

# Climate Risk Assessments as a catalyst for transformative adaptation action

Workshop on Climate Information for Risk Assessment and Regional Adaptation from Global Scale Climate Projections to Local Scale Climate Hazards, Trieste June 2023

Jaroslav Mysiak

with contributions from Jeremy Pal, Veronica Casartelli, Arthur Essenfelder, Andrea Staccione, Margherita Sarcinella, Sepher Marzi, Mattia Amadeo, Anna Pirani



# Outline

## A Personal Journey through Climate Risk Assessment Advancements

- Evolutionary Shift
- Purpose
- Multi-level governance
- Analytical depth
- Empowering agency
- Embracing complexity
- Building capacity
- Crafting risk narratives
- Seizing technological opportunities
- Unlocking Specialized Services

## Embracing Transformative Change for a more resilient world

- Mission oriented research and innovation
- Three Goals and converging paths
- Role of climate risk assessment
- Principles of regional climate risk assessment
- Tools for actionable regional climate risk assessment

# Evolutionary Shift

from climate change impact assessment to resilience building

Climate change  
impact

Impact of a single or multiple hazards, risk drivers or CIDS on social, economic and environmental systems, with varying degree of complexity.

Climate risk assess-  
ment &

Unfolds risk dynamics and propagate the cascading effects for tailored actors (risk for whom) and decision purposes with emphasis on critical stress/system conditions

Resilience building  
in

Simultaneous multiple risk and crises manifestations, depletion of resilience as a legacy of previous crises, and emphasis on anticipation and capability enhancement.

# Purpose

## how risk assessment empowers multiple scopes

A non-exhaustive list of the roles of risk assessment include

- generating knowledge,
- driving scientific advancements,
- supporting risk-informed decisions,
- identifying priorities and trade-offs,
- building awareness,
- fostering dialogue,
- exploring uncertainties,
- informing policy evaluation,
- ...

Climate risk assessments serves as a basis for or contributes to

- agenda and strategy setting,
- short- and long-term strategic and operational planning,
- capacity and impact stress tests,
- regulation and regulatory supervision,
- allocation of resources,
- ...

**The ways of designing and implementing climate risk assessment can vary depending on the specific context and purpose/objectives of the assessment.**



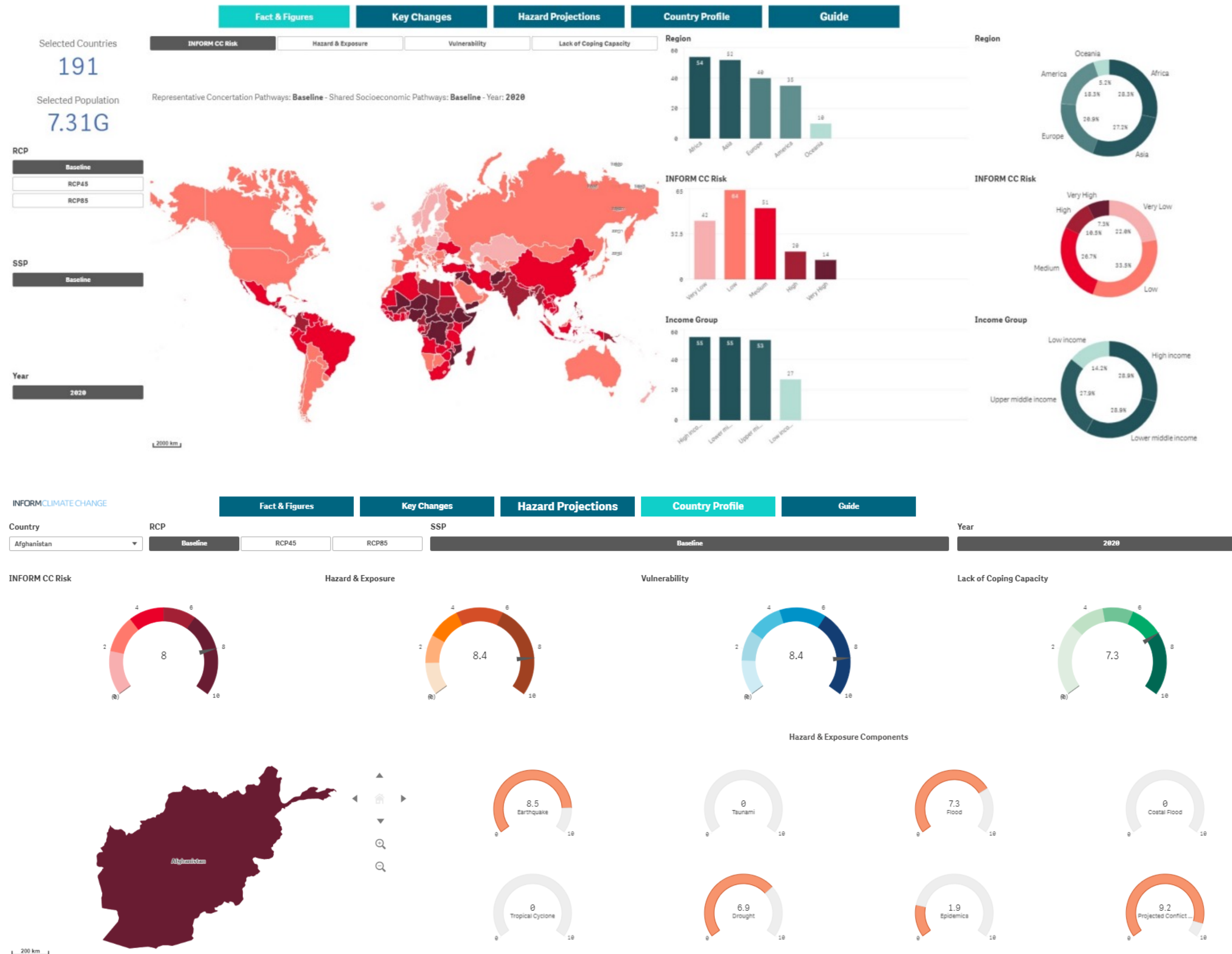
**INFORM RISK** is a collaboration of the UN Inter-Agency Standing Committee and the European Commission.

## INFORM Climate Change

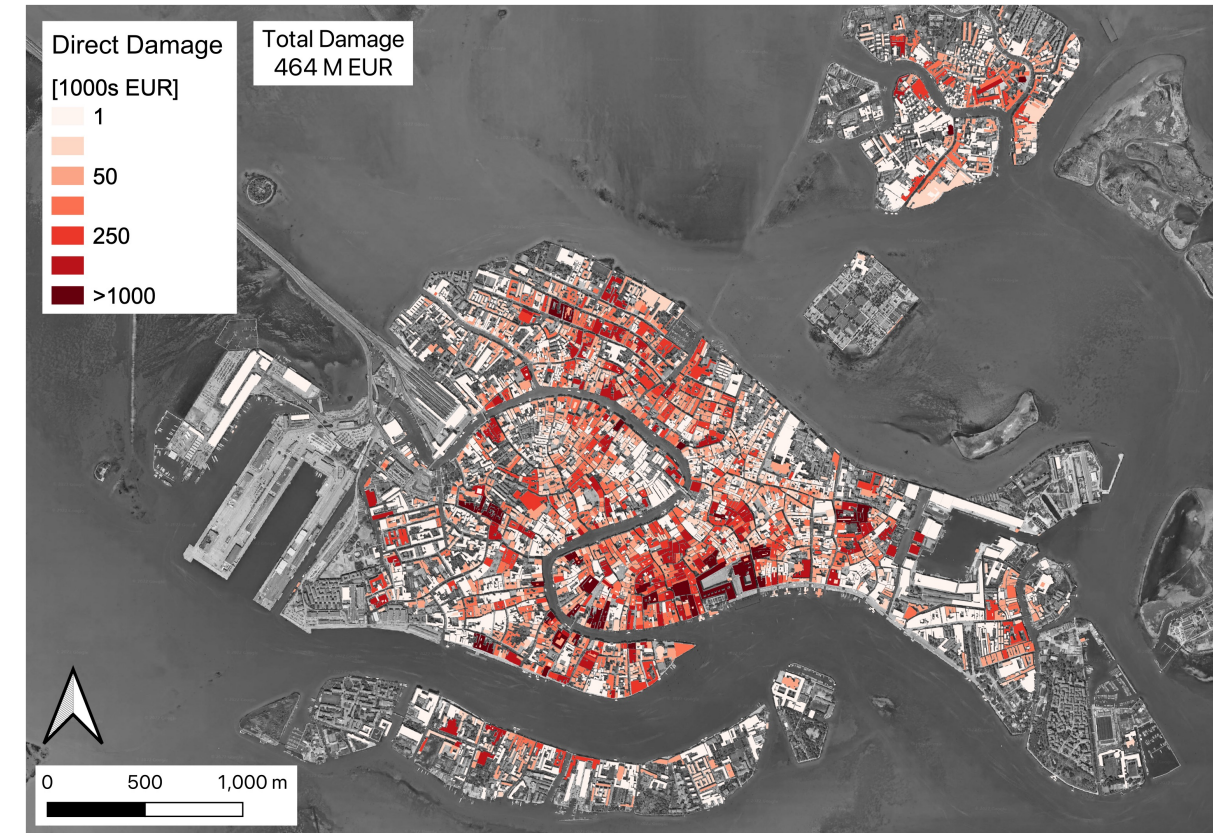
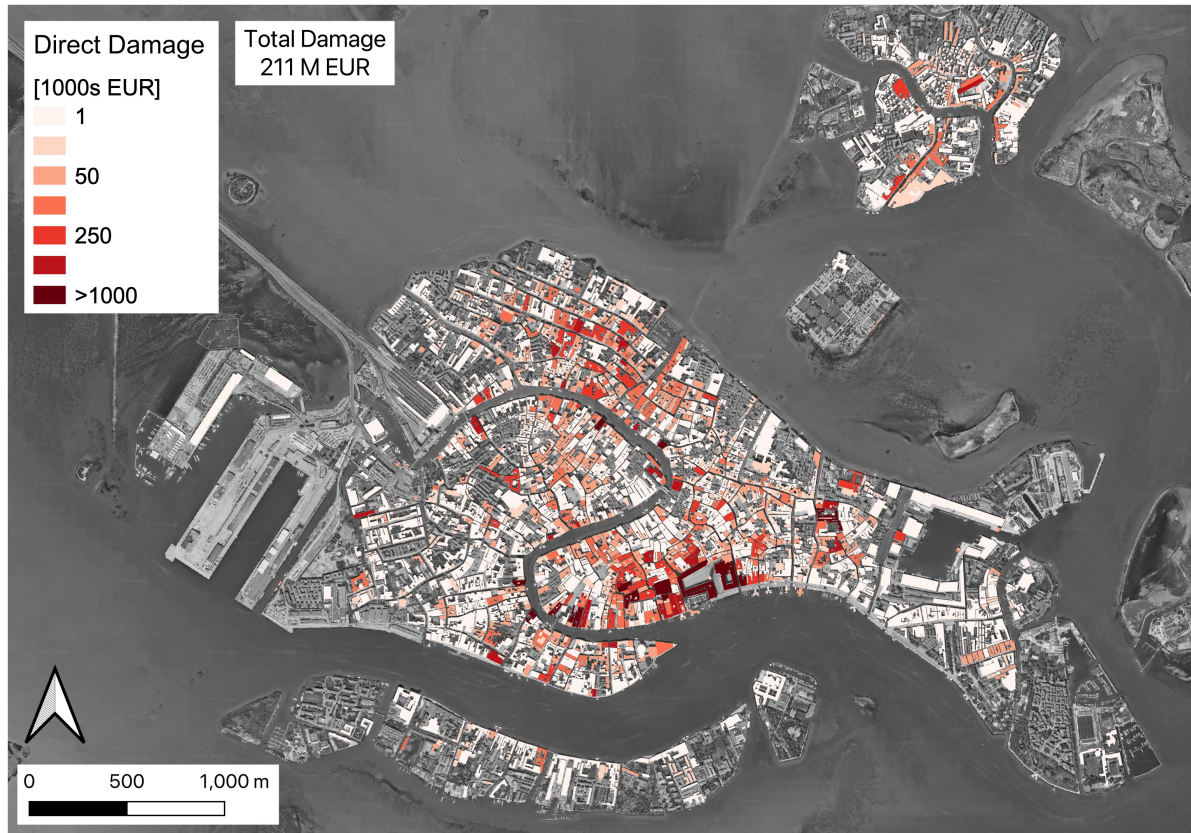
- fosters a shared understanding of climate change's influence on the risk of humanitarian crises.

- identify disparities in climate impacts, including those affecting marginalized groups like displaced populations.

