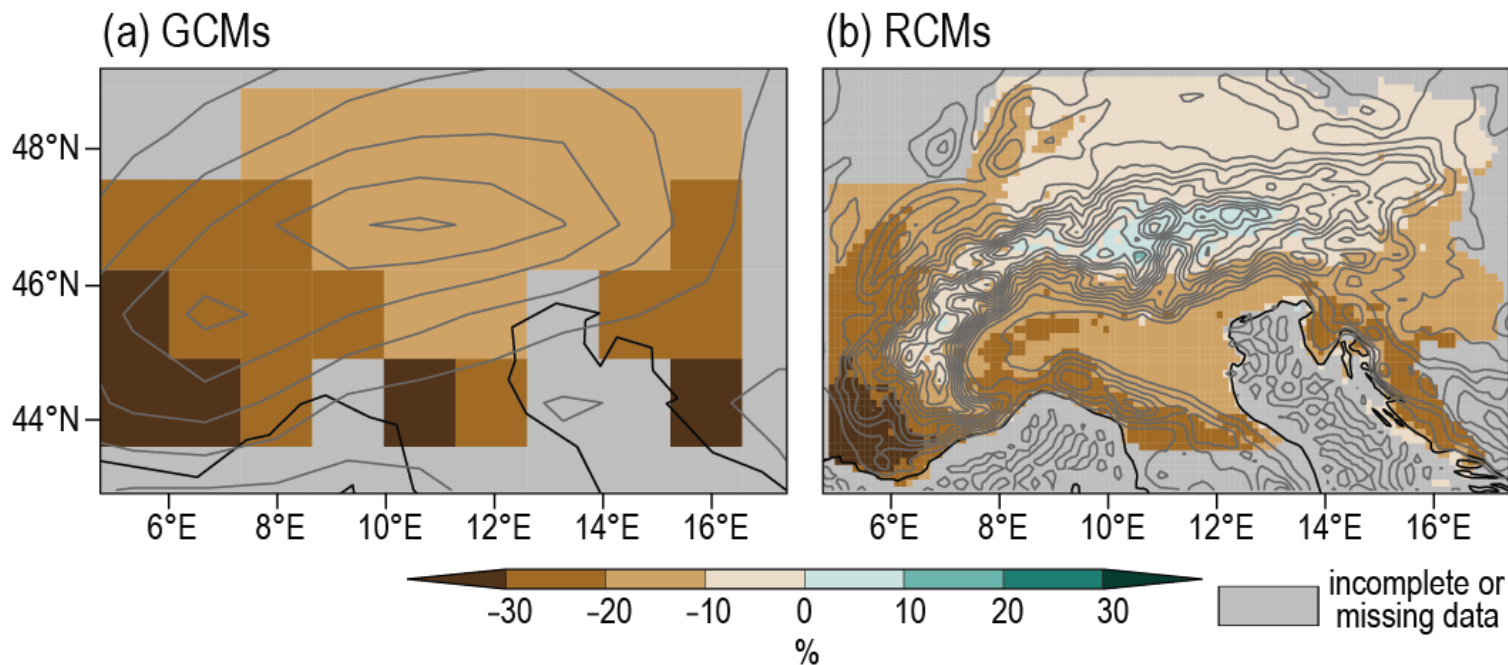
- High or very high-end emissions scenarios can be explored to assess future high-risk outcomes.
- Comparison of projected changes (anomalies) to pre-industrial, historical conditions, or a low-end emissions scenario can be helpful as a baseline to assess current and future conditions.
- Comparison with more moderate risk outcomes, and the related implications for adaptation strategies, expected from low-end emissions scenarios may also be beneficial.



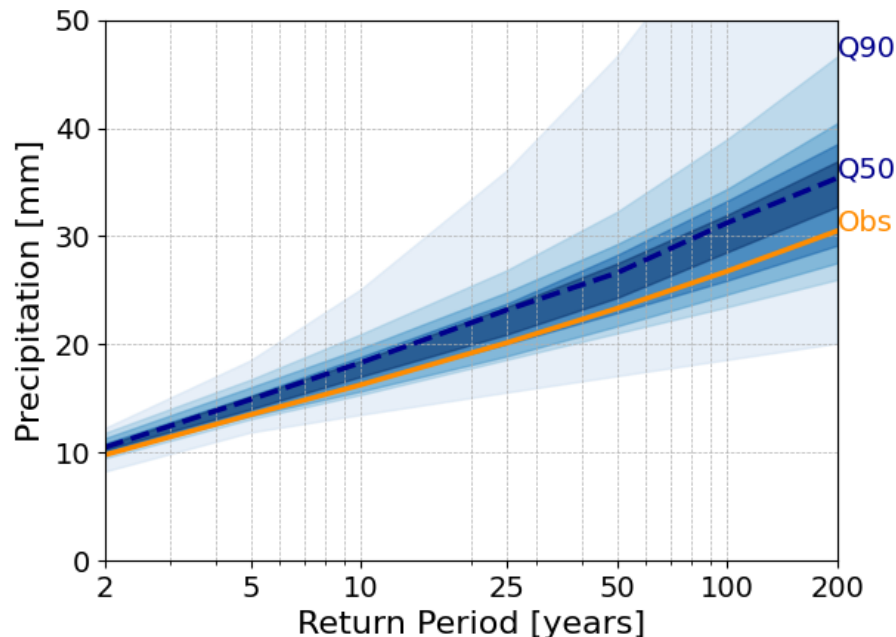
How to promote action now if in the near-term scenarios do not show big differences with the present situation?



Which limitations to consider when using climate models at local scales?



How should uncertainty be communicated?



An ensemble of model projections should be used to explore possible future regional climate.

- The median of the models (Q50) can be considered a best estimate.
- The spread indicates the uncertainty.
- The upper bound of the ensemble (e.g. Q90) can indicate a possible “worst case” outcome.

EURO CORDEX-11: Downscaled, 12.5-km, bias adjusted. 33 Ensemble members



How can we develop “reliable” or “complete” regional climate information?

- Assemble all relevant lines of evidence relevant to assess changes in hazards.
- Study regional climate changes.
- Assess the robustness of regional climate change information based on multiple lines of evidence.



CLIMAAX Handbook

Christopher Polster, Milana Vučković, Fredrik Wetterhall
ECMWF

Handbook webinar
4 July 2024



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CLIMAAX
climate ready regions

Website: handbook.climaax.eu

- **Climate Risk Assessment (CRA) resource**
- Created by CRA experts
- Conceptual and technical guidance
- Experience from participating regions
- **Working document**

Regional Climate Risk Assessment Resources

Navigating Climate Risk Assessments (CRA): CLIMAAX guides you through your regional Climate Risk Assessments and provides you with tools and datasets for the assessment.

Apply now to receive funding for your regional Climate Risk Assessment

Do you have an up-to-date climate risk assessment for your region?

A regional climate risk assessment is often needed to design or update a climate adaptation and/or risk management plan. Regular updates are needed considering changing climate risk profiles!

HAZARD + EXPOSURE + VULNERABILITY = RISK

Changing trends in climate hazards (extreme weather or hydrological conditions)

Changing exposure (due to evolving land use or infrastructure layout)

Changing vulnerability patterns (due to dynamic population structures)

Before starting your climate risk assessment, it is recommended to make an inventory of potential hazards affecting your region and sketch the policy context where the CRA will be used.