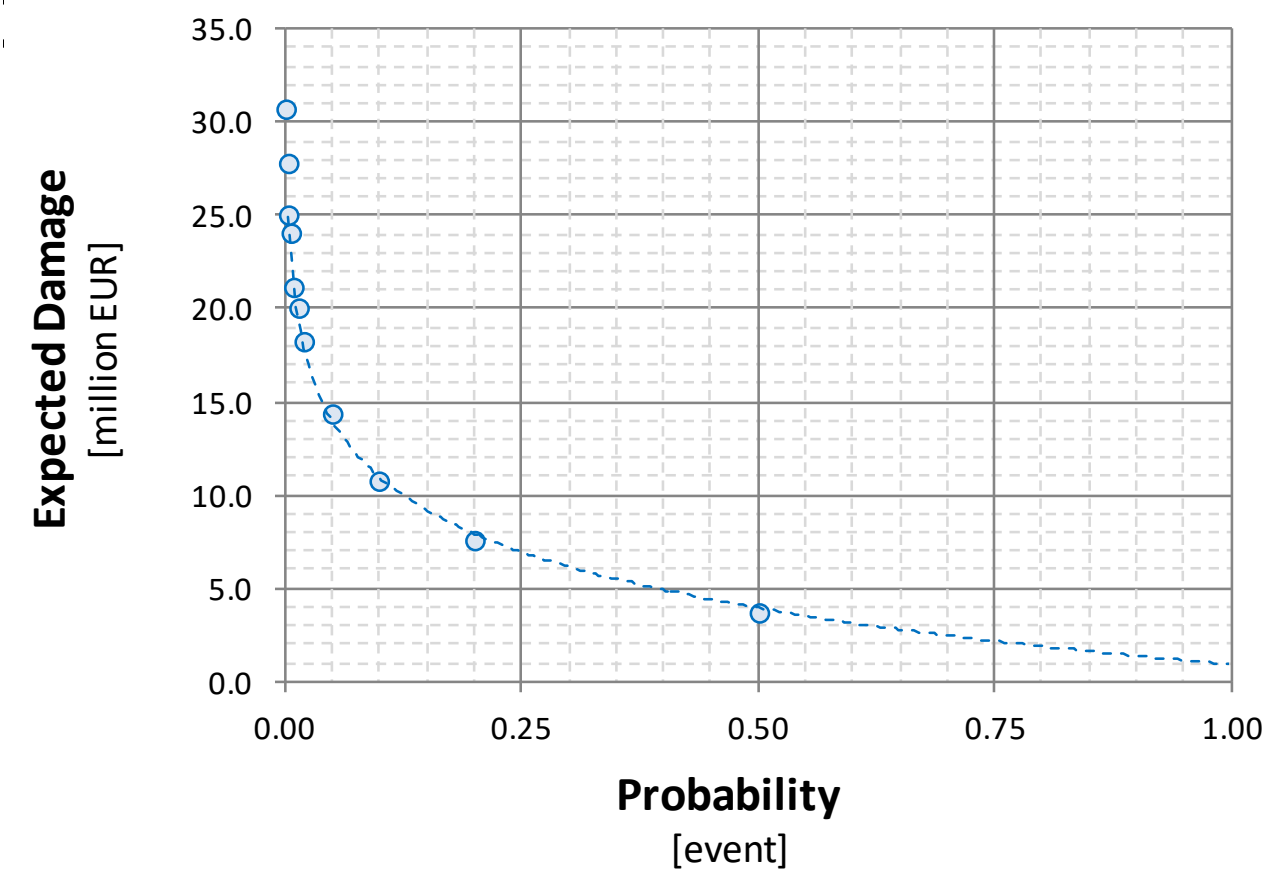
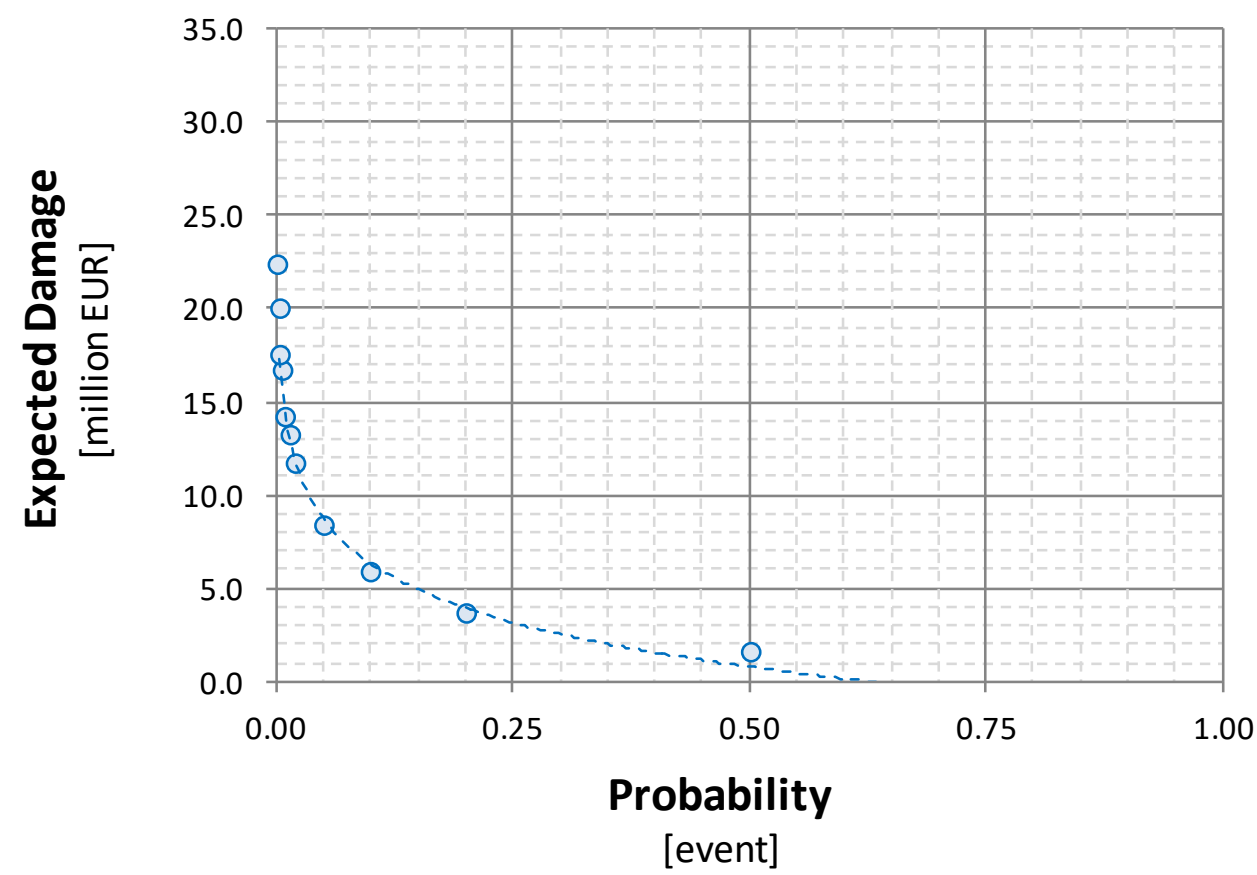
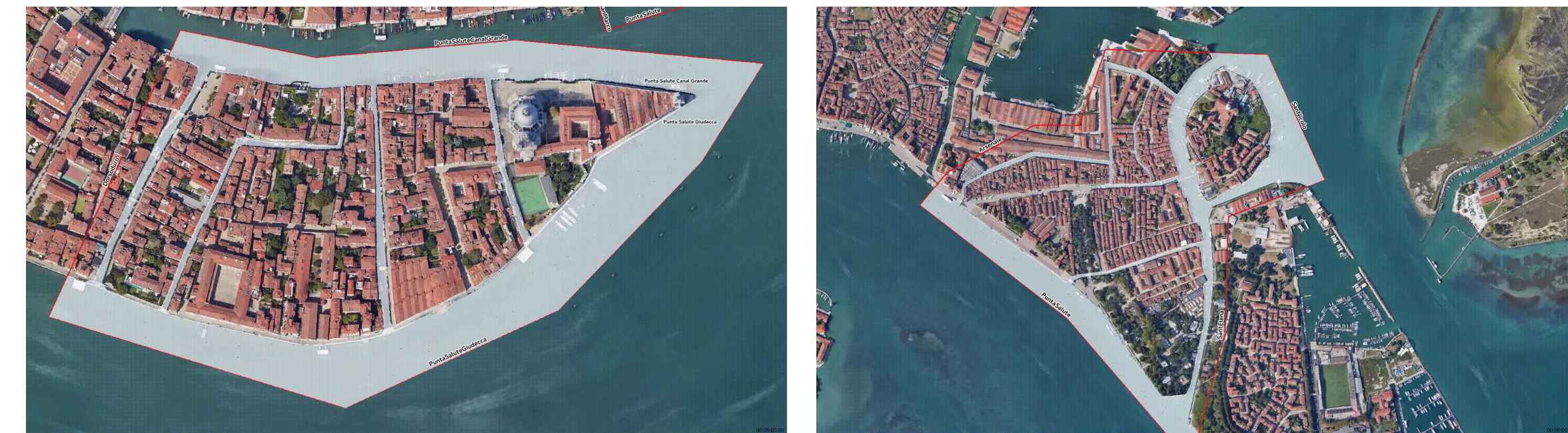
Marzi et al, 2021 , Global Env Change [link](#) UNDRR GAR Global Assessment Report 2022 [link](#)







**Venezia 2021**, assessment of the economic benefits arising from the flood protection in Venice. Annual expected damage (AED) and loss (AEL) under current



Source: Essenfelder et al, in preparation



# Multi-level governance

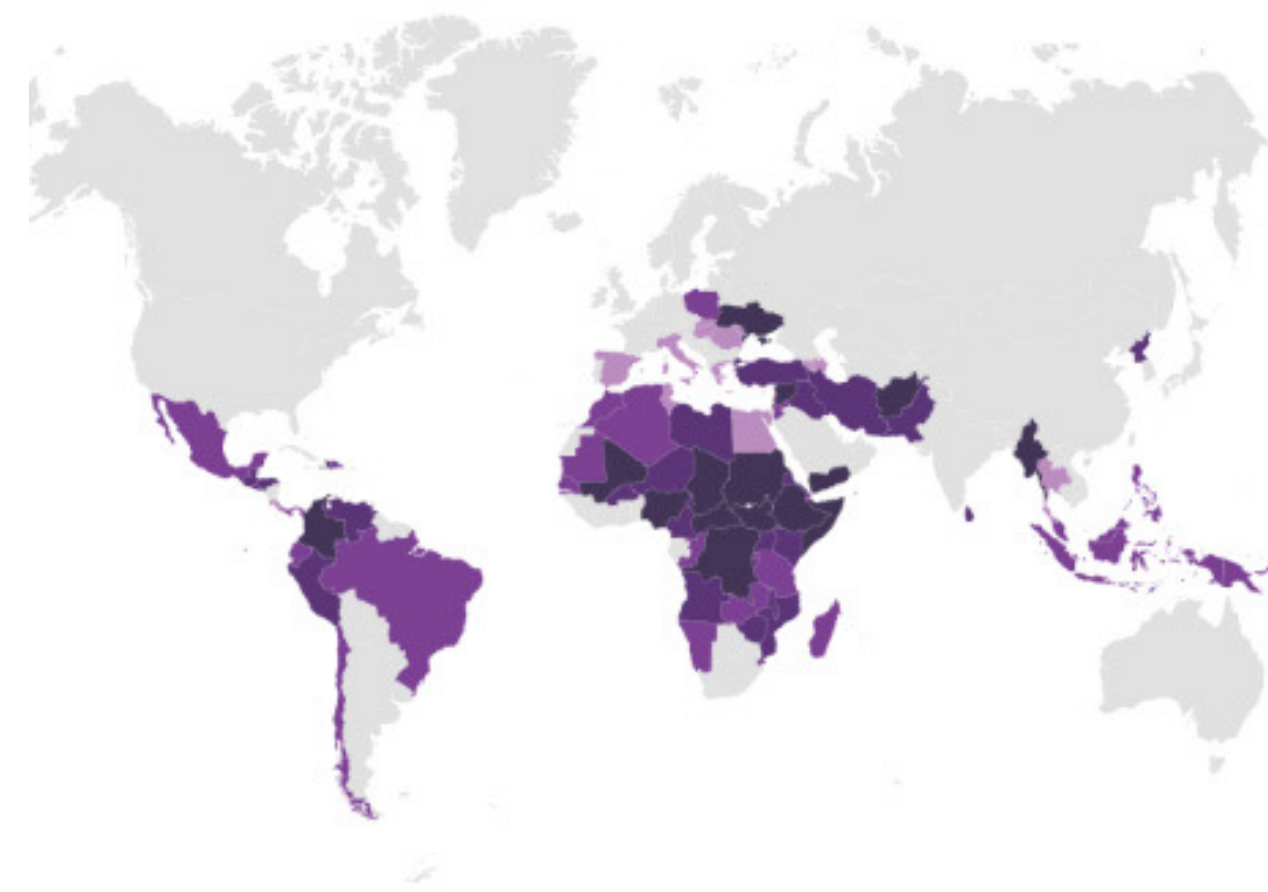
bridging local to global assessments for resilient futures

**Global and continental** – to identifying and monitoring long-term trends and patterns of large-scale transformations.

**National** – to identify sector-specific risks, such as impacts on agriculture, water resources, infrastructure, and public health, inform national priorities and allocate roles and responsibilities.

**Regional and local** – to guide responses to specific risks faced by communities, and develop targeted adaptation and resilience strategies, enhancing

**Risk assessment is a critical governance aspect that involves streamlining climate risk assessments across different administrative sectors, coordinating them with other risk evaluations, and supporting reporting efforts.**





# Analytical depth

unravelling differentiated causes and effects of risk, and integrate social justice

ETC-CA Technical Paper 1/23

Just Resilience for Europe: Towards measuring  
justice in climate change adaptation



Authors:

Frída Lager (SEI), Ingrid Coninx (WENR), Margaretha Breil (CMCC),  
Inès Bakhtaoui (SEI), Anders Branth Pedersen (DCE-AU), Kati  
Mattern (EEA), Hanne van den Berg (EEA), Eugenio Sini (CMCC),  
Giulia Galluccio (CMCC), Richard Klein (SEI) and Kati Vierikko (Syke)

## Ensuring equitable outcomes

Breaking down risk assessment to address social justice is essential for ensuring **equitable outcomes** in climate change adaptation and resilience efforts.

- Identify and address the disproportionate impacts of climate change on marginalized and vulnerable communities,
- Pursue a more inclusive and participatory process, taking into account the diverse needs, knowledge, and perspectives of different social groups.
- Mitigate existing social inequalities and ensures that

The EEA-ETC-CA [report](#) provides valuable evidence supporting the significance of just the most vulnerable resilience, as referenced in the [EU Adaptation Strategy 2021](#)



# Empowering Agency

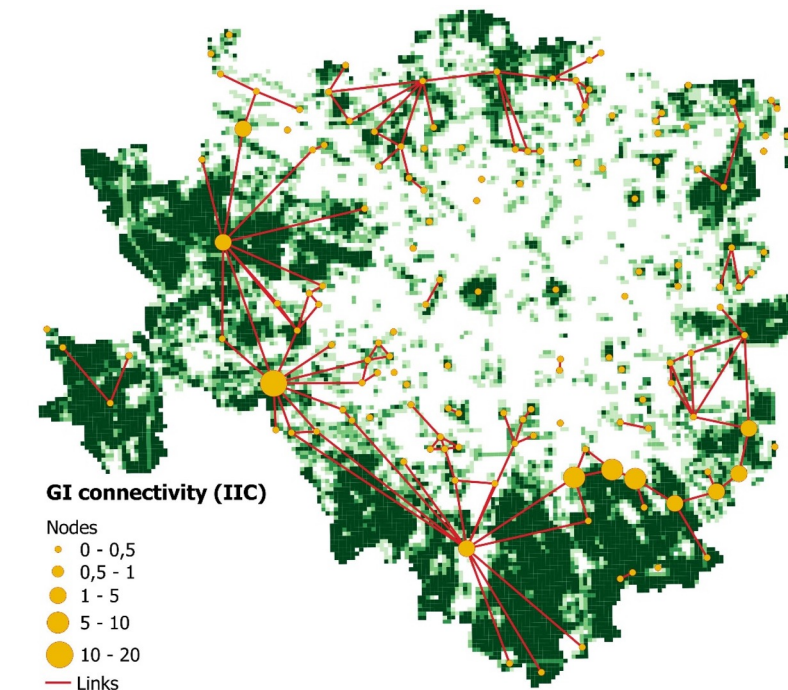
unveiling how risk assessment drives action

Risk assessments that are not framed to catalyse actions are less useful and fail to fully exploit their potential.

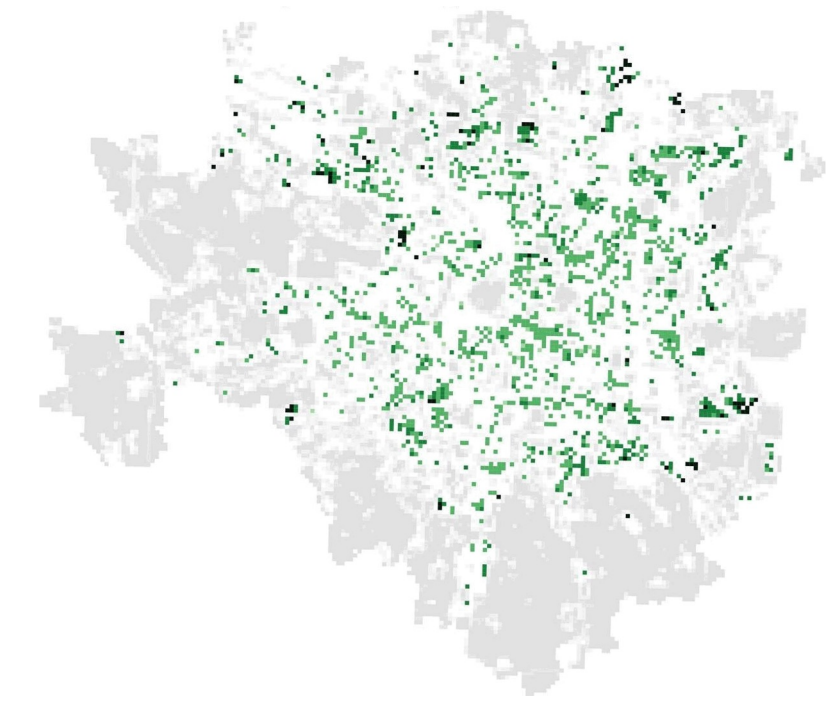
Risk assessments should empower individuals, communities, and businesses to assume agency in risk management, promote engagement, enable informed decision-making and effective solutions, and contribute to raising awareness.

Behavioural research within climate risk assessment is crucial for understanding human behaviour, informing risk perception and response, assessing barriers and drivers of adaptive behaviour, designing effective interventions, and enhancing policy and decision-making processes.

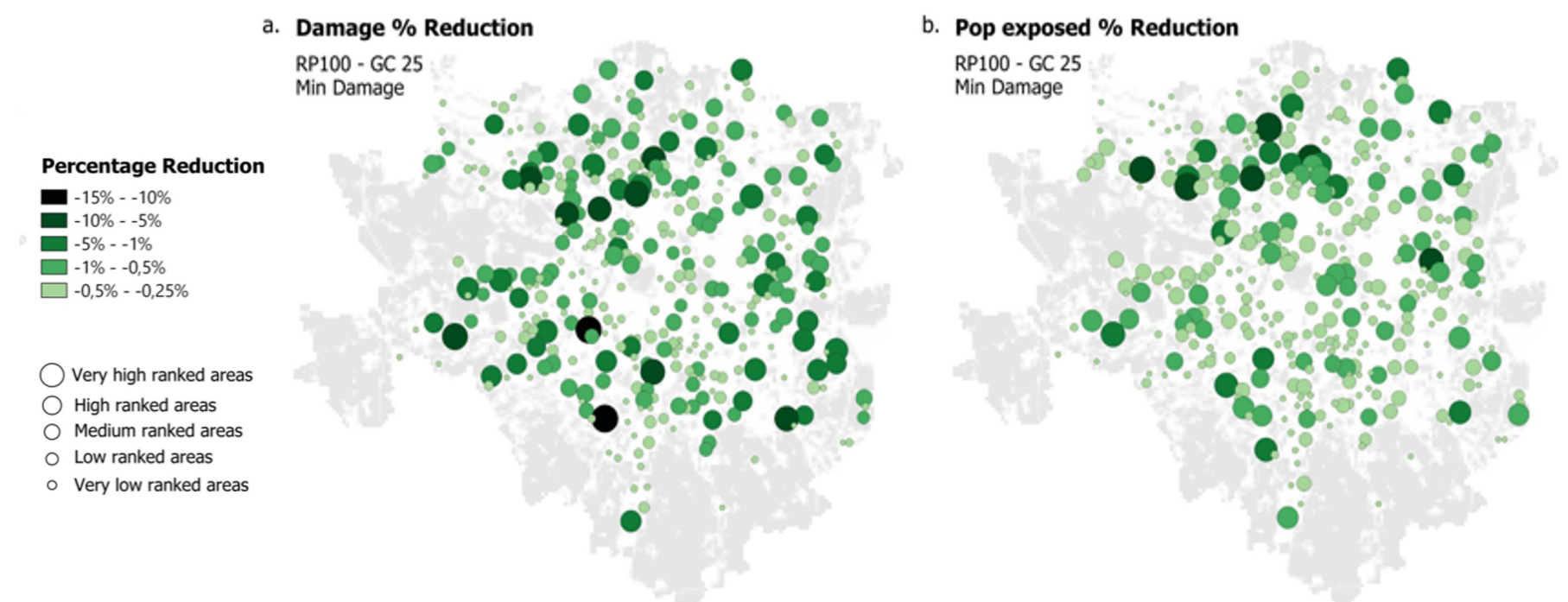
**Analysis of existing urban green network**



**Definition of greening scenarios**



**Assessment of green network to reduce pluvial flood impacts**



Source: Staccione et al, under review

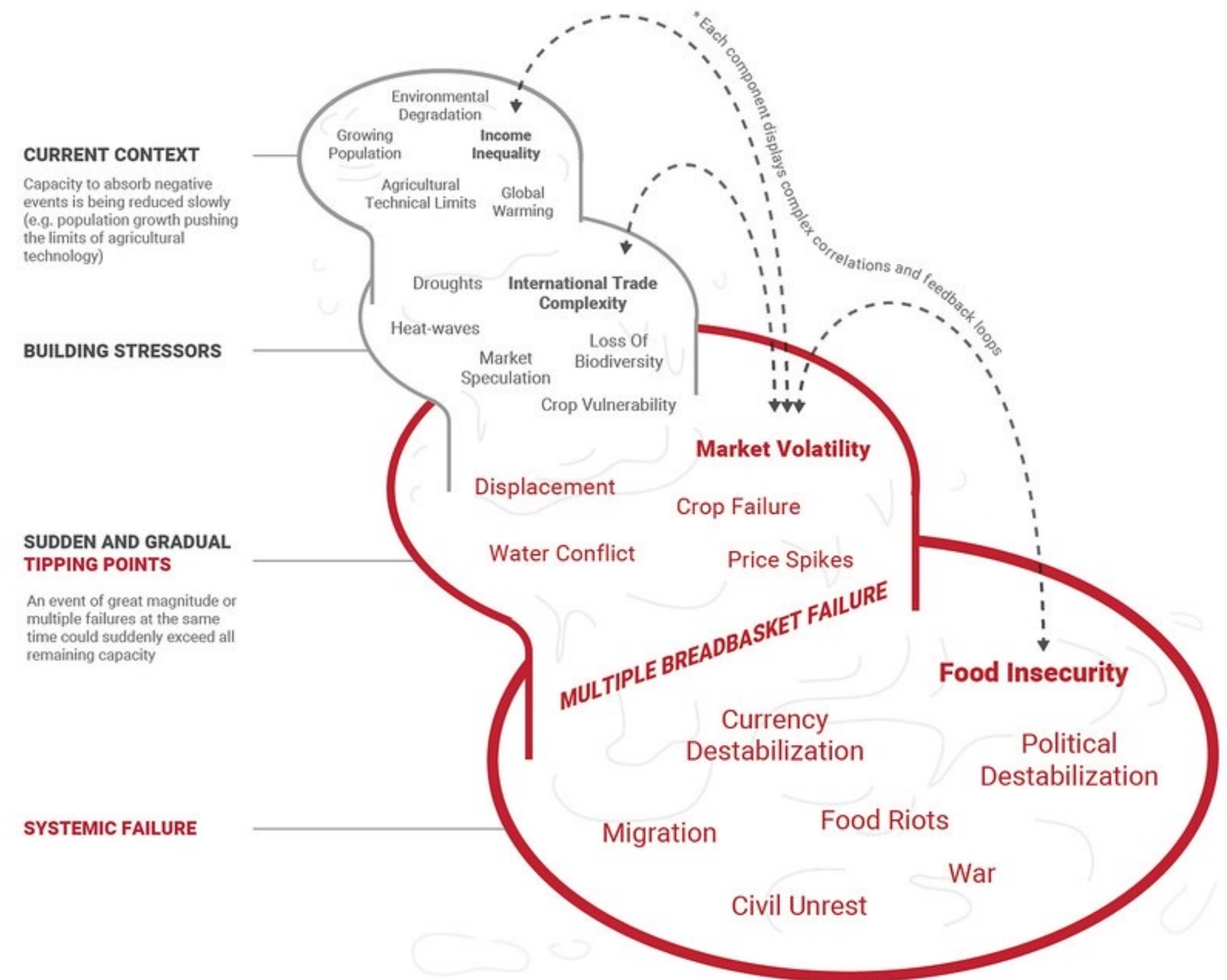


# Embracing complexity

unlocking interconnected risks through modelling and assessment

Climate risks often exhibit complexity, non-linearity, and interconnections, with cross-border and spill-over effects across geographic and functional boundaries.

In such contexts, single-hazard perspectives no longer suffice to guide extensive policy development.

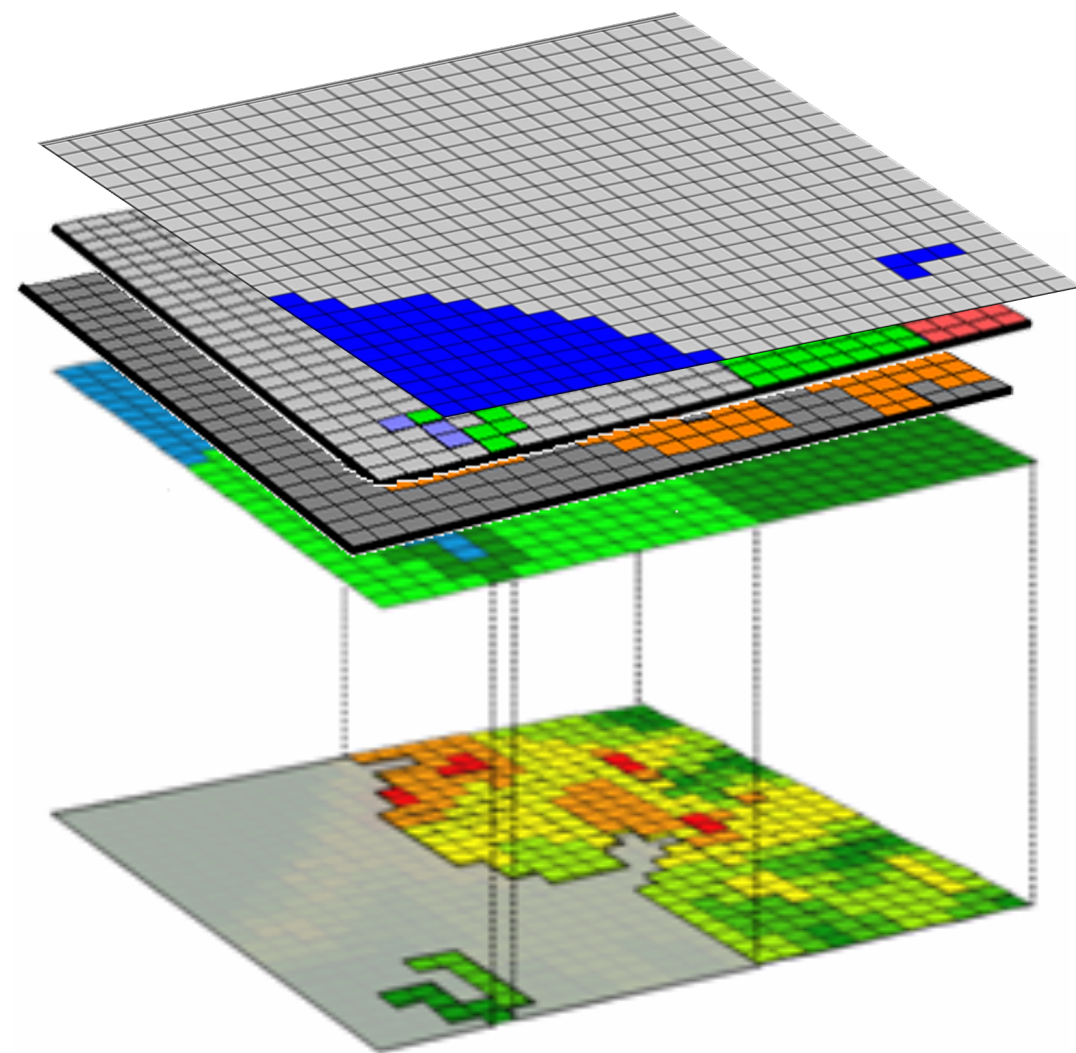




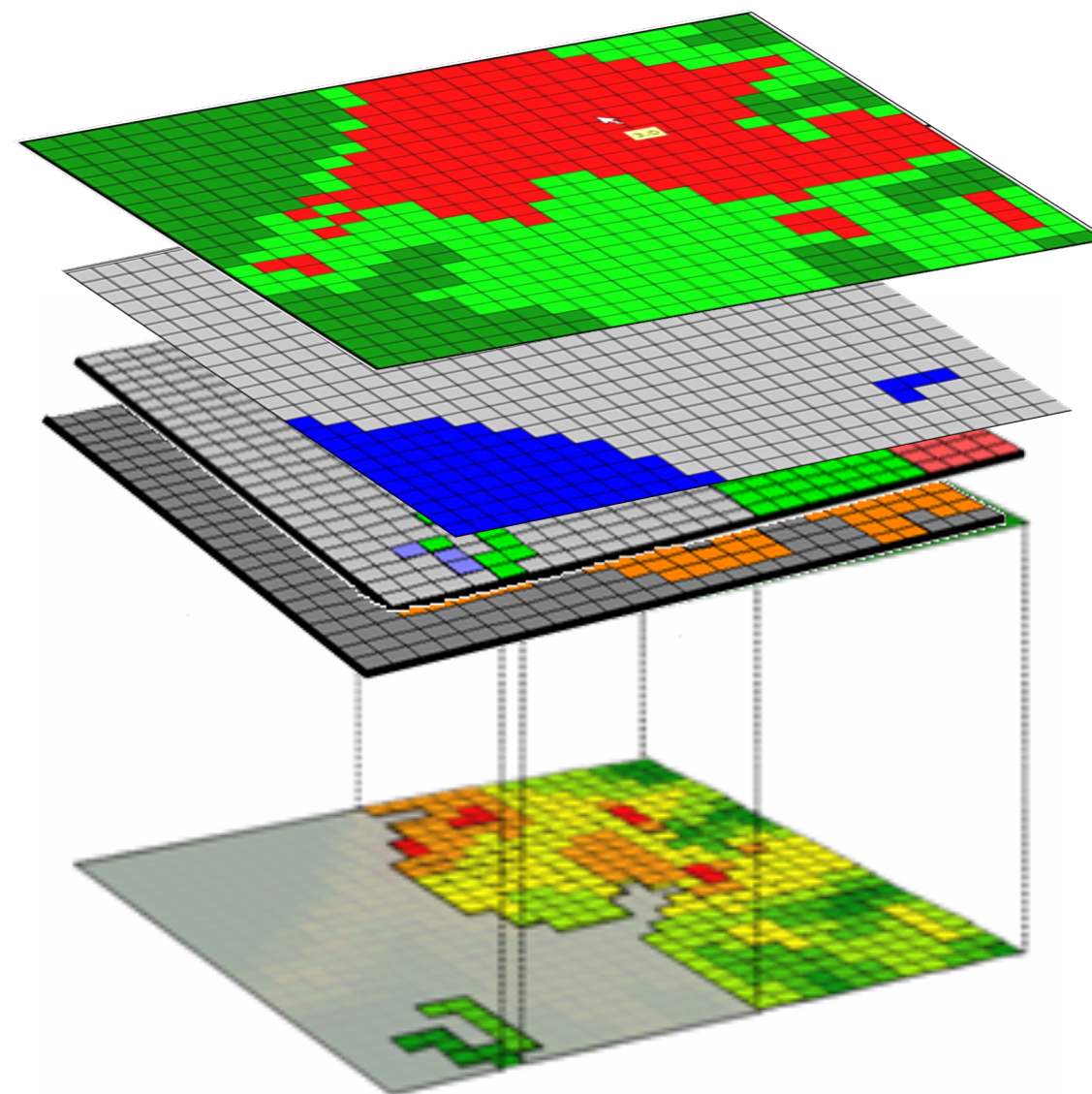
# Embracing complexity

unlocking interconnected risks through modelling and assessment

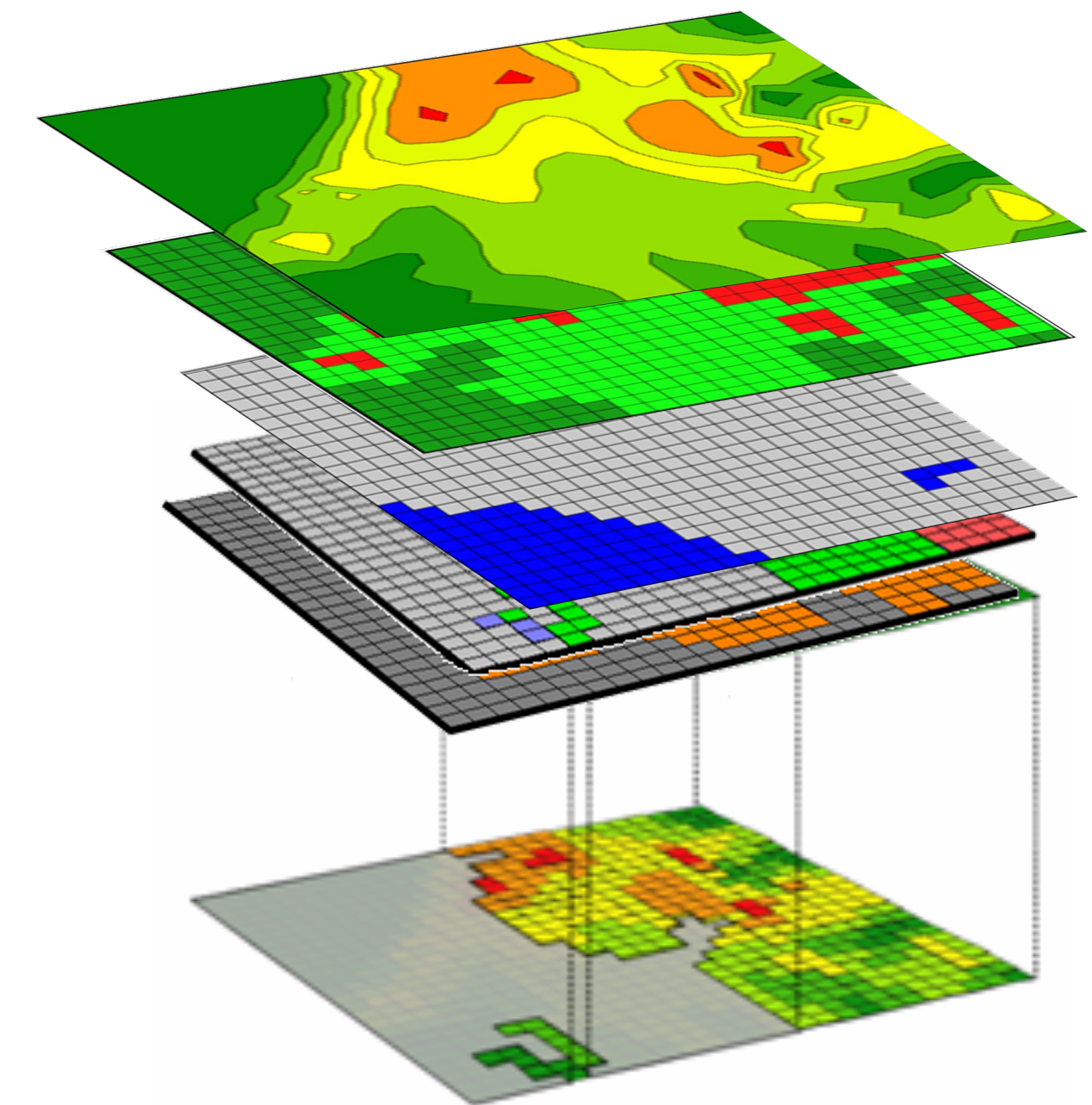
change in exposure due to **amplified climate-related hazards** (single/multiple)



change in risk due to amplified hazard **and exposure** (elements at risks)