CLIMAAX Framework

Step-by-step with

- Descriptions
- Illustrations
- References
- Guiding Questions



Q Search [x] [+ K]

About us

The CLIMAAX project
Funding opportunities

CRA Steps

What is the CLIMAAX Framework?
Before you start
Scoping
Risk Exploration
CRA Datasets
Risk Analysis
Key Risk Assessment
Monitoring and Evaluation
Connect CLIMAAX with Climate Risk Management

Risk workflows

How to use risk workflows

- RIVER & COASTAL FLOODS
- HEAVY RAINFALL
- HEATWAVES
- DROUGHTS
- FIRE
- SNOW
- WIND

Resources

Coding resources
Glossary



Risk Exploration



Carrying out the Risk Exploration step kicks off a comprehensive process that starts with identifying hazards and risks that are most apparent or of significant concern to key stakeholders and the wider public. Leveraging current knowledge, including insights from experts and stakeholders identified in the scoping phase, allows a first identification of impacted sectors (including activities, supply chains, processes, and infrastructure) and geographic areas at risk (such as ecosystems, landscapes, and communities). It is useful for stakeholders to consider past and ongoing impacts on different sectors, areas and vulnerable groups, and connect them to specific hazards and risks to make "risk" more tangible at this early stage of the CRA process. A deeper dive into the system aspects may concretize affected entities (key systems, elements, sectors, communities, social groups, sub-regions), functions or processes that hold significant value in the local context (e.g. stakeholder interests, community priorities or public agenda) and a priori reveal (transboundary) connections or dependencies. These considerations are key for exploring risk in more depth and to choose Risk Workflows. From this step, potential risks can be narrowed down and prioritized by broadly exploring hazards, exposures



Contents

Guiding questions

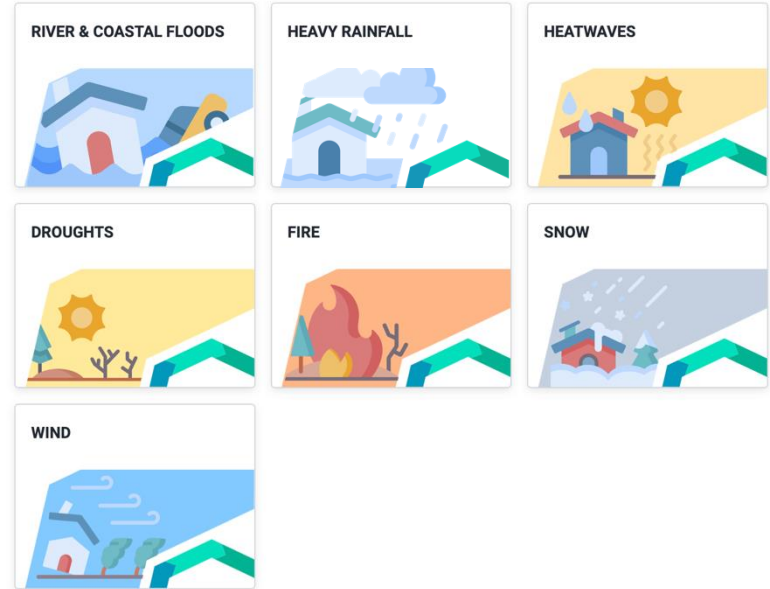
- How is the scoping phase applied? Which parts of the scoping phase are relevant for the workflow and scenario selection?
- How does the existing stakeholder knowledge come into play?



CLIMAAX Workflows

- Implementation of **Risk Analysis**
- Risk = Hazard × Exposure × Vulnerability

- Grouped **by hazard**
- **Starting point**, building blocks, examples
- **To be adapted to the local context**



CLIMAAX Workflows: Structure

Introduction to risk assessment for coastal flooding

The causes of coastal flooding

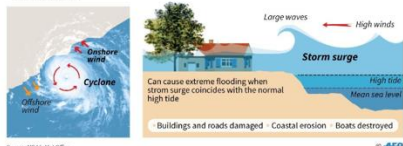
Coastal flooding is one of the most damaging hazards in coastal areas. Coastal flood risk is expected to increase under the pressures of sea level rise (SLR), climate change and growth of population in coastal regions. A good understanding of which areas are prone to coastal flooding, and how this may change in the future will be instrumental in identifying appropriate mitigation and adaptation strategies.

Coastal flooding can be caused by high coastal water levels, driven by tide and storm surges, and further increased by sea level rise. Storm surges in particular can vary greatly depending on the atmospheric conditions. Storm surge is increased when wind pushes the ocean water towards the land resulting in elevated water levels.

Storm surge

Cyclone winds can be deadly, but surging water levels can also threaten life

- High winds push sea water towards the coast
- The cyclone makes landfall, water has nowhere to go but inland



Source: NOAA, Met Office

Fig. 14 Illustration of extreme water levels and storm surge. Credits: NOAA, MetOffice

Risk assessment methodology

How is risk calculated?

The risks from coastal flooding can be assessed by analyzing extreme water levels at the coast, constructing

Introduction

Visualize coastal flood hazard dataset

Now we can compare the maps of flood potential in different scenarios and with different return periods. We will plot the maps next to each other.

```
# define upper limit for inundation depth for plotting
inun_max = 7 # np.nanmax(floodmaps.sel(year>2050, return_period=250)['inun'].values)

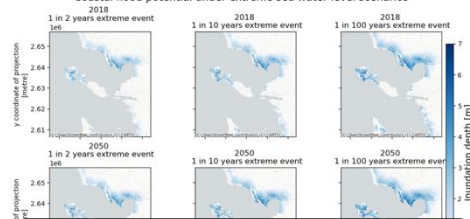
# select return periods to plot
rps_sel = [2, 10, 100]

fig, axs = plt.subplots(figsize=(10, 10/len(rps_sel)*2), nrows=len(years), ncols=len(rps_sel),
                          for rr, rp in enumerate(rps_sel):
    bs=floodmaps.sel(year=year, return_period=rp)['inun'].plot(ax=axs[yy,rr], vmin=0, vmax=inun_max)
    ctx.add_basemap(axs[yy,rr], crs=floodmaps.rio.crs.to_string(), source=ctx.providers.CartoDB.Positron)
    axs[yy,rr].set_title(f'{year} \n 1 in {rp} years extreme event', fontsize=12)
    if rps==2:
        axs[yy,rr].yaxis.label.set_visible(False)
    if yy==0:
        axs[yy,rr].xaxis.label.set_visible(False)

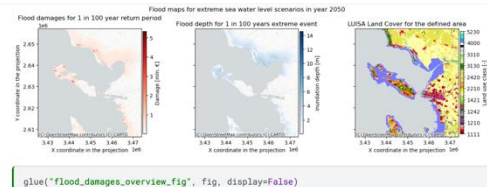
fig.colorbar(bs, ax=axs[0,0], orientation='vertical', pad=0.01, shrink=0.9, aspect=30).set_label('Inundation depth [m]')
fig.suptitle('Coastal flood potential under extreme sea water level scenarios', fontsize=16);

fileout = os.path.join(plot_dir, 'Floodmap_{}_overview.png'.format(areaname))
fig.savefig(fileout)
```

Coastal flood potential under extreme sea water level scenarios



Hazard assessment



```
glue("Flood_damages_overview_fig", fig, display=False)
```

Here we see both the potential flood depths and the associated economic damages. This overview helps to see which areas carry the most economic risk under the flooding scenarios.

Make sure to check the results and try to explain why high damages do or do not occur in case of high inundation. Find that something is wrong? Reiterate your assumptions made in the [LUISA_damage_info_curves.xlsx](#) and run the workflow again.

Conclusions

Now that you were able to calculate damage maps based on flood maps and view the results, it is time to revisit the information about the accuracy and applicability of global flood maps to local contexts (see section [Global Flood Maps dataset and its applicability for local risk assessment](#) in the risk workflow description).

Consider the following questions:

- How accurate do you think this result is for your local context? Are there geographical and/or infrastructural factors that make this result less accurate?
- What information are you missing that could make this assessment more accurate?
- What can you already learn from these maps of coastal flood potential and maps of potential damages?

Important

In this risk workflow we learned:

- How to access use European-scale land use datasets.
- How to assign each land use with a vulnerability curve and maximum damage.