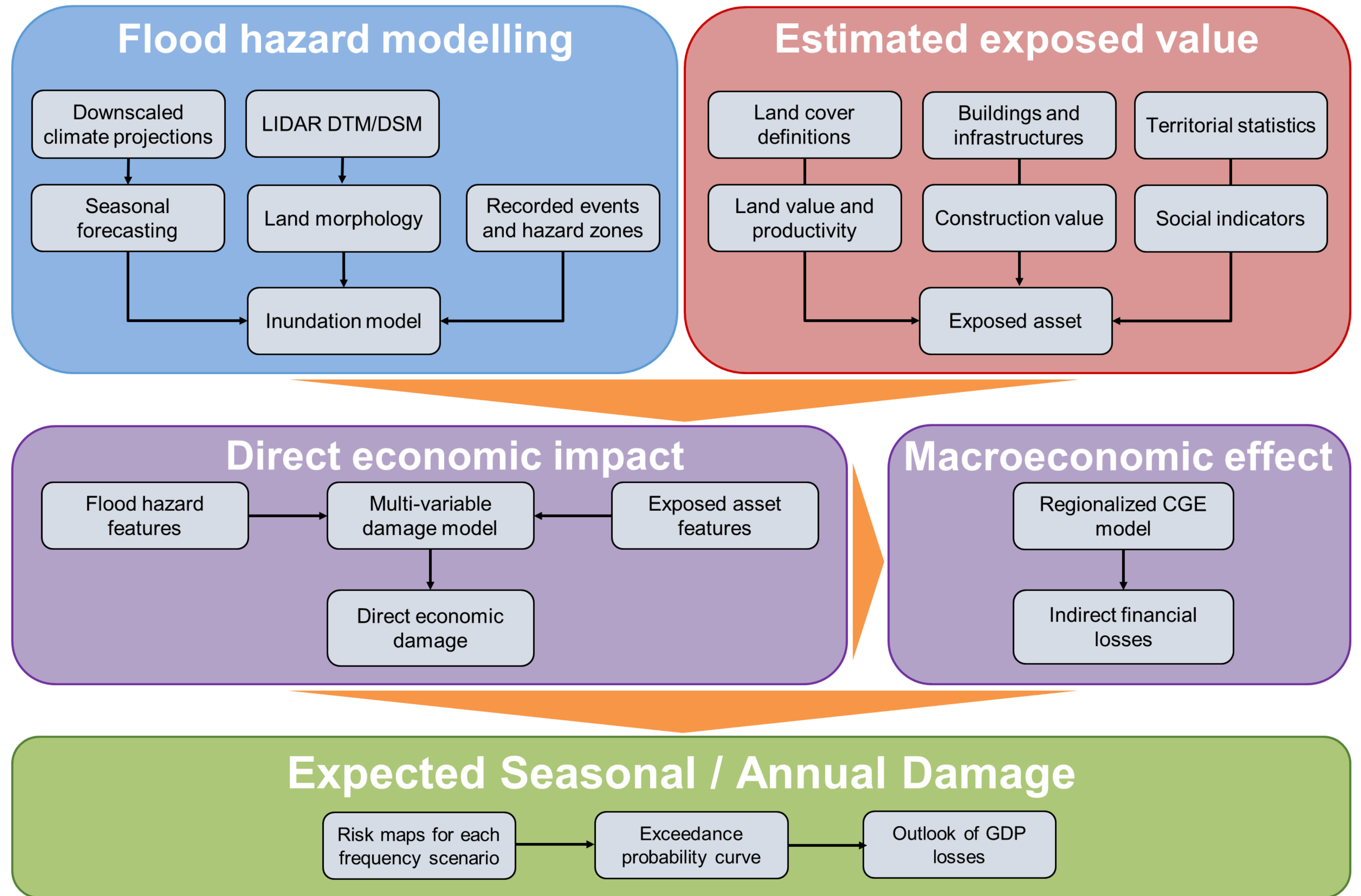


change in risk due to amplified hazard, exposure **and vulnerability**





An example of a climate risk assessment framework which combines high-resolution hazard, exposure, and vulnerability assessments with climate, hydro-economic, and economic modelling. This integrated approach allows for the analysis and projection of the cascading impacts of climate-related hazards on various sectors and systems, providing a comprehensive understanding of the potential consequences





# Building Capacity

unveiling the how-to for effective understanding

The modern assessment of climate risks fosters understanding institutional and organizational vulnerabilities and continuous capacity and capability building.

The peer review of risk management capabilities, promoted by the Union Civil Protection Mechanism (UCPM), is an evaluation process involving experts in risk management. Its goal is to improve and strengthen strategies, methods, and tools used to address and reduce associated risks, including those related to climate change.

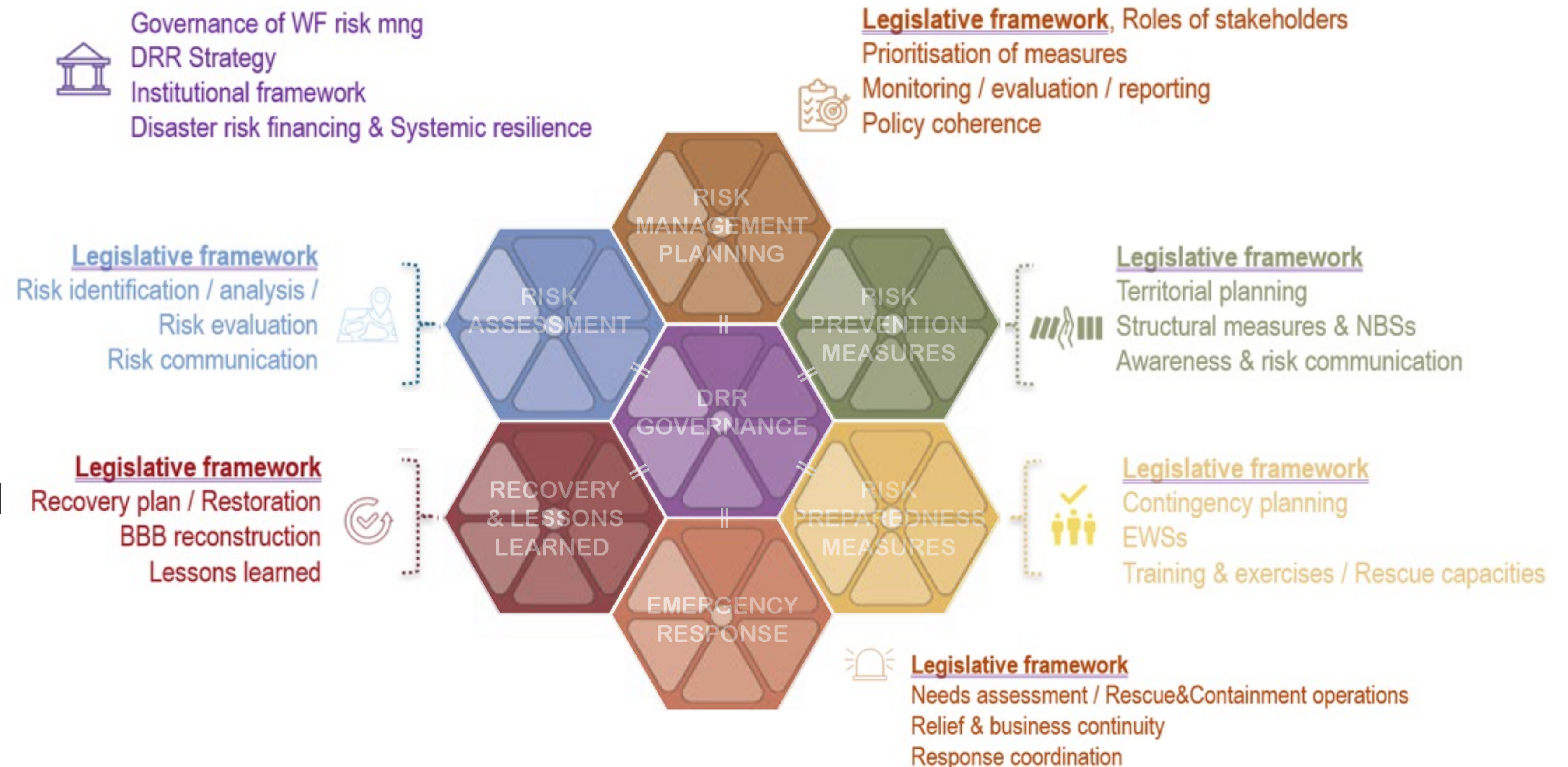




# Building Capacity

## unveiling the how-to for effective understanding

During the peer review, experts critically examine and assess the risk management capabilities adopted by an organization or public entity, comparing practices with best practices and international standards. This process identifies strengths and areas for improvement, while promoting knowledge exchange and mutual learning among





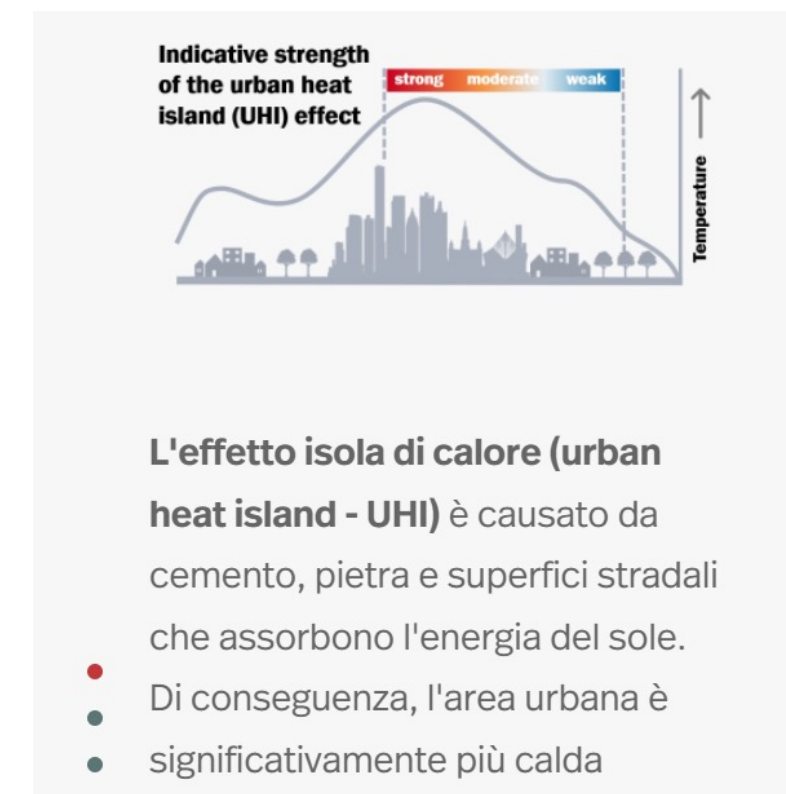
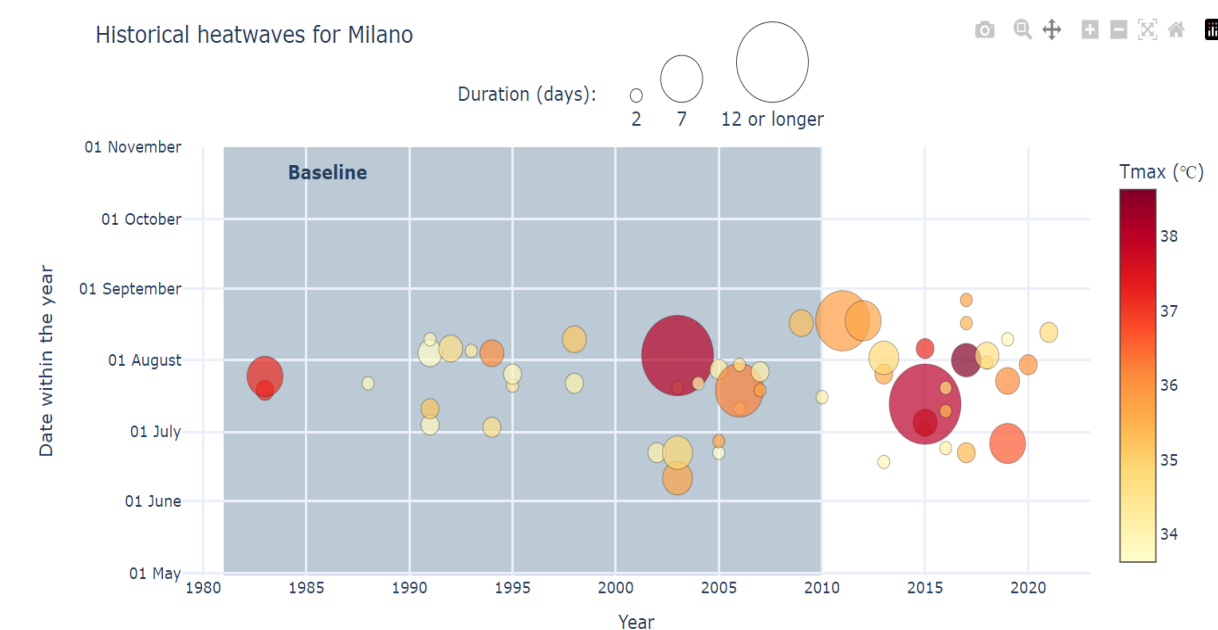
# Crafting Risk Narratives

## mastering engagement and effective communication

Storylines combine insights from climate and social sciences (and arts), anecdotal evidence and counterfactuals, and local - contextual or culturally embedded knowledge - in the search to identify plausible interconnections, challenges and possible courses of actions.

IPCC AR6 defines storylines as “a way of **making sense** of a situation or a series of events through the construction of a set of explanatory elements”.

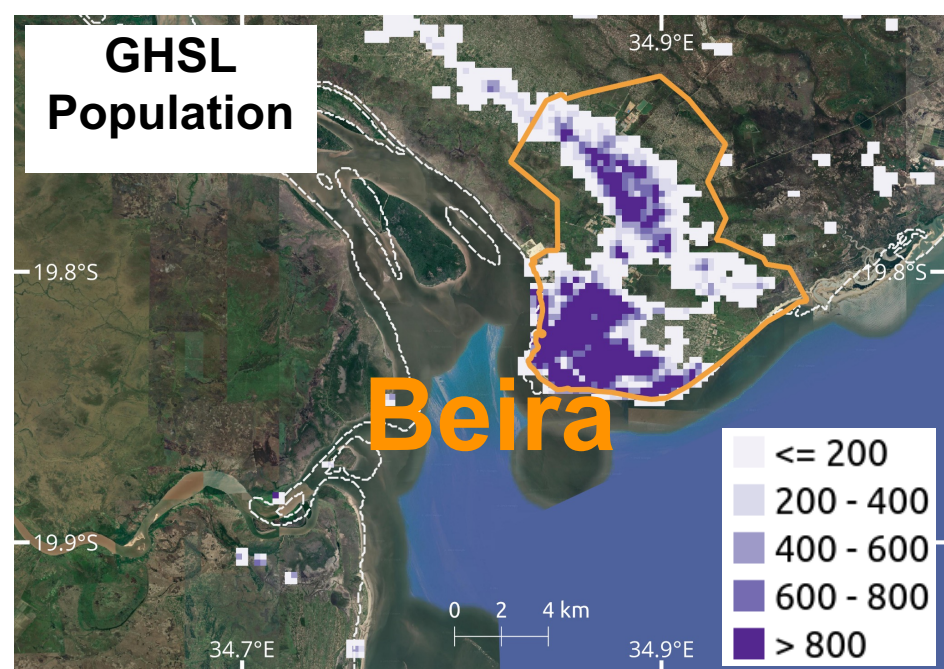
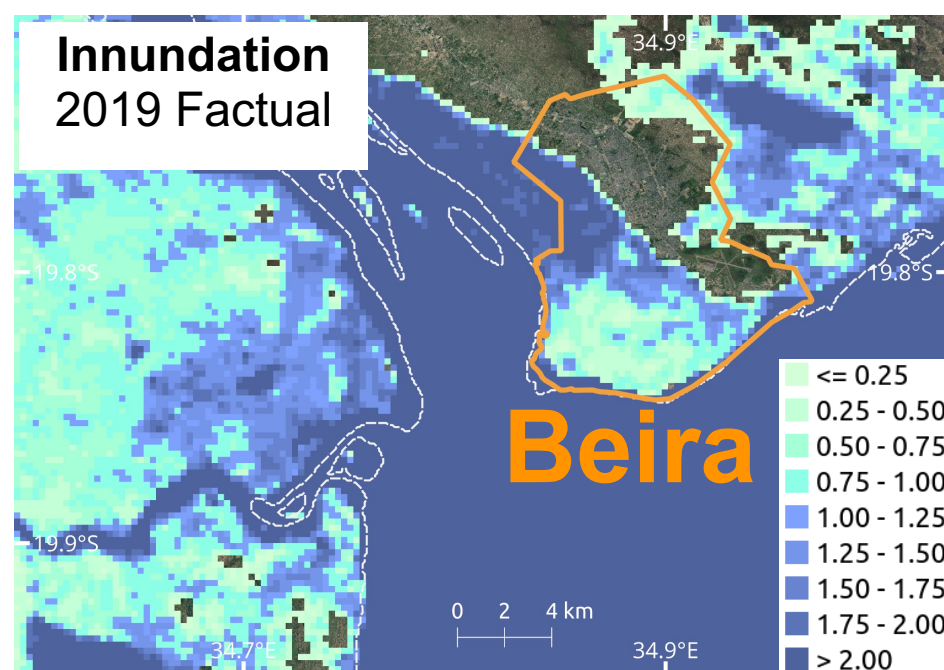
Shepherd and Lloyd (2021) refer to (physical) storylines as ‘physically self-consistent unfolding of past events or of plausible future events or pathways’ which ensures that data can be meaningfully interpreted’.





# Crafting Risk Narratives

unfolding storylines of alternative risk dynamics - tropical cyclone in Mozambique



Scenario	Affected	Internal Displacements (> 1m)	Aid Required <sup>1</sup>	Direct Building Damage <sup>2</sup>	INFORM Severity Index
<b>2019 Factual: TC Idai</b>	1.9M	478K	\$95M	\$257M	Very Low (0-1), Low (1-2), Medium (2-3), High (3-4), Very High (4-5)
<b>2100 RCP8.5<sup>3</sup></b>	2.6M	647K	\$128M	\$871M	Very Low (0-1), Low (1-2), Medium (2-3), High (3-4), Very High (4-5)
<b>2100 RCP8.5<sup>3</sup> + HA</b>	2.6M	647K	\$128M	\$871M	Very Low (0-1), Low (1-2), Medium (2-3), High (3-4), Very High (4-5)
<b>2100 RCP2.6<sup>4</sup></b>	2.1M	529K	\$105M	\$361M	Very Low (0-1), Low (1-2), Medium (2-3), High (3-4), Very High (4-5)

HA = Extreme Humanitarian Access Constraints

<sup>1</sup> Aid required per person affected = \$50 (32 to 68)

<sup>2</sup> Beira only & no agriculture; World Bank Mozambique estimate = \$656M to \$773M

<sup>3</sup> 2100 RCP8.5 = 33% Wind & 156cm SLR

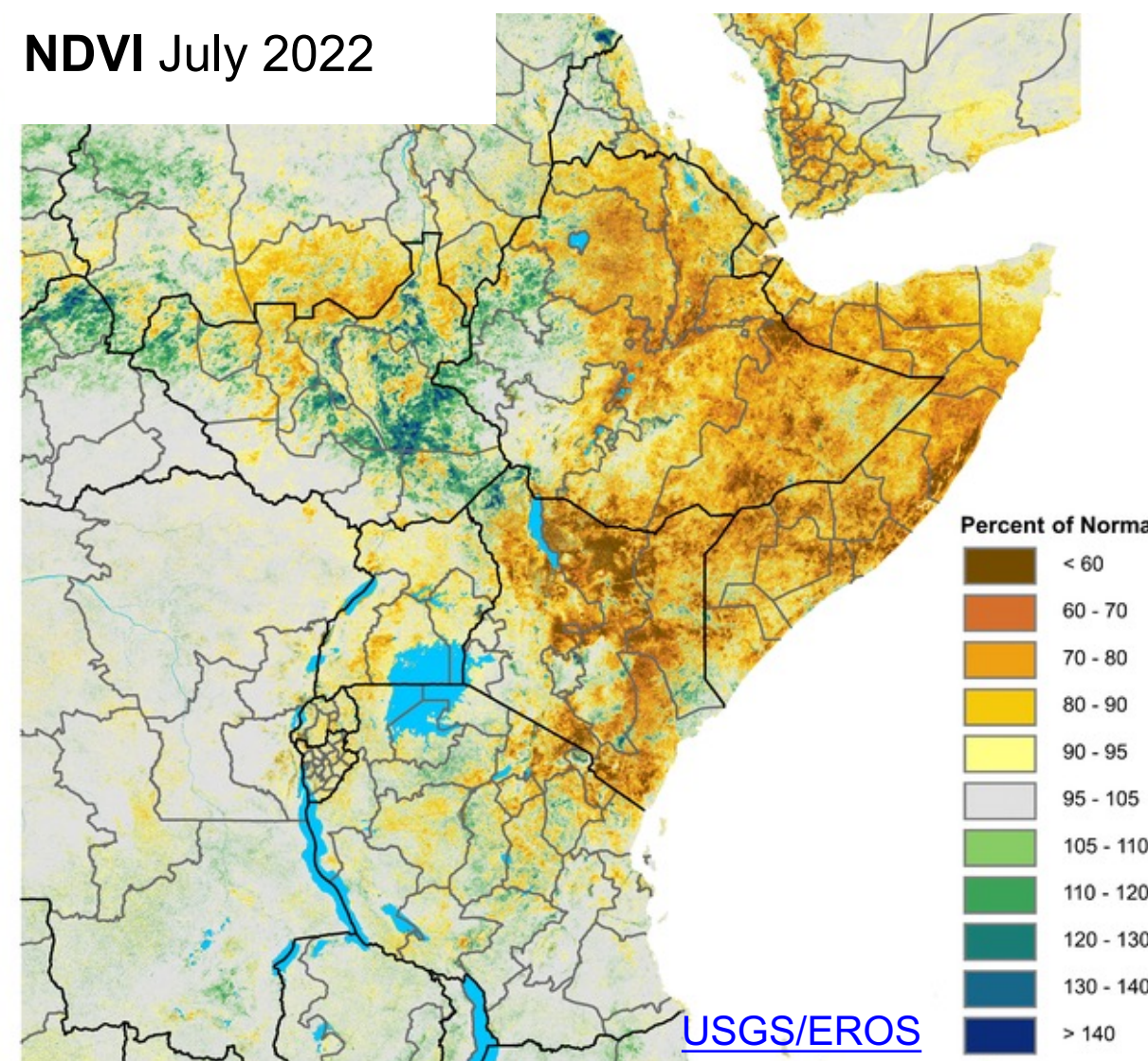
<sup>4</sup> 2100 RCP2.6 = 21% Wind & 39cm SLR



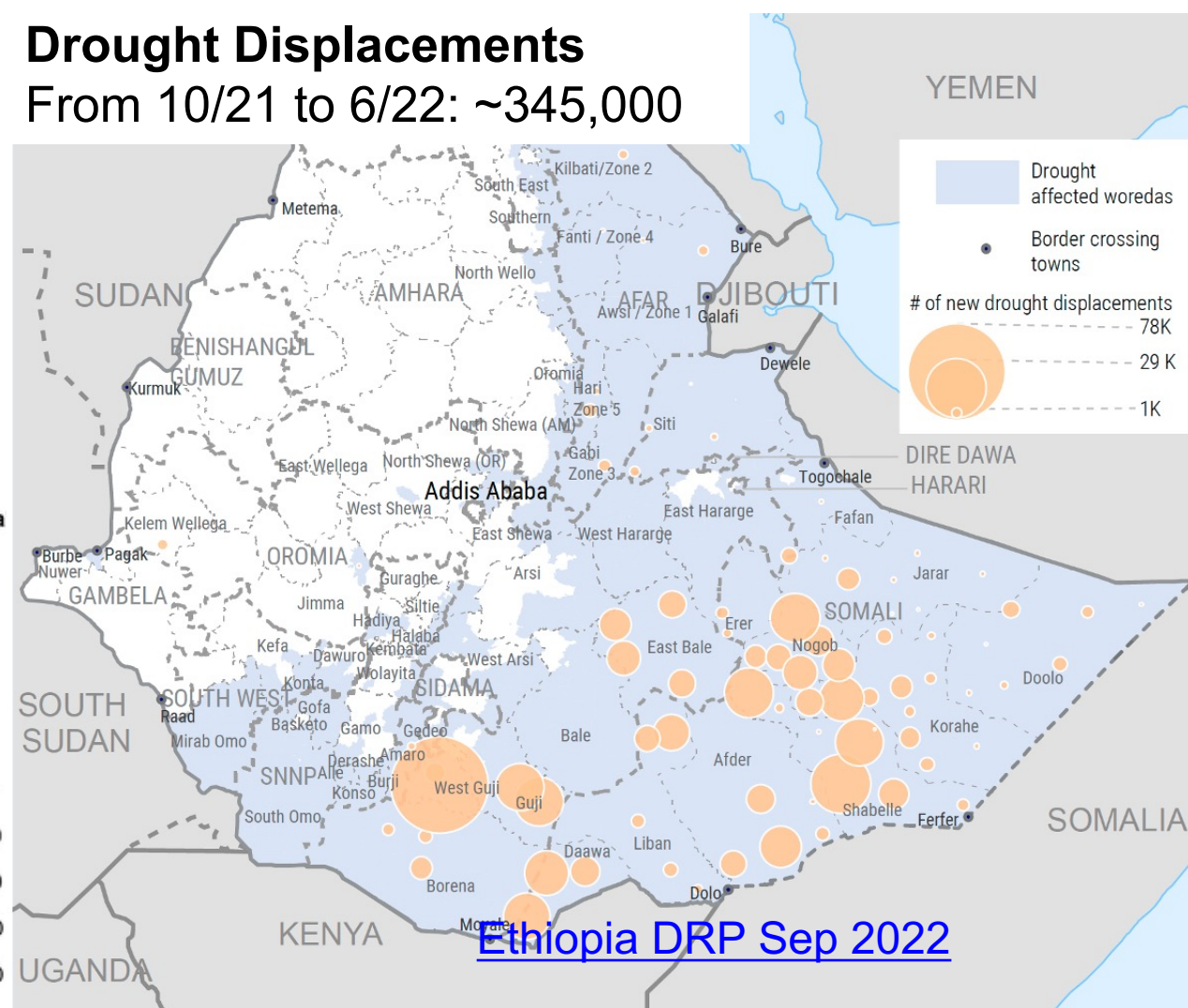
# Crafting Risk Narratives

unfolding storylines of alternative risk dynamics – multiannual drought in Ethiopia

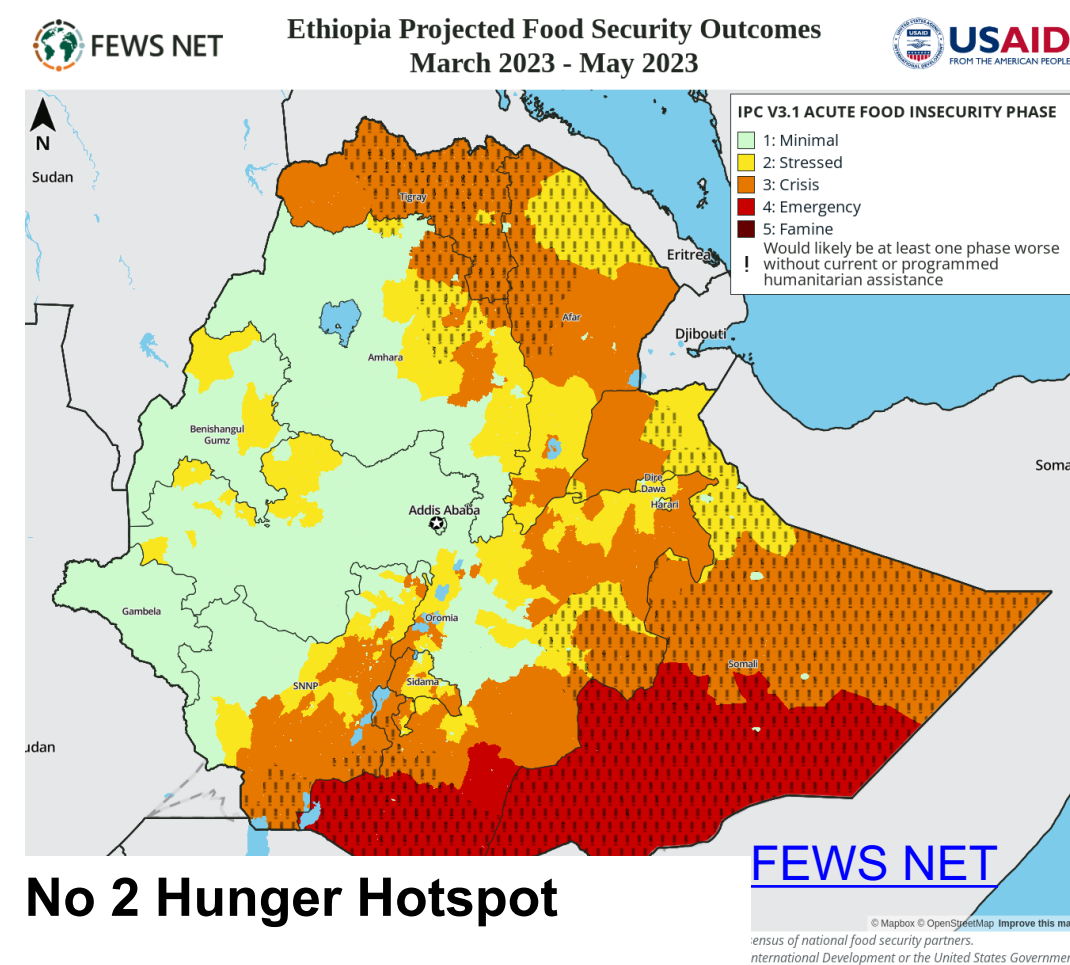
NDVI July 2022



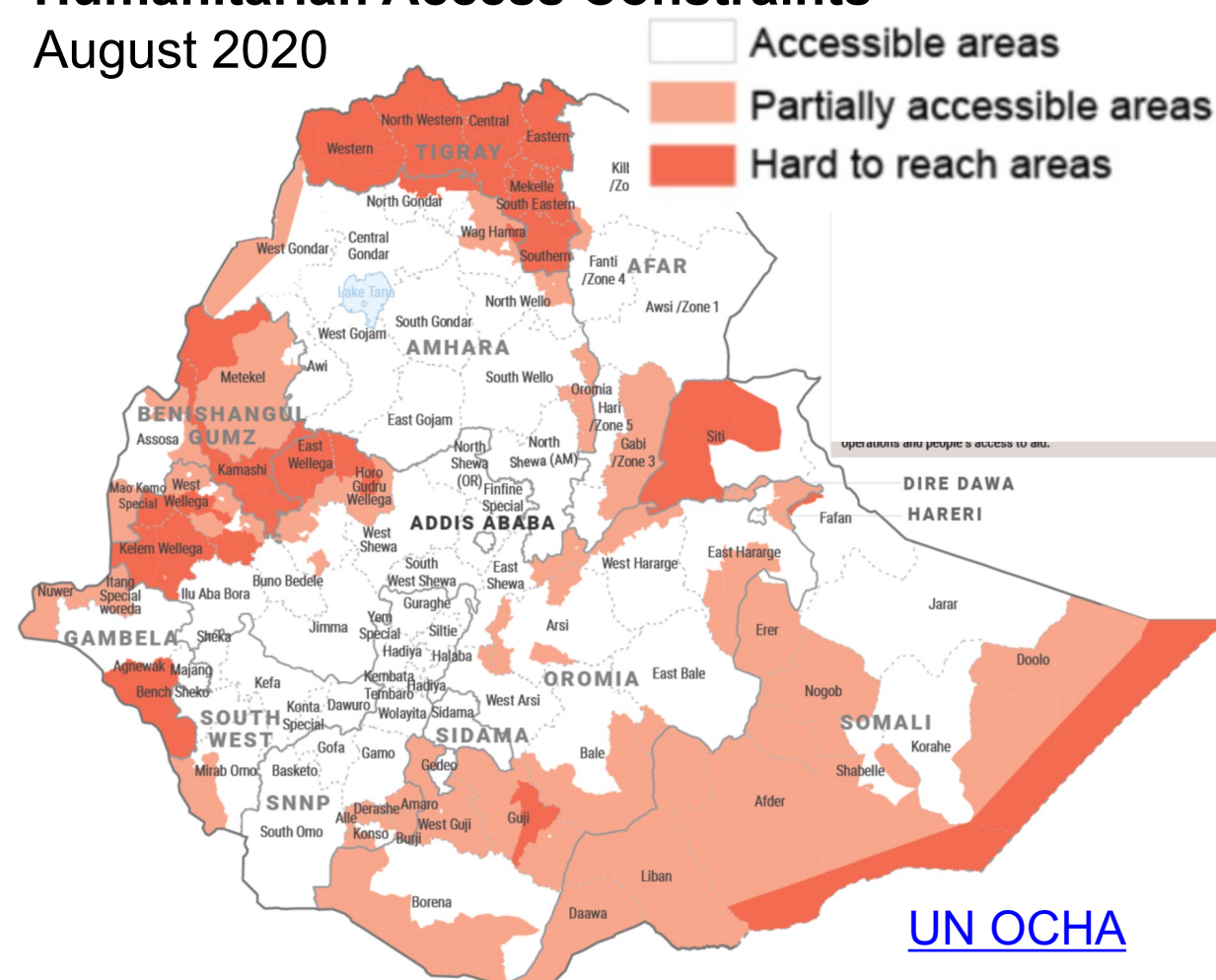
Drought Displacements  
From 10/21 to 6/22: ~345,000