Risk assessment



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CLIMAAX Workflows: Implementation

- **Python** programming language
- Jupyter notebooks
 - Data retrieval, processing and visualization
 - **Documentation, code and output** in one place
- Standard data formats



Note

The risk category for each region is always relative to the other regions considered in the workflow (here: country level) and therefore not directly comparable between datasets. This means that the risk category of one region may be higher or lower compared to the other regions, but not between e.g. historical vs. future datasets. Please refer to the risk assessment workflow for more details on how drought risk is calculated.

```
x_nuts, y_nuts = gpd.GeoSeries(nuts.geometry).unary_union.centroid.xy
selected = nuts.loc[nuts['NUTS_ID'].str.slice(0,4) == focal, 'NUTS_ID']

fig = px.choropleth_mapbox(df_, geojson=nuts.geometry, locations='Location', color='risk_cat',
    animation_frame = "data", color_continuous_scale="reds", range_color = [1,
    mapbox_style="open-street-map"])

# Customize line properties for selected polygons
fig.update_geos(fitbounds="locations", visible=False)

fig.update_layout(title="Current and projected drought risk",
    mapbox_center = {"lat": list(y_nuts)[0], "lon": list(x_nuts)[0]},
    mapbox_zoom=4,
    height=700,
    coloraxis_colorbar=dict(
        title="Risk category",
        tickvals = [1, 2, 3, 4, 5],
        ticktext = [1, 2, 3, 4, 5]
    ))

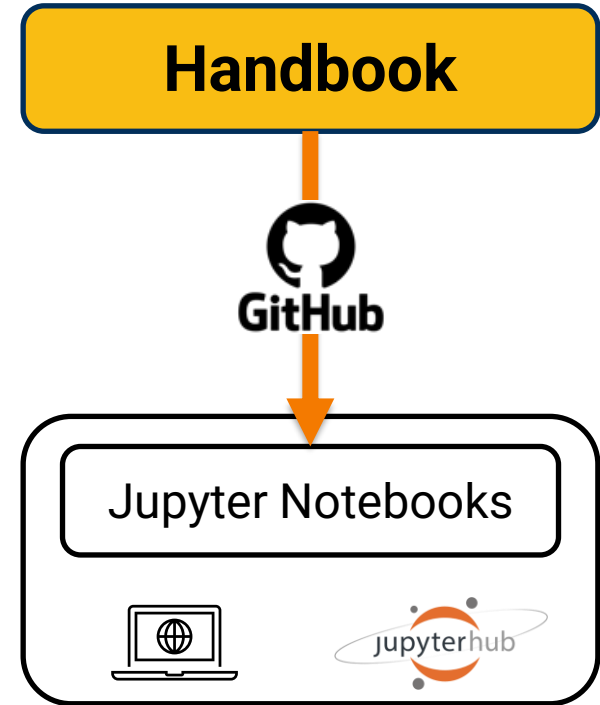
fig.show()
```

Current and projected drought risk



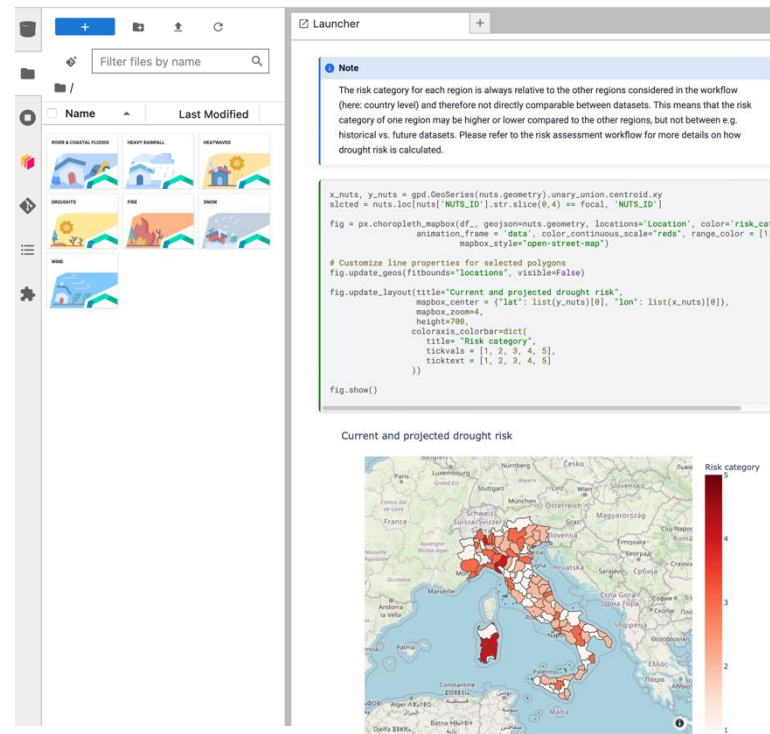
CLIMAAX Workflows: How To Run

- Available from **GitHub**
- **All open-source software**
(no licenses required!)
- Environments:
 - **Local computer**
 - **(CLIMAAX) JupyterHub**



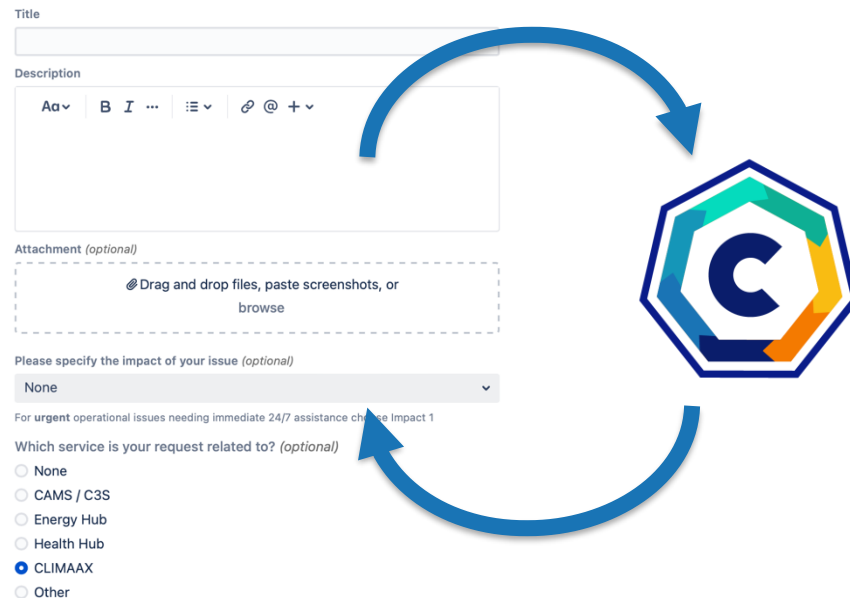
CLIMAAX JupyterHub

- **Computing and storage** in the cloud
- Maintained by CLIMAAX
- **Ready-to-use** environment:
 - Software preinstalled
 - Workflows prepared
- Upload your **own data**



CLIMAAX Support

- **Support desk** for JupyterHub, Workflows and Framework
- Forum (public)
- GitHub
- Handbook documentation

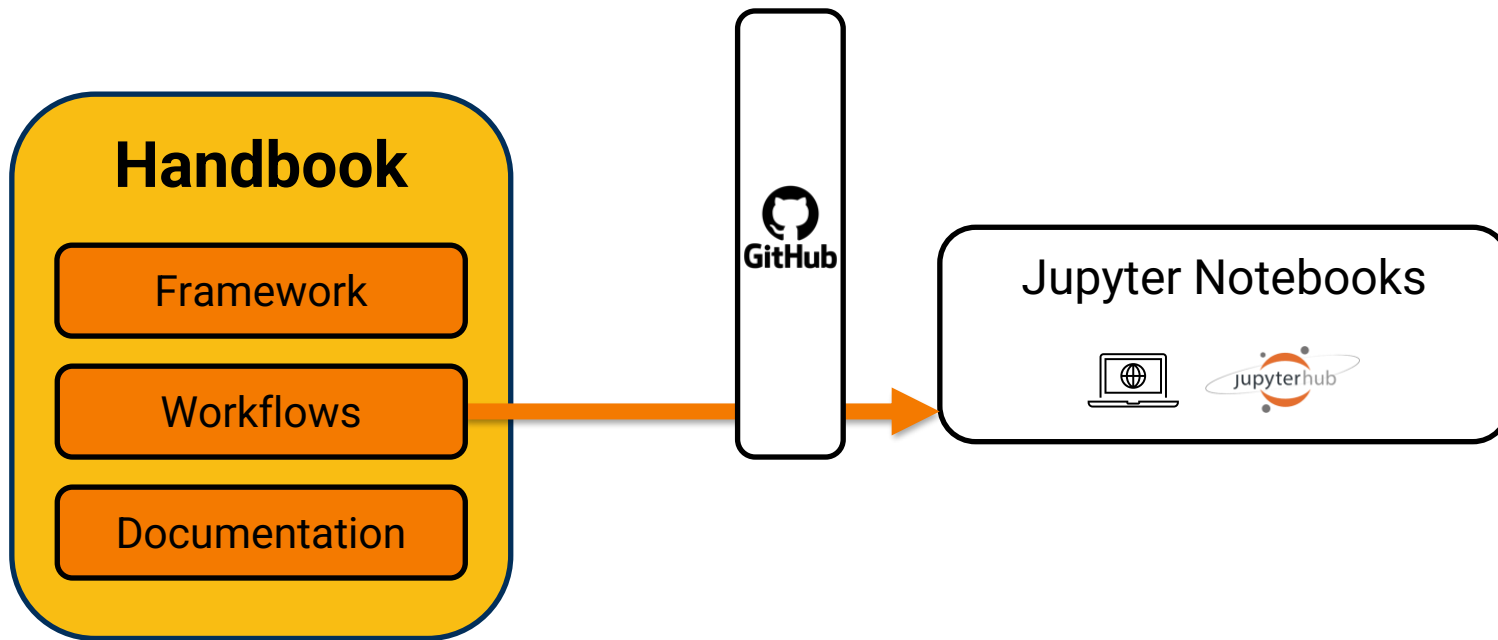


The image shows a screenshot of a support ticket form. The form fields include: Title, Description (with a rich text editor toolbar), Attachment (optional) with a dashed border and a prompt to drag and drop files, a dropdown menu for 'Please specify the impact of your issue (optional)' currently set to 'None', and a radio button selection for 'Which service is your request related to? (optional)'. The 'CLIMAAX' option is selected. A large blue circular arrow diagram is overlaid on the form, pointing from the 'CLIMAAX' radio button to the CLIMAAX logo on the right, which is a stylized 'C' inside a hexagon with colored segments.