Projected Food Insecurity  
March 2023



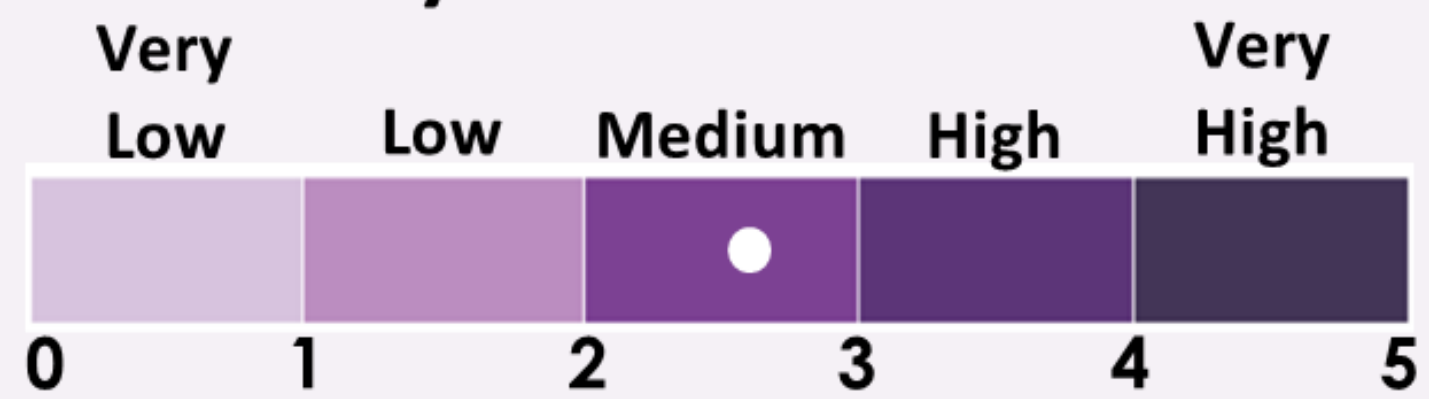
Humanitarian Access Constraints  
August 2020



INFORM Severity Index

Factual: No UA Conflict;  
Early Drought (Jan 2022)

0.3M PIN



UA Conflict; Severe  
Drought (Jan 2023)

11.8M PIN

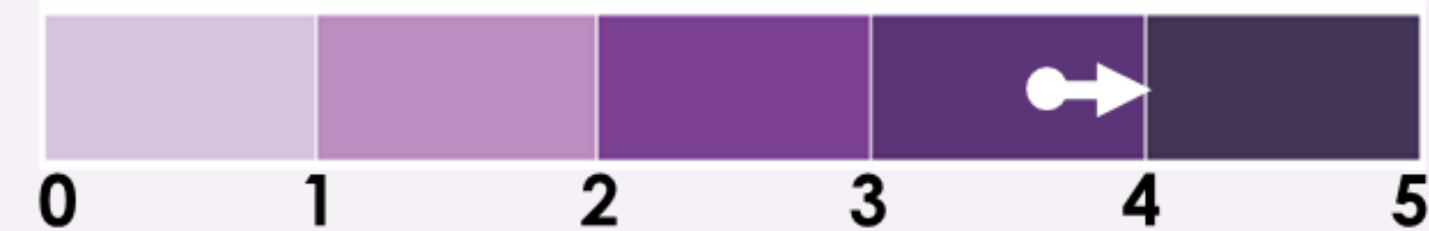
1.15B USD



2050 RCP8.5-SSS

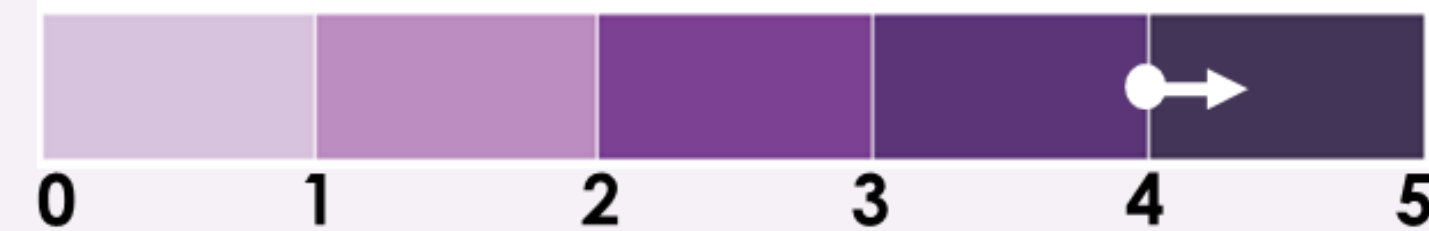
25.5M PIN

2.51B USD



2050 RCP8.5-SSS  
+ HA + COVID

26.9M PIN



2050 RCP4.5-TSS

4.7M PIN

0.79B USD



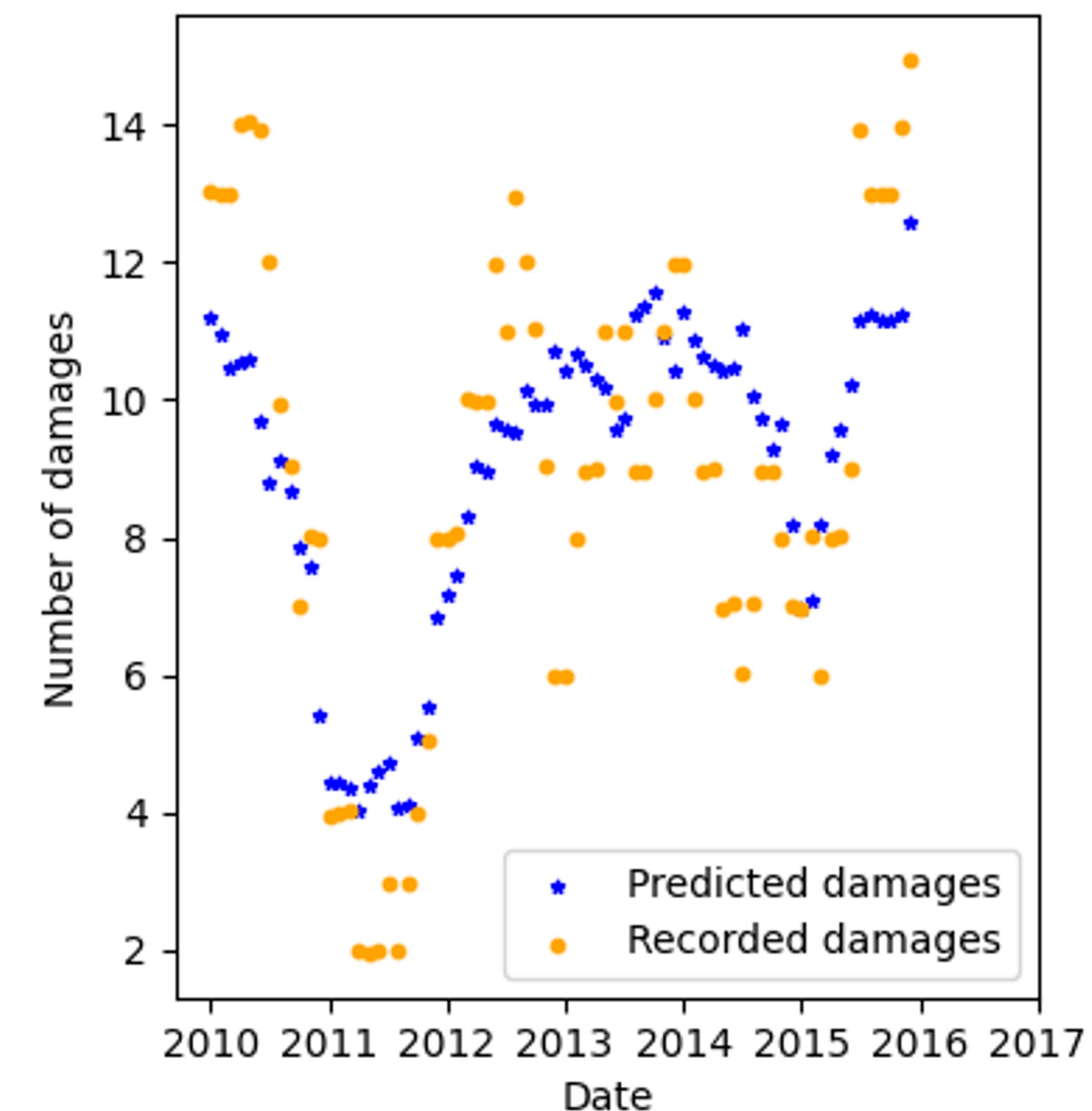
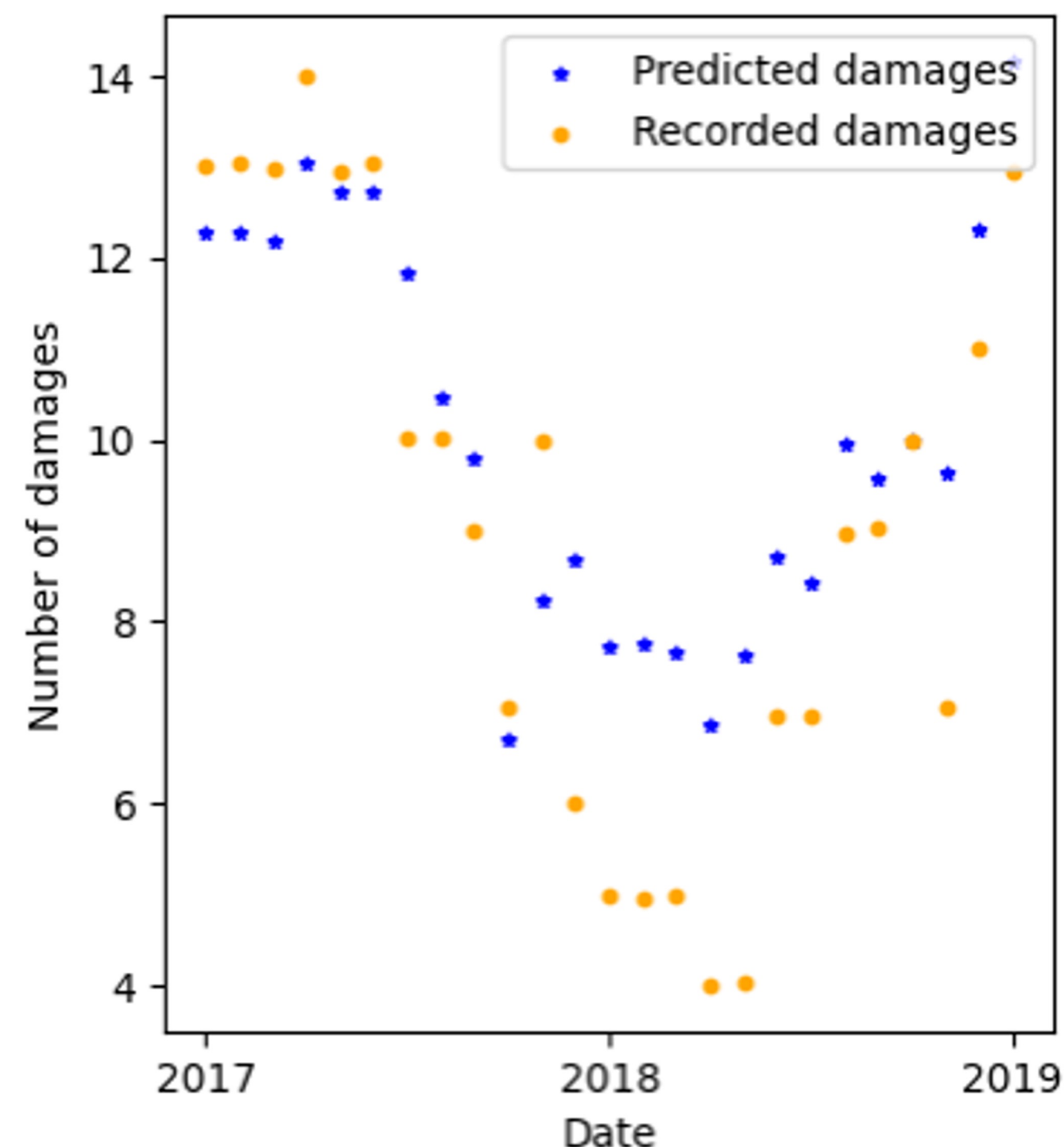
People in Need (PIN) = High acute malnutrition or higher (IPC 3 to 5).  
HA = Extreme Humanitarian Access Constraints



# Seizing Technological Opportunities

## unlocking a new era of risk assessment understanding

Advancements in high-performance computing have facilitated the development of large-scale hazard and risk models, alongside high-resolution exposure mapping. Ensembles of climate and risk models enable innovative approaches to uncertainty quantification and robust decision-making.



**Annual frequency of impacts** caused by extreme climate and weather events, including precipitation, wind and storm surge. The model predicted quite well (in **blue**) the recorded damages (in **orange**).