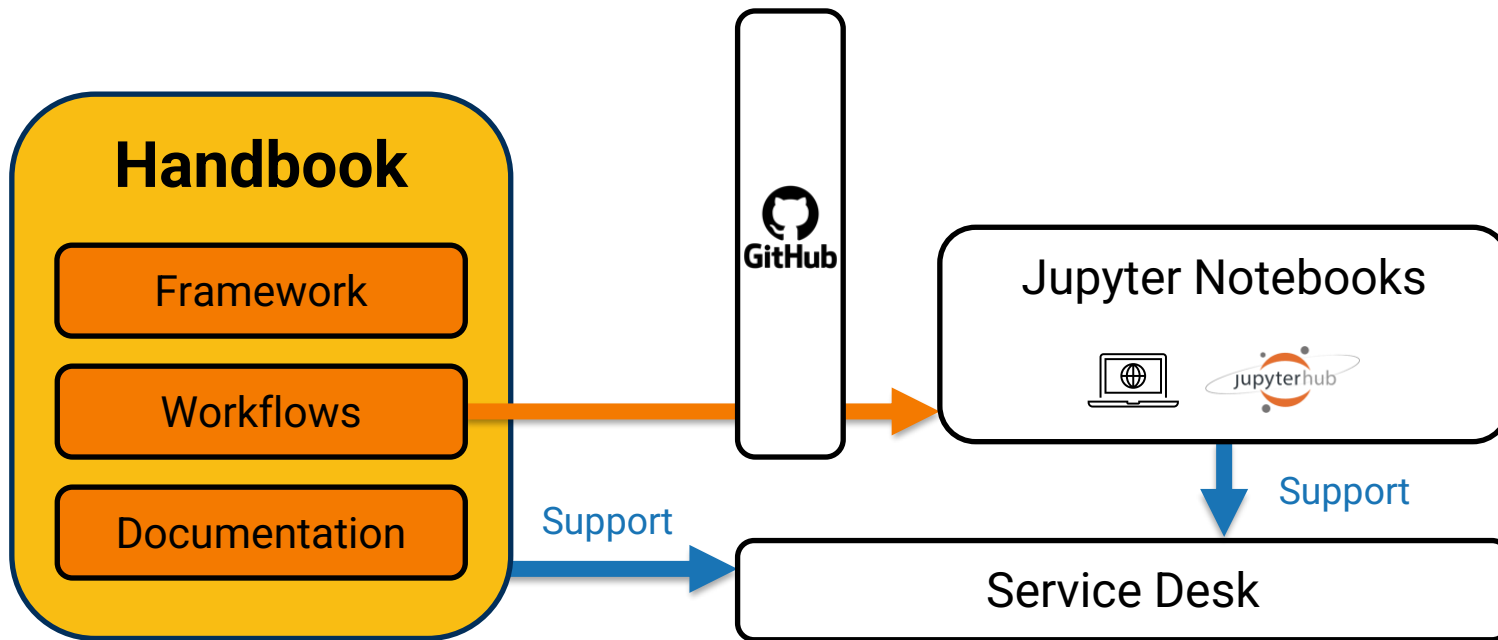
Introduction provided separately



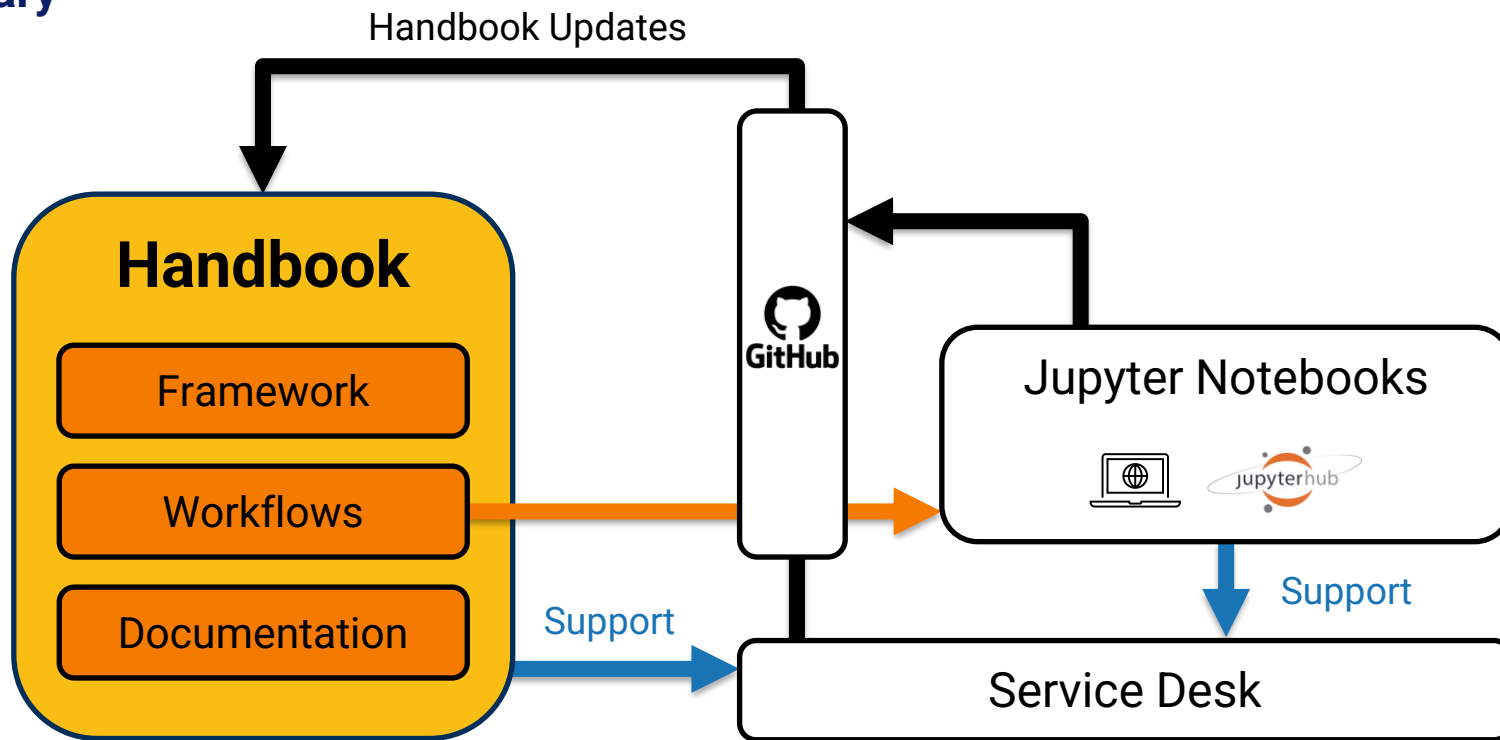
Summary



Summary



Summary



Estimating changes in Heavy Rainfall

Catalonia Regional example

Erika Meléndez

Universitat Politècnica de Catalunya

Handbook webinar

4 July 2024



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climate ready regions

HEAVY RAINFALL



Terrassa, Spain 2023



Terrassa, Spain 2023



Blanes, Spain 2015



In a Climate Change Scenario

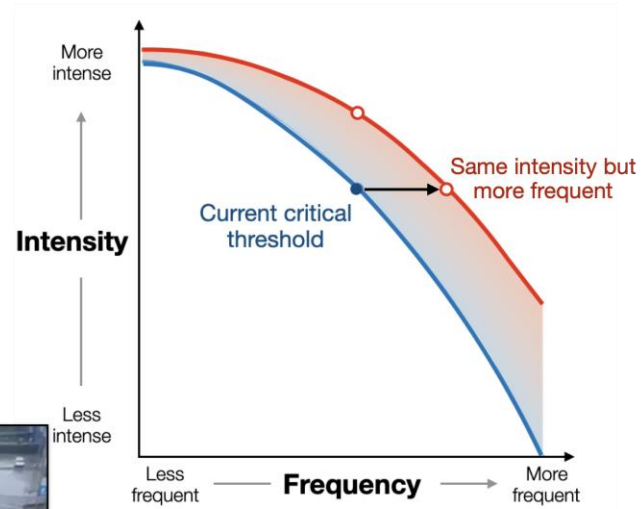
T > 10 years

30 mm/ 30 min



T > 2 years

30 mm/ 30 min



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In a Climate Change Scenario

T > 10 years

30 mm/ 30 min

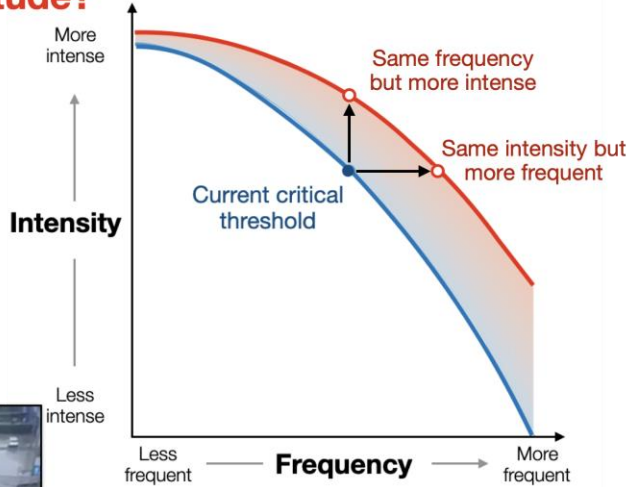


How do we manage the expected **change in frequency and magnitude?**

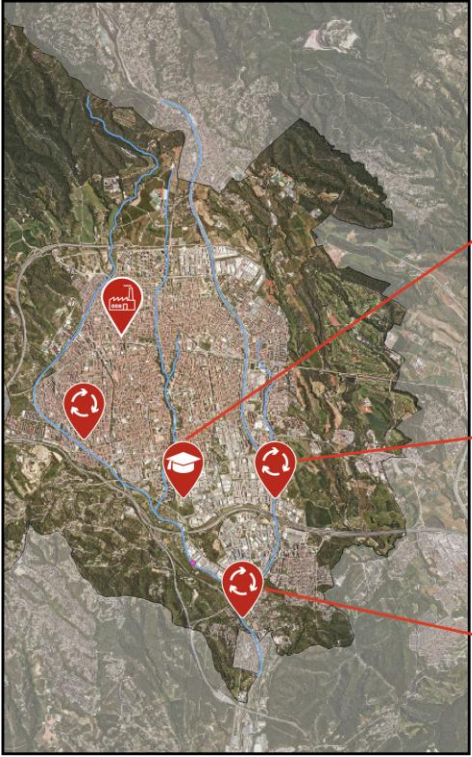


T > 10 years

45 mm/ 30 min



In a Climate Change Scenario



**35
mm/ 30 min**



**30
mm/ 30 min**



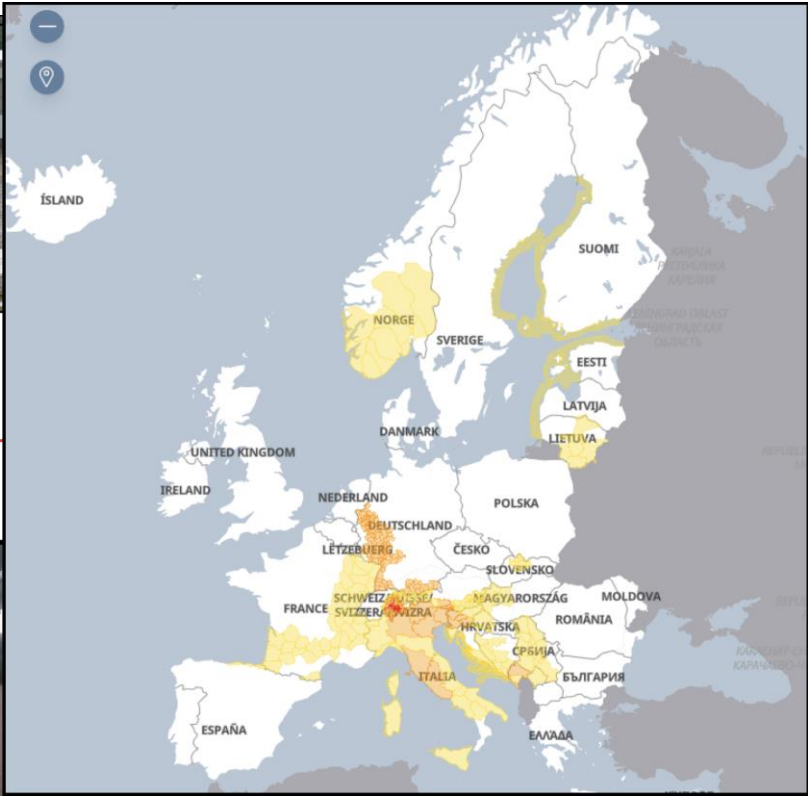
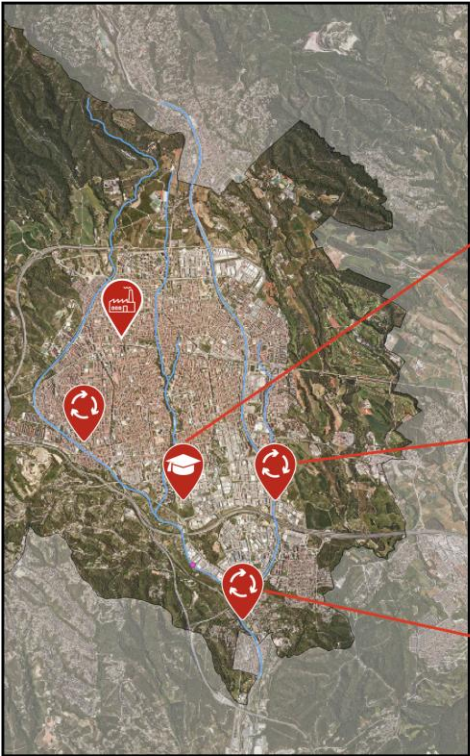
T > 10 years



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In a Climate Change Scenario