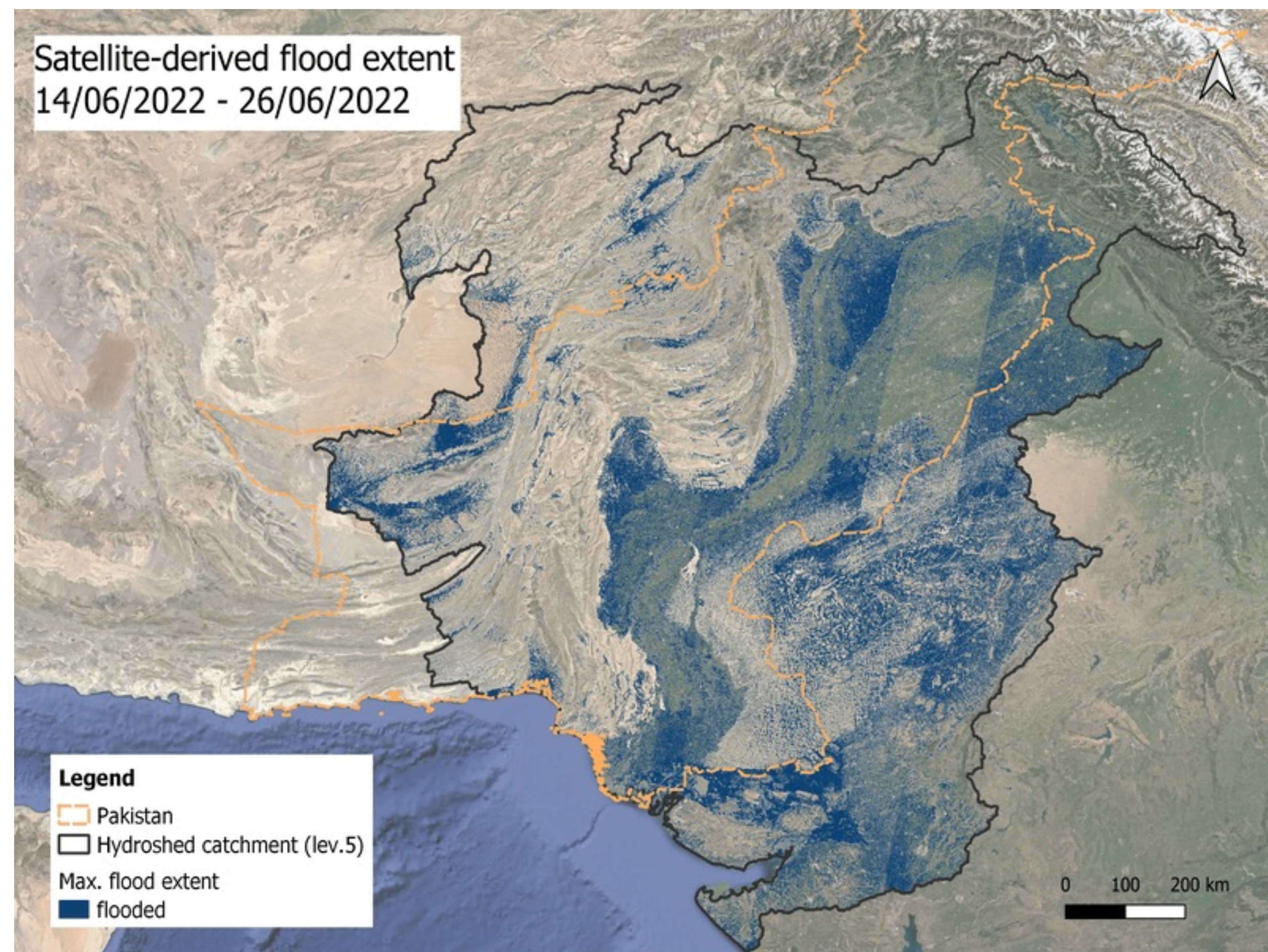


# Seizing Technological Opportunities

## unlocking a new era of risk assessment understanding

Advancements in high-performance computing have facilitated the development of large-scale hazard and risk models, alongside high-resolution exposure mapping. Ensembles of climate and risk models enable innovative approaches to uncertainty quantification and robust decision-making.

The detection and monitoring of the flooded area during the 2022 floods in Pakistan were essential for understanding the extent and evolution of the flood event over time.



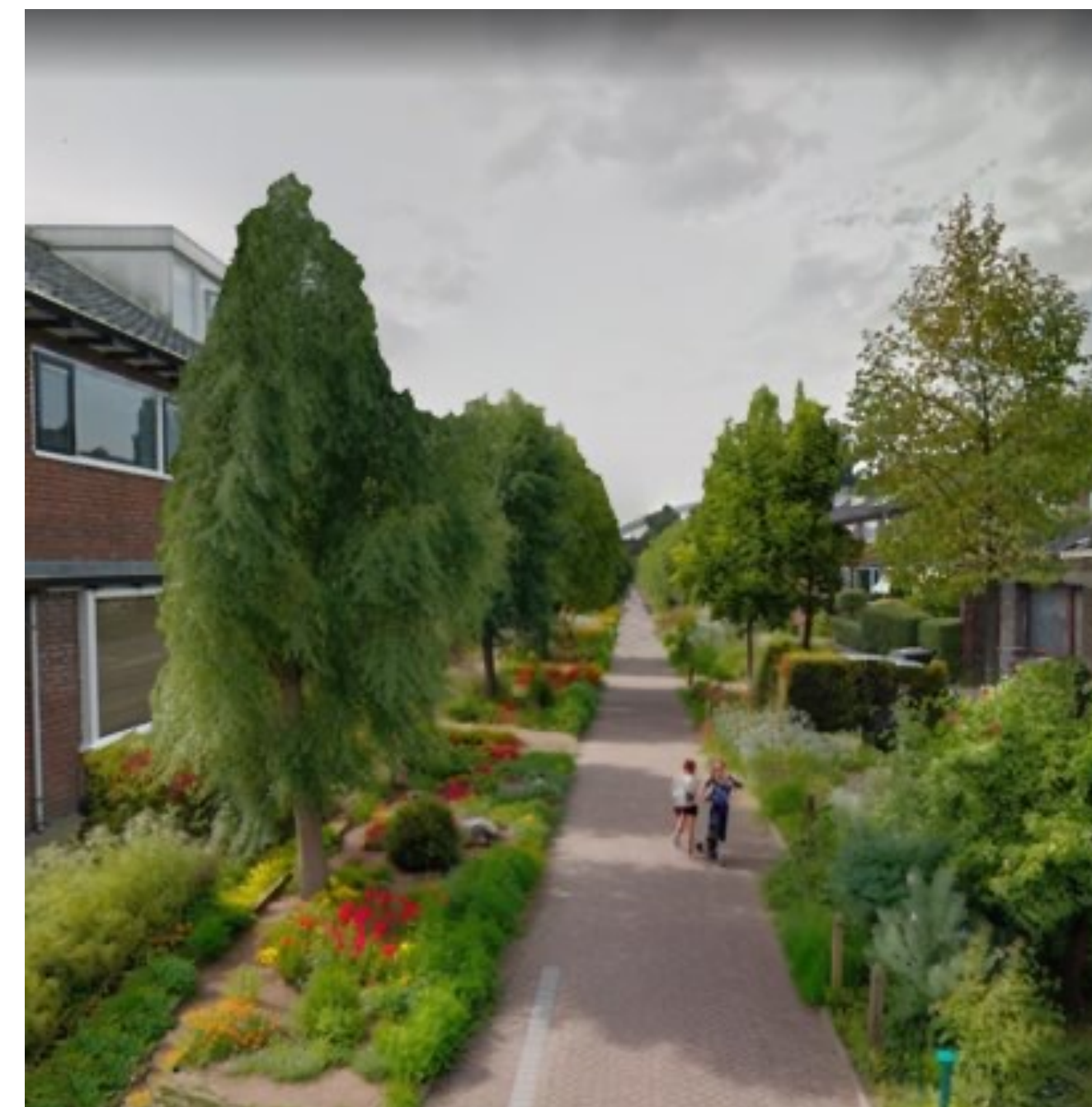
Source: Sarcinelli et al, 2023, under review



# Seizing Technological Opportunities

## unlocking a new era of risk assessment understanding

Advancements in high-performance computing have facilitated the development of large-scale hazard and risk models, alongside high-resolution exposure mapping. Ensembles of climate and risk models enable innovative approaches to uncertainty quantification and robust decision-making.



AI generated images of adaptation measures in urban environment, anticipating the adaptation measures.



# Unlocking Specialized Services

towards the commodification of risk assessment for climate adaptation and resilience

Born out of the recognition that climate information & knowledge **is not or not sufficiently** used for and relied on in tactic and operative decision making,

- many divergent but useful definitions but little recognition as a common trademark, hence difficult to convey,

- a type of (science-based) **knowledge intensive business services** KIBS - with all the challenges and risks this involves,

- **not** Decision Support Systems (DSS) - although similar in some respects,

- a specific, if not unique, area of **model-based decision aid** - which has implications for this session  
- how models are responsibly used for policy and decision making.

EU Research & Innovation [roadmap](#) on CS: **Climate services entail** 'transformation of climate-related data - together with other relevant information - into customised products such as projections, forecasts, information, trends, economic analysis, assessments (including technology assessment), counselling on best practices, development and evaluation of solutions and any other service in relation to climate that may be of use for the society at large'

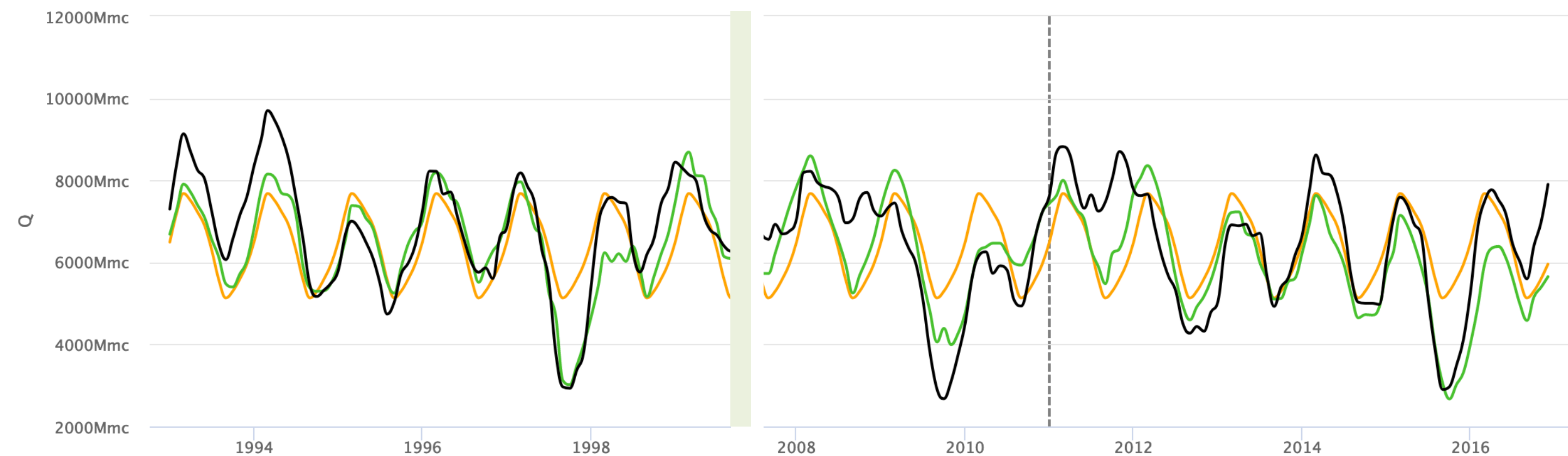
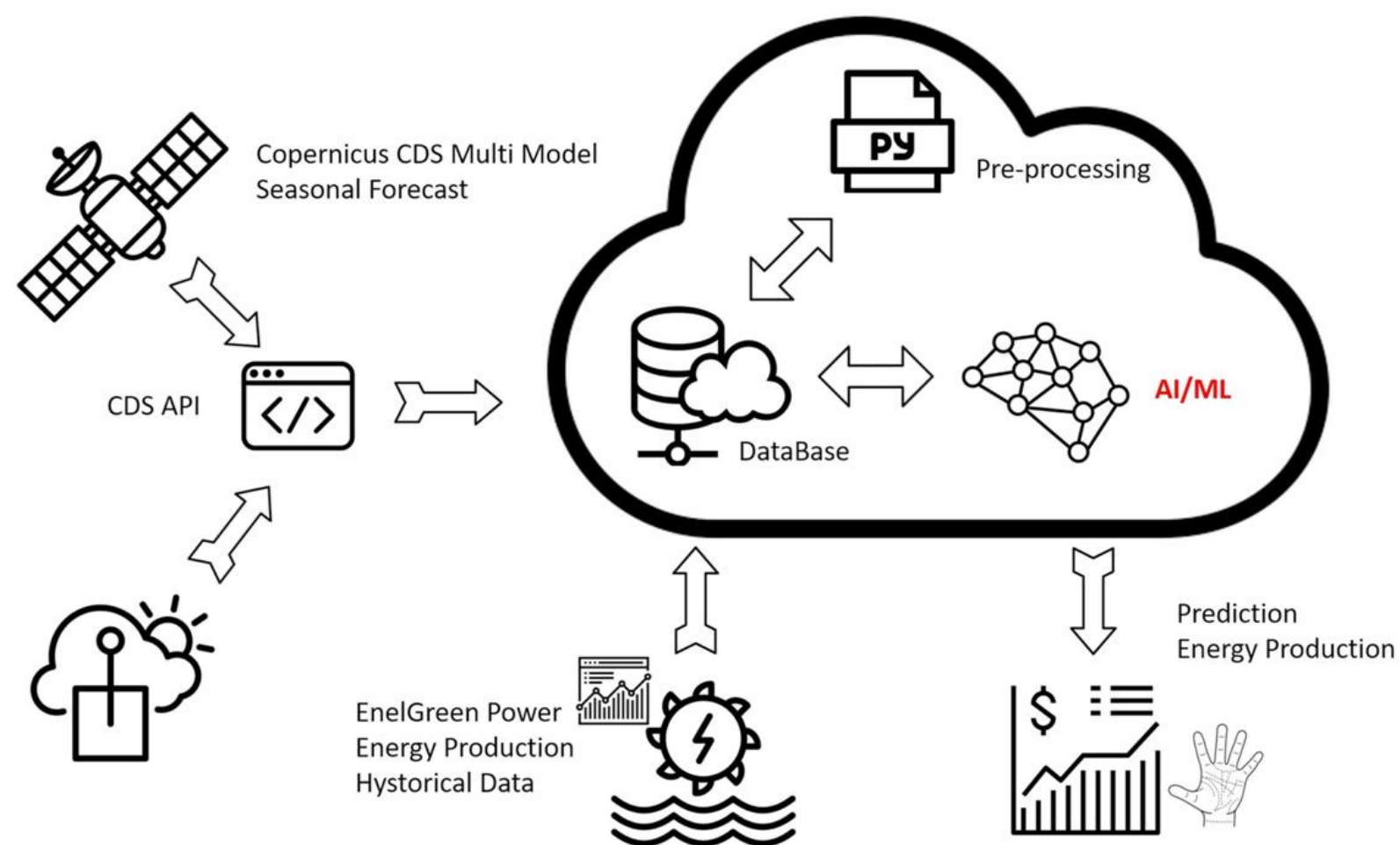
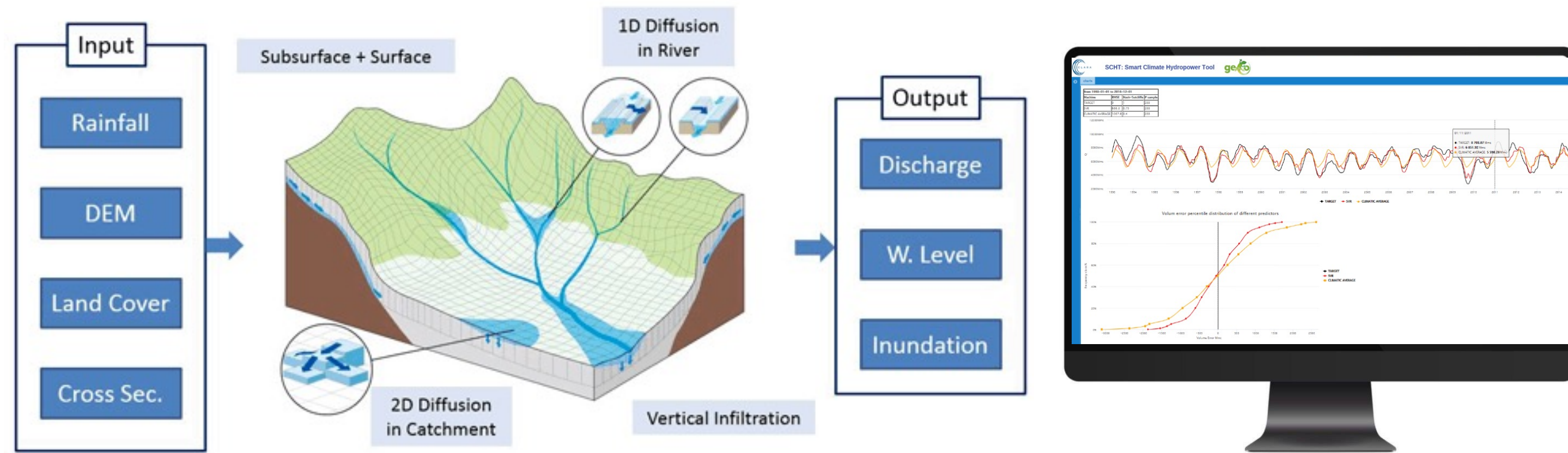
Global Framework for Climate Services (GFCS) and its evolution – Hewitt et al. 2020. [10.1175/BAMS-D-18-0211.A](#) Harjanne. 2017. GEC [10.1016/j.gloenvcha.2017.06.008](#)

Mapping of climate services - Larosa & Mysiak ERL 2019, 14(9). [10.1088/1748-9326/ab304d](#)

Business model innovation. Larosa & Mysiak CLIMS 2020 [10.1016/j.cliser.2019.100111](#)

## Smart river (web, leaflet)

Hydropower forecast - predict the accumulated seasonal river discharge into the reservoir and estimates the difference between the scheduled and achievable hydropower production to choose corrective sales or purchase of energy. Web-cloud-based service based on data-driven methods relying on ML.