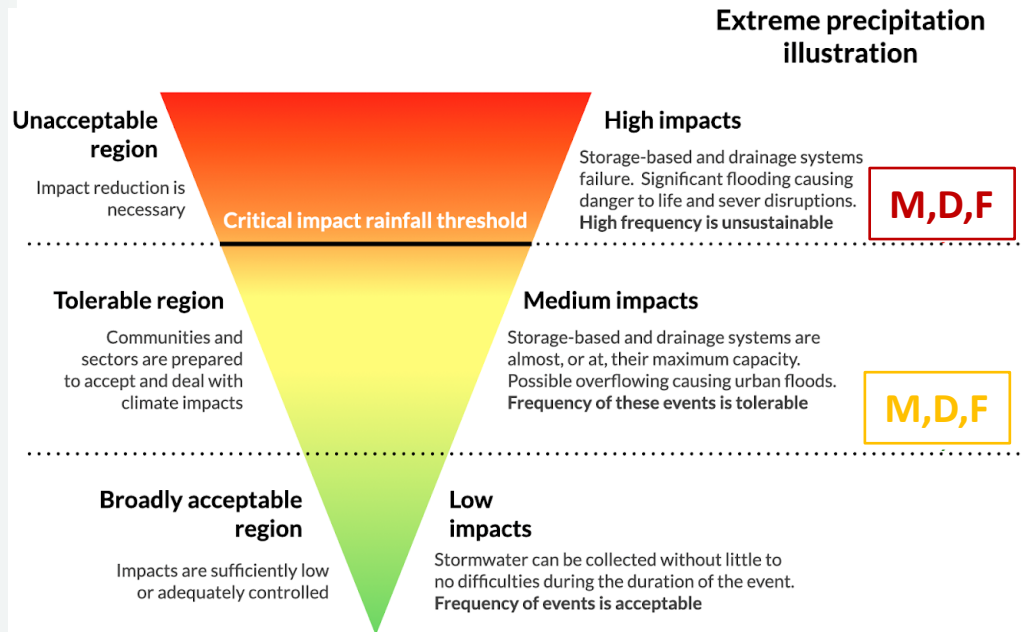
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Heavy rainfall workflow: Structure

1 Guidance on developing critical rainfall thresholds

In terms of **M**agnitude (mm), **D**uration (hrs) and **F**requency (T/return period)



Heavy rainfall workflow: Structure

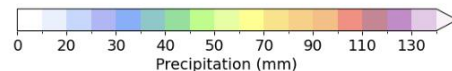
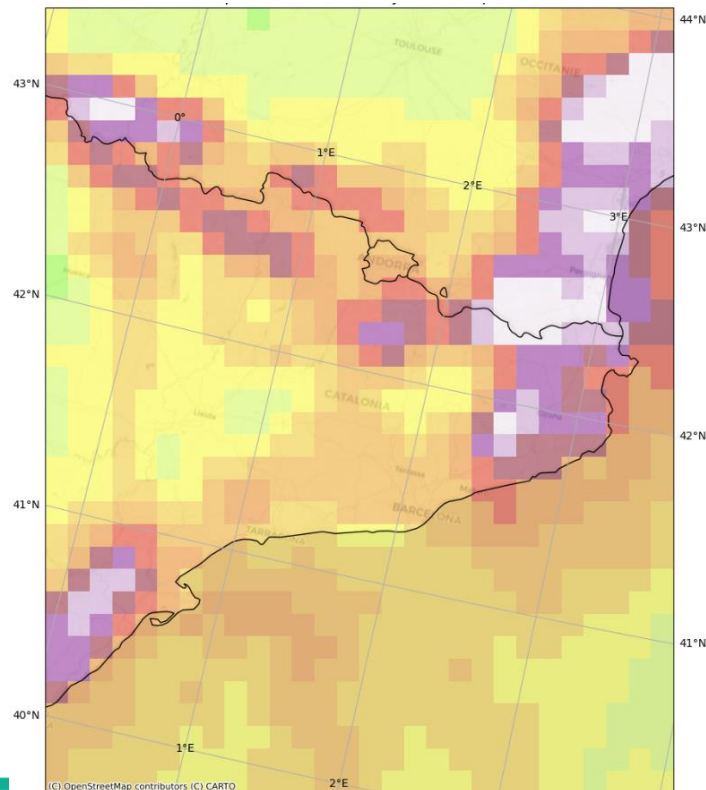
1 Guidance on developing critical rainfall thresholds

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

24-hour (**D**) Precipitation (**M**) for a 10-year return period (**F**) [1976-2005]



Heavy rainfall workflow: Structure

1 Guidance on developing critical rainfall thresholds

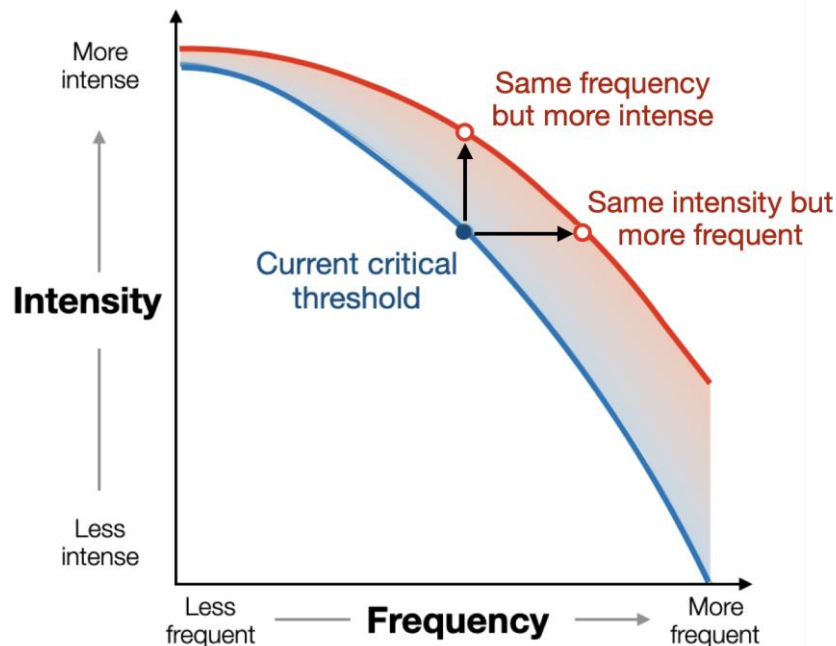
In terms of **M**agnitude (mm), **D**uration (hrs) and **F**requency (T/return period)

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?





Are Rainfall warning levels ready for climate change?

A Case Study in Catalonia, Spain



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- Catalonia is highly vulnerable to extreme rainfall events
- The Meteorological Service of Catalonia (SMC) issues warnings for Dangerous meteorological Situations due to rainfall using two critical thresholds:

Low risk

100 mm/24 hours

High risk

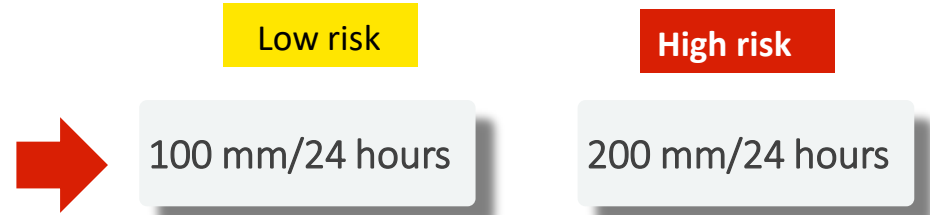
200 mm/24 hours

How will these critical rainfall thresholds vary in the context of climate scenarios?





- Catalonia is highly vulnerable to extreme rainfall events
- The Meteorological Service of Catalonia (SMC) issues warnings for Dangerous meteorological Situations due to rainfall using two critical thresholds:



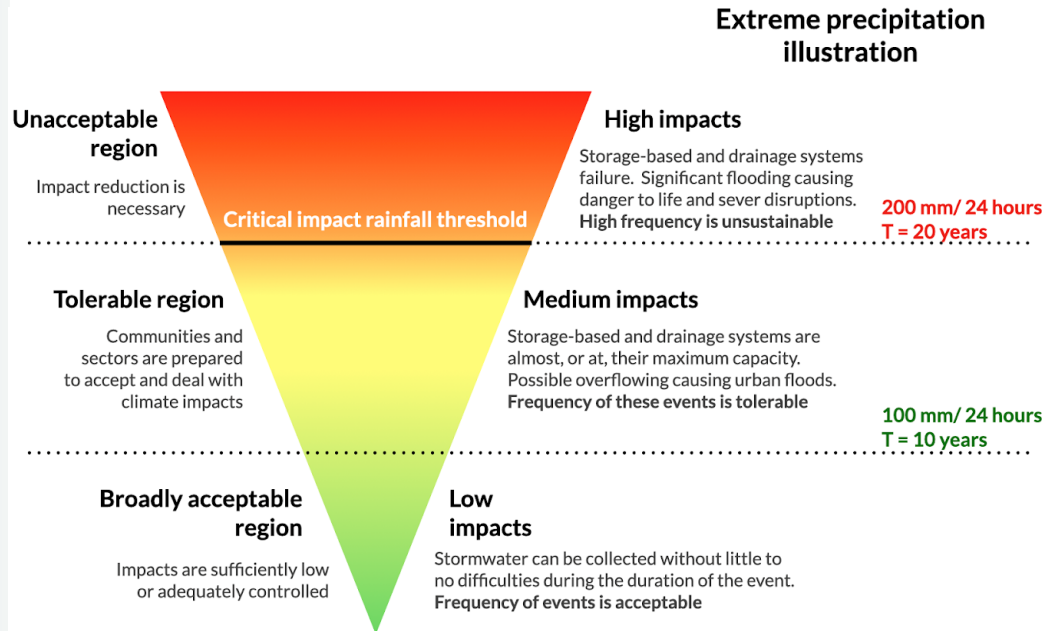
How will these critical rainfall thresholds vary in the context of climate scenarios?



Heavy rainfall workflow: Structure

1 Guidance on developing critical rainfall thresholds

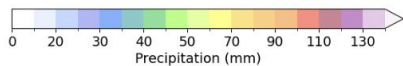
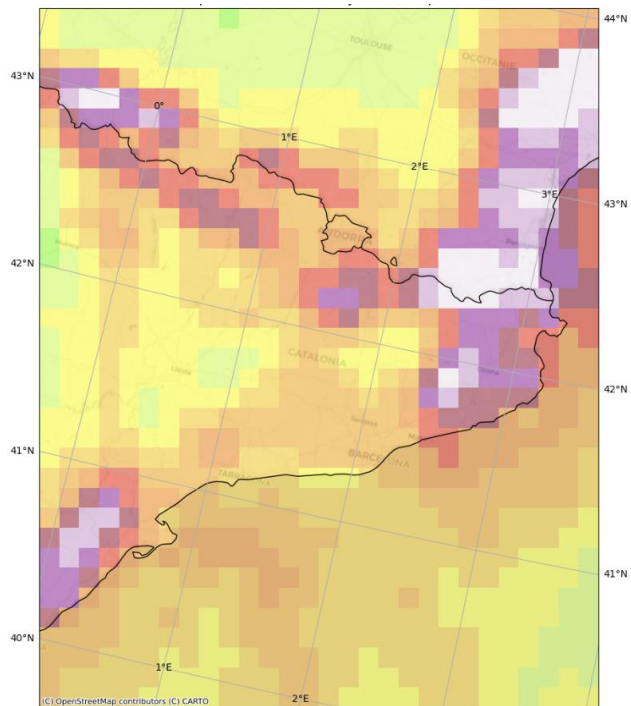
In terms of **M**agnitude (mm), **D**uration (hrs) and **F**requency (T/return period)



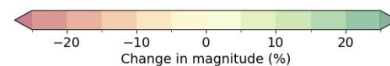
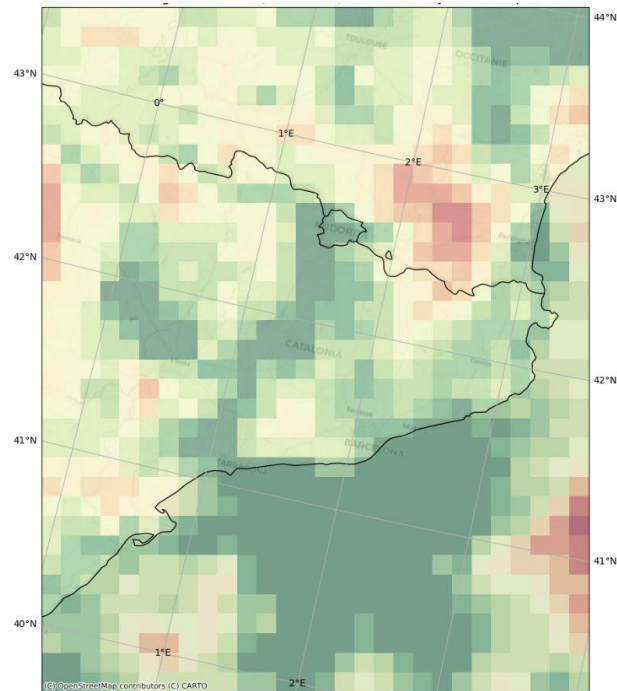
2 Calculating expected precipitation for different durations and frequencies

For current and future climate scenarios based on CORDEX

24-hour (D) Precipitation (M) for a 10-year return period (F) [1976-2005]



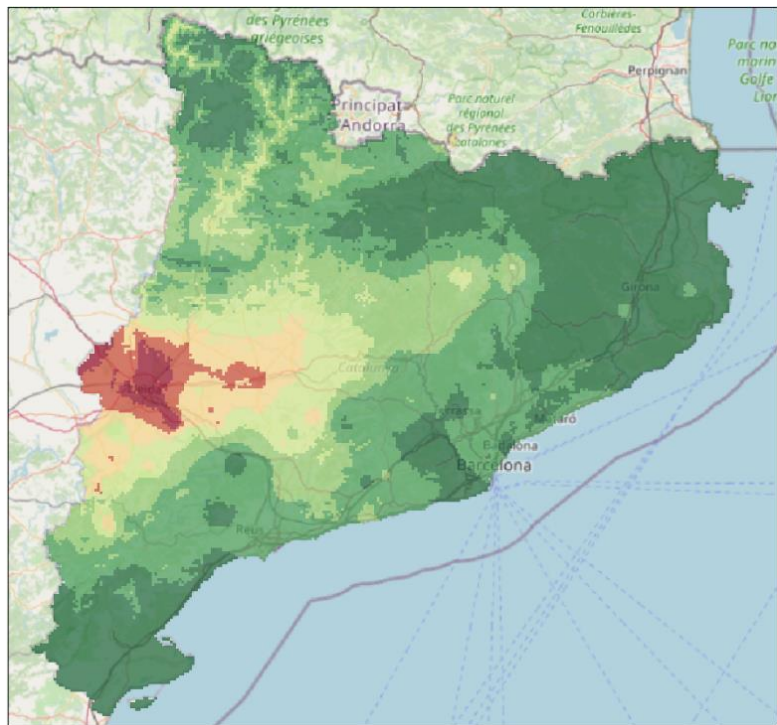
24-hour (D) Precipitation (M) for a 10-year return period (F) - Relative magnitude shift [2005 vs 2070]



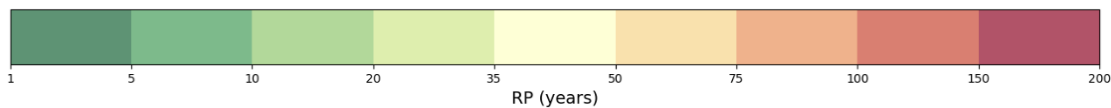
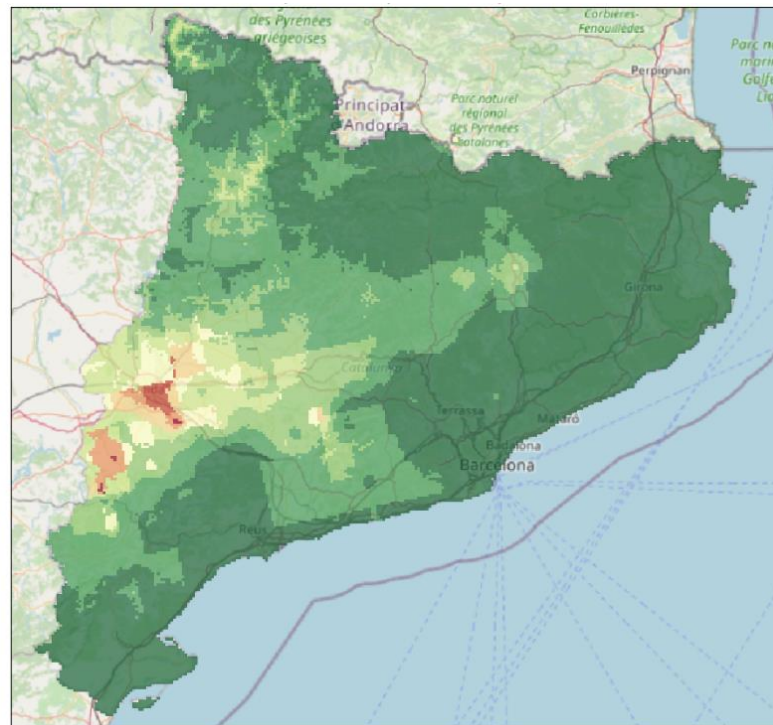
3 Assessing changes under climate scenarios

For current and future climate scenarios based on CORDEX

Return periods (F) for 100 mm/ 24 hours (M/D) [1976-2005]



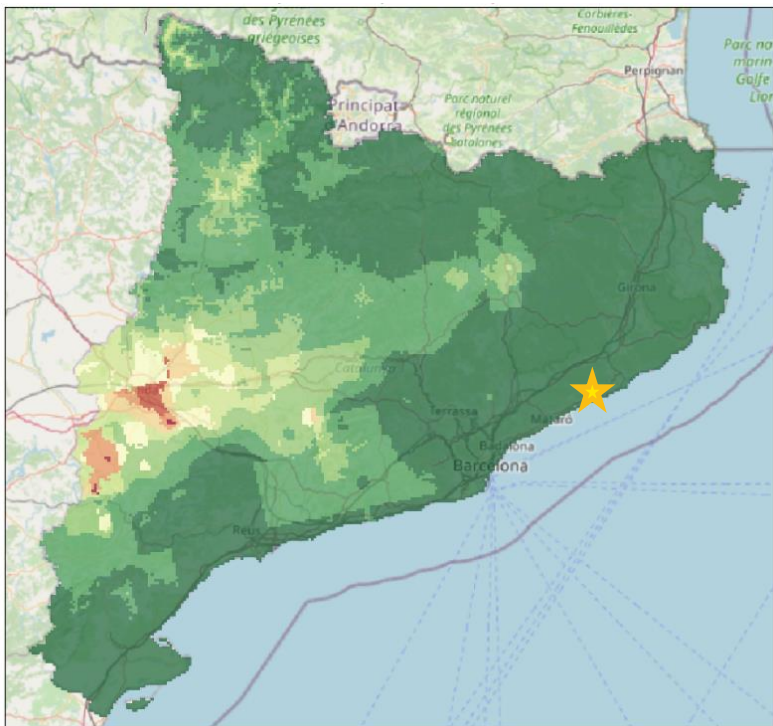
Return periods (F) for 100 mm/ 24 hours (M/D) [2041-2070, RCP 85]



3 Assessing changes under climate scenarios

For current and future climate scenarios based on CORDEX

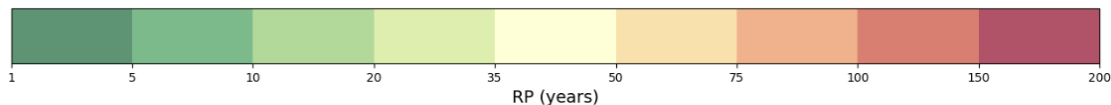
Return periods (F) for 100 mm/ 24 hours (M/D) [2041-2070, RCP 85]



Blanes

- For the period of 2041-2070, the critical rainfall threshold of 100 mm/24 hours, associated with a 5-year return period:

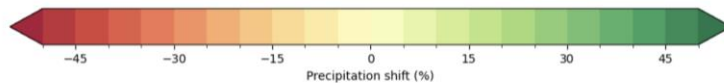
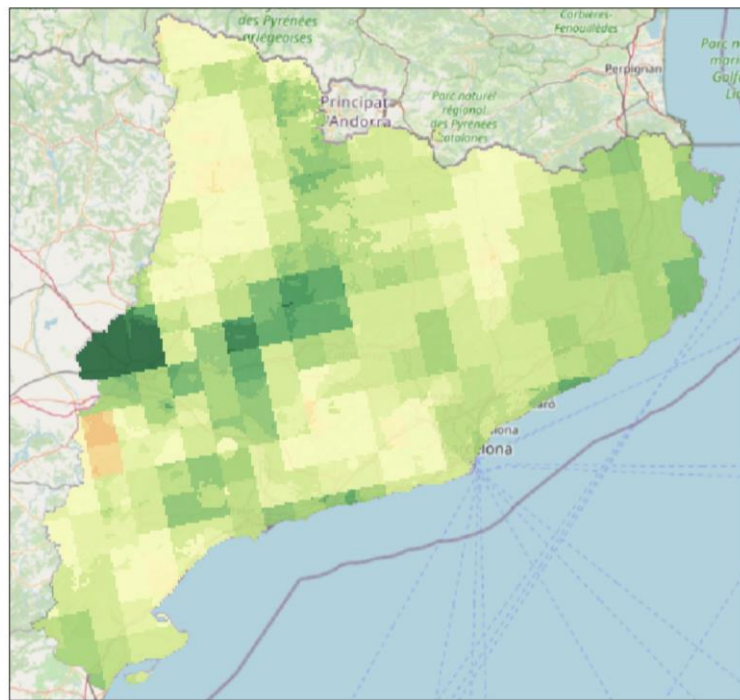
If we want to maintain the current magnitude (100mm/24 hours), the return period (F) **will change from 5 to 3 years**



3 Assessing changes under climate scenarios

For current and future climate scenarios based on CORDEX

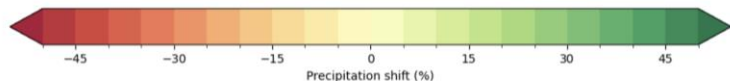
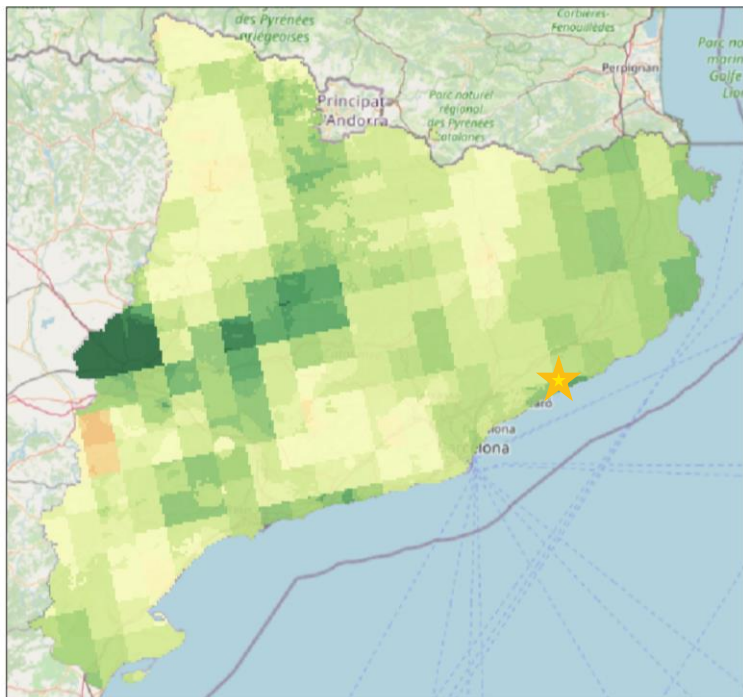
Relative magnitude shift [**2005 vs 2070**] for 100 mm/24 hours



3 Assessing changes under climate scenarios

For current and future climate scenarios based on CORDEX

Relative magnitude shift [2005 vs 2070] for 100 mm/24 hours



Blanes

- For the period of 2041-2070, the critical rainfall threshold of 100 mm/24 hours, associated with a 5-year return period:

If we want to maintain the same return period (frequency), the magnitude **will increase** by **19%** from the current magnitude (100/24 hours)



Q&A SESSION

Handbook webinar
4 July 2024



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