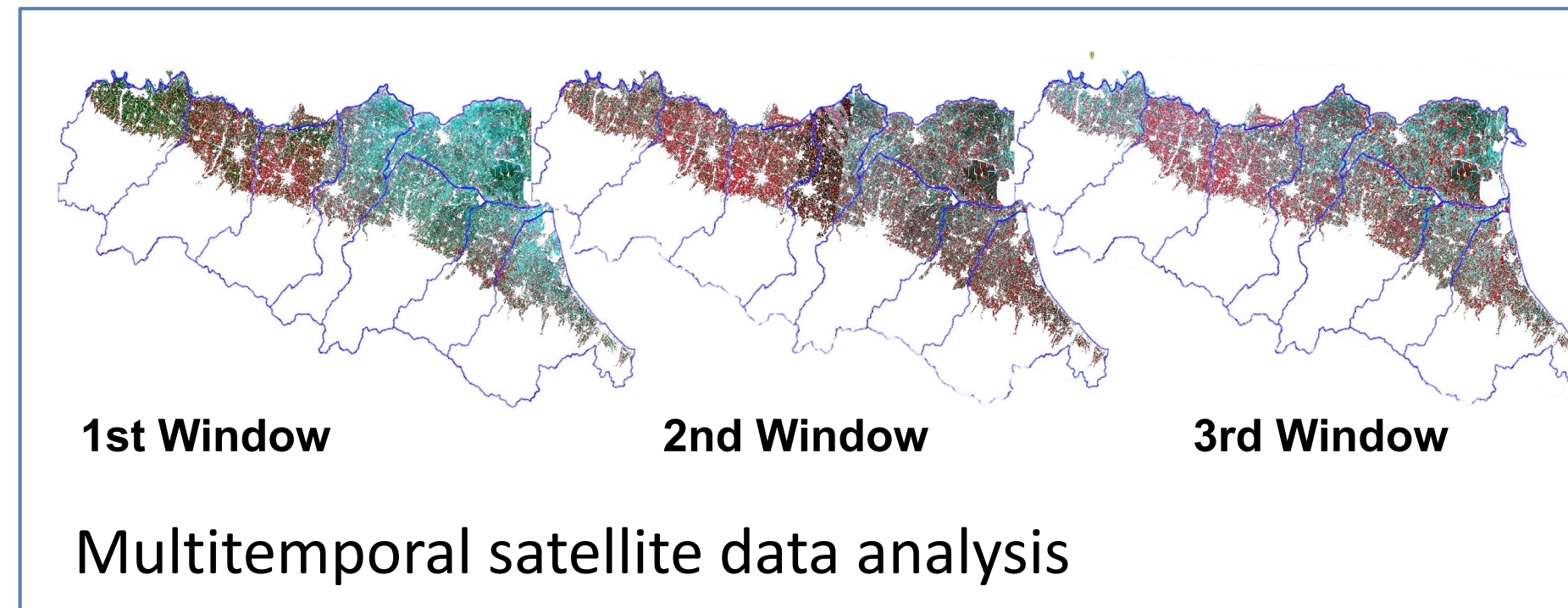
## WRI (web, leaflet)

Water availability and irrigation demand over irrigation season

Water irrigation demand during the irrigation season from April to September.

Forecasts provide anomalies of crop water needs with respect to reference climate.

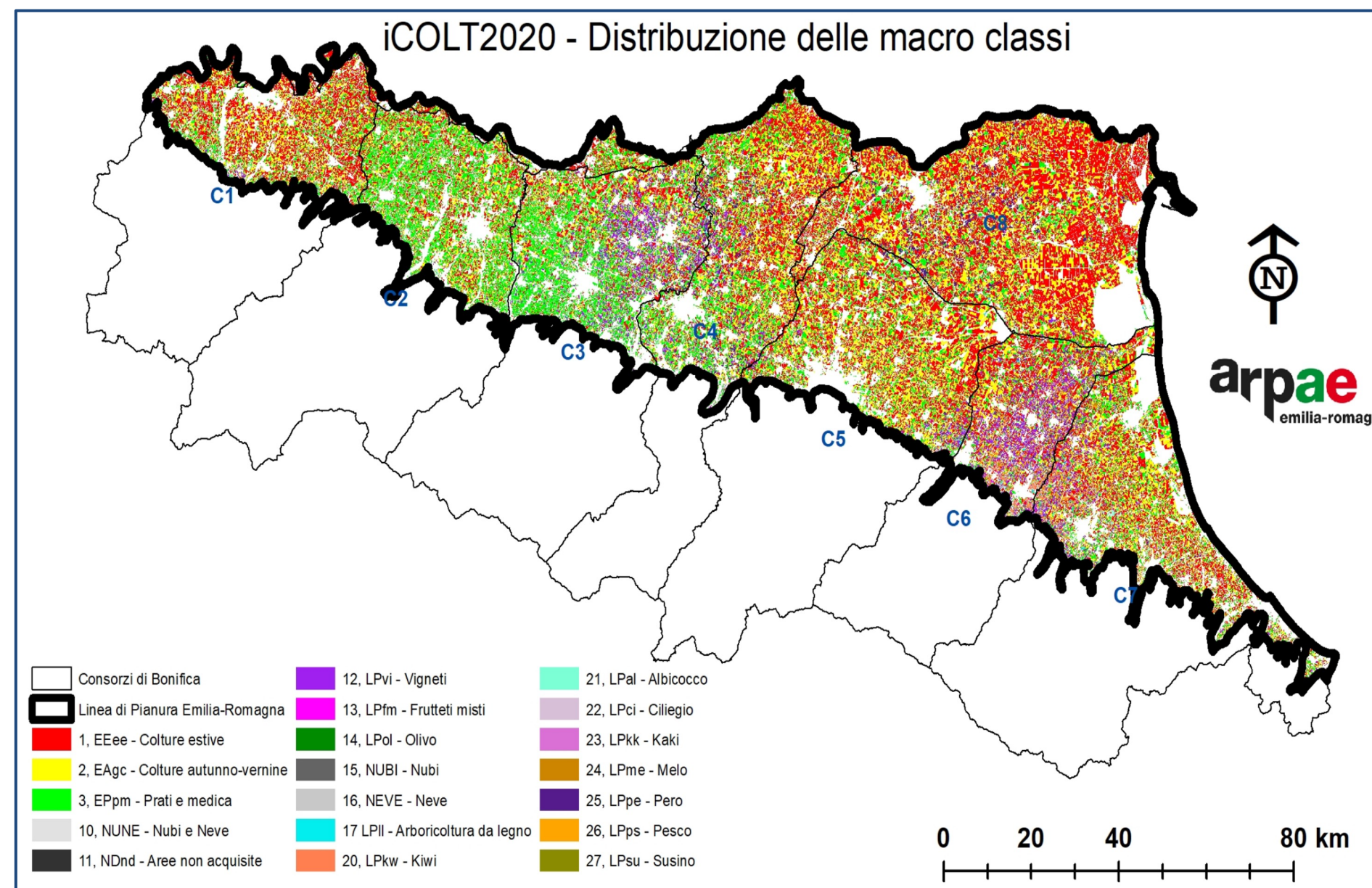
Seasonal forecasts (+3 months) are produced every month, and weekly forecasts (+7



Sep-Oct-Nov

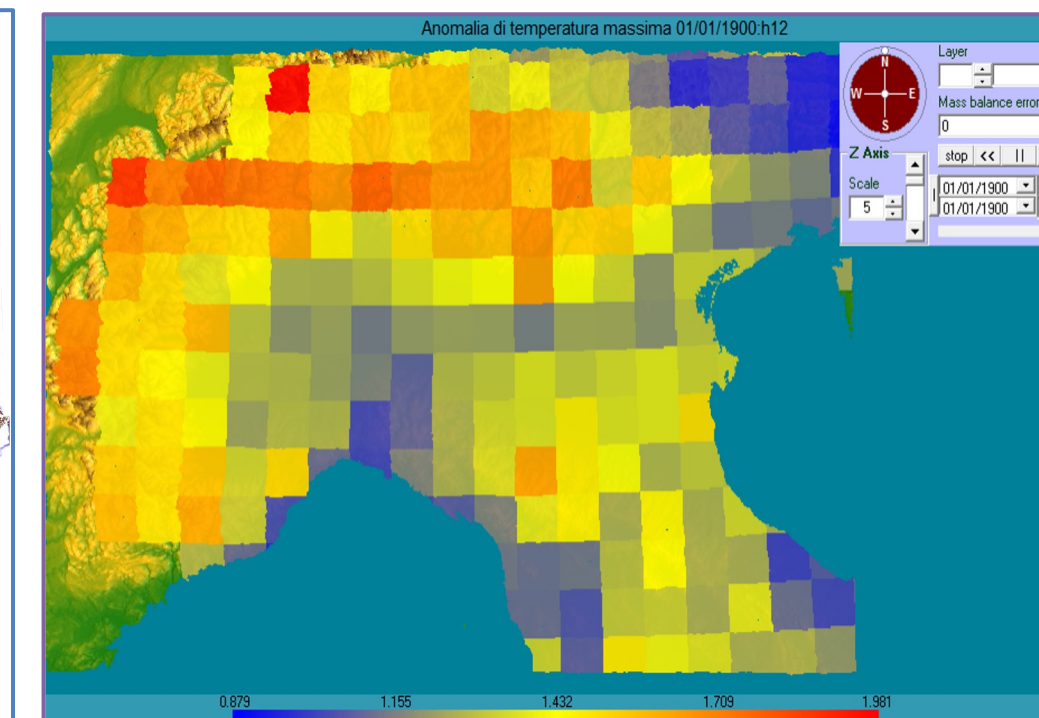
Feb

Mar/Apr

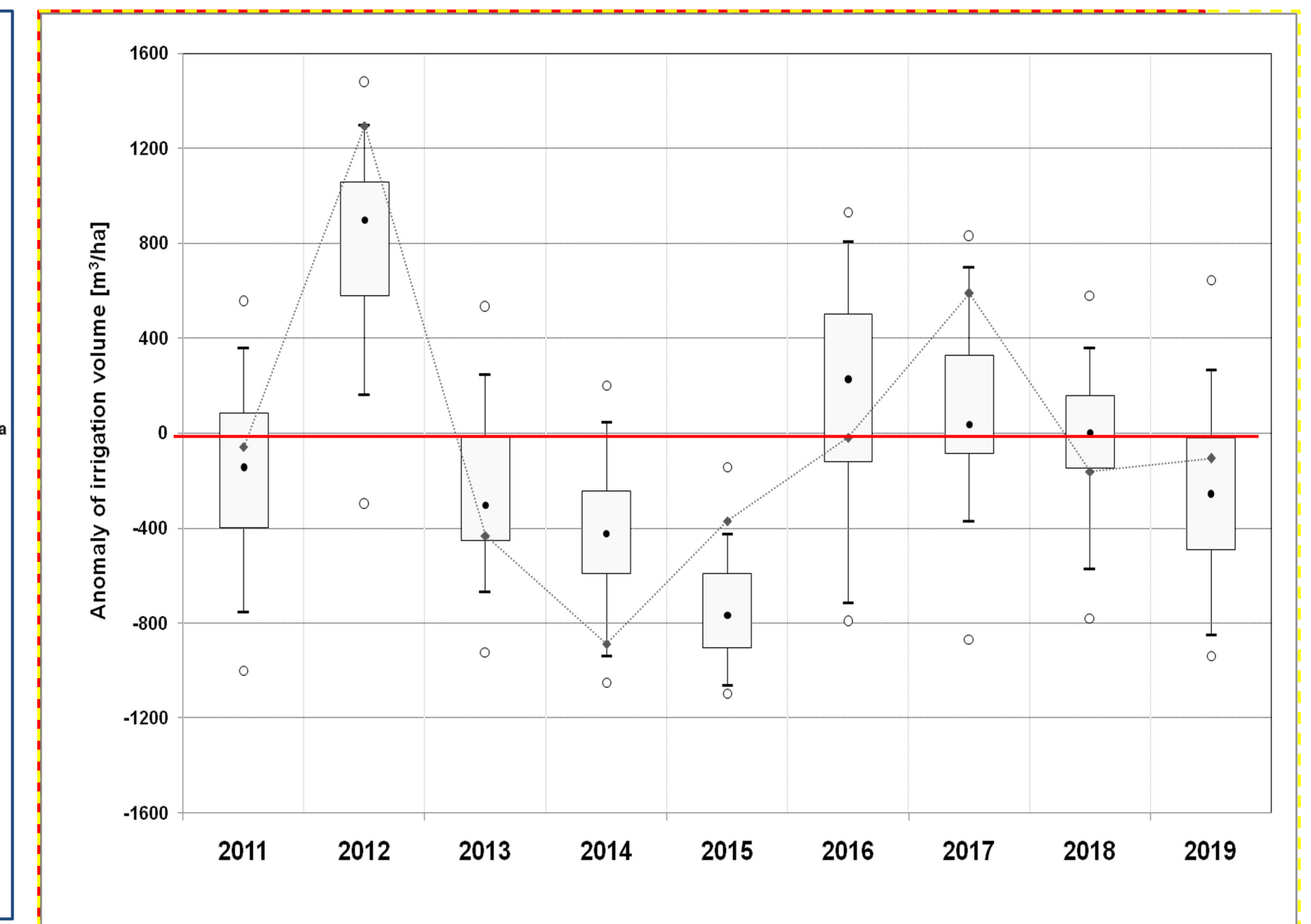
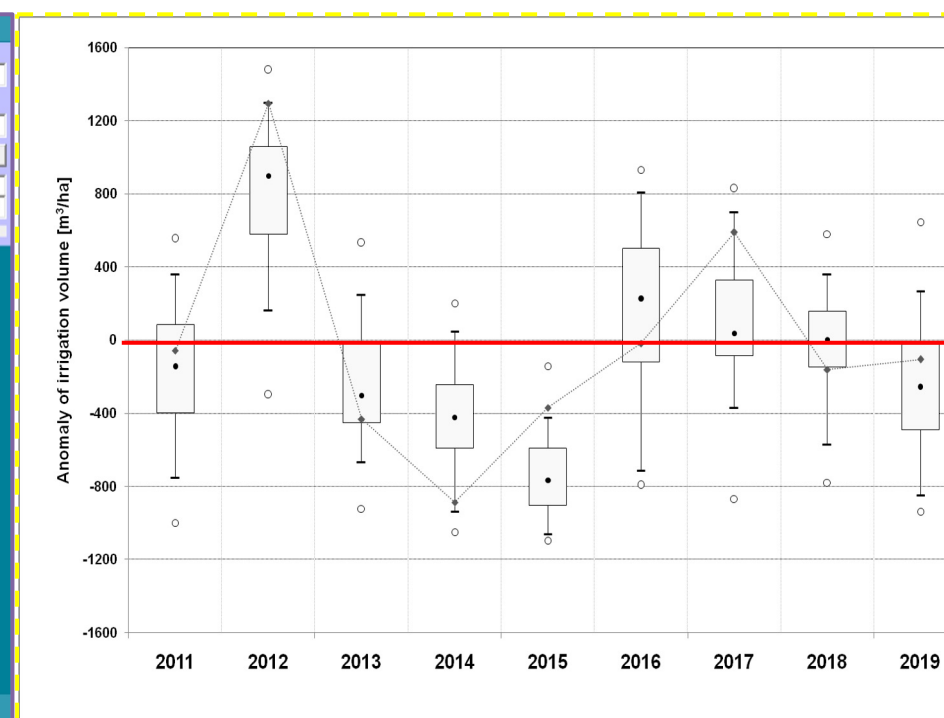


Early crop classification map

Downscaled, bias-corrected seasonal forecasts



Validation of irrigation forecast



Villani et al

<https://doi.org/10.1002/met.2007>



## **FLOODMAGE** (web, leaflet)

From forensic analysis of the drivers of risks to economic and social benefits of improved climate risk assessments.

From in-depth asset-level to community & regional to national risk assessments.

### **Examples of applications:**

- Cost benefit assessment of restored natural dunes to protect coastal residential areas,
- Pluvial urban hazard and risk assessment and management through urban green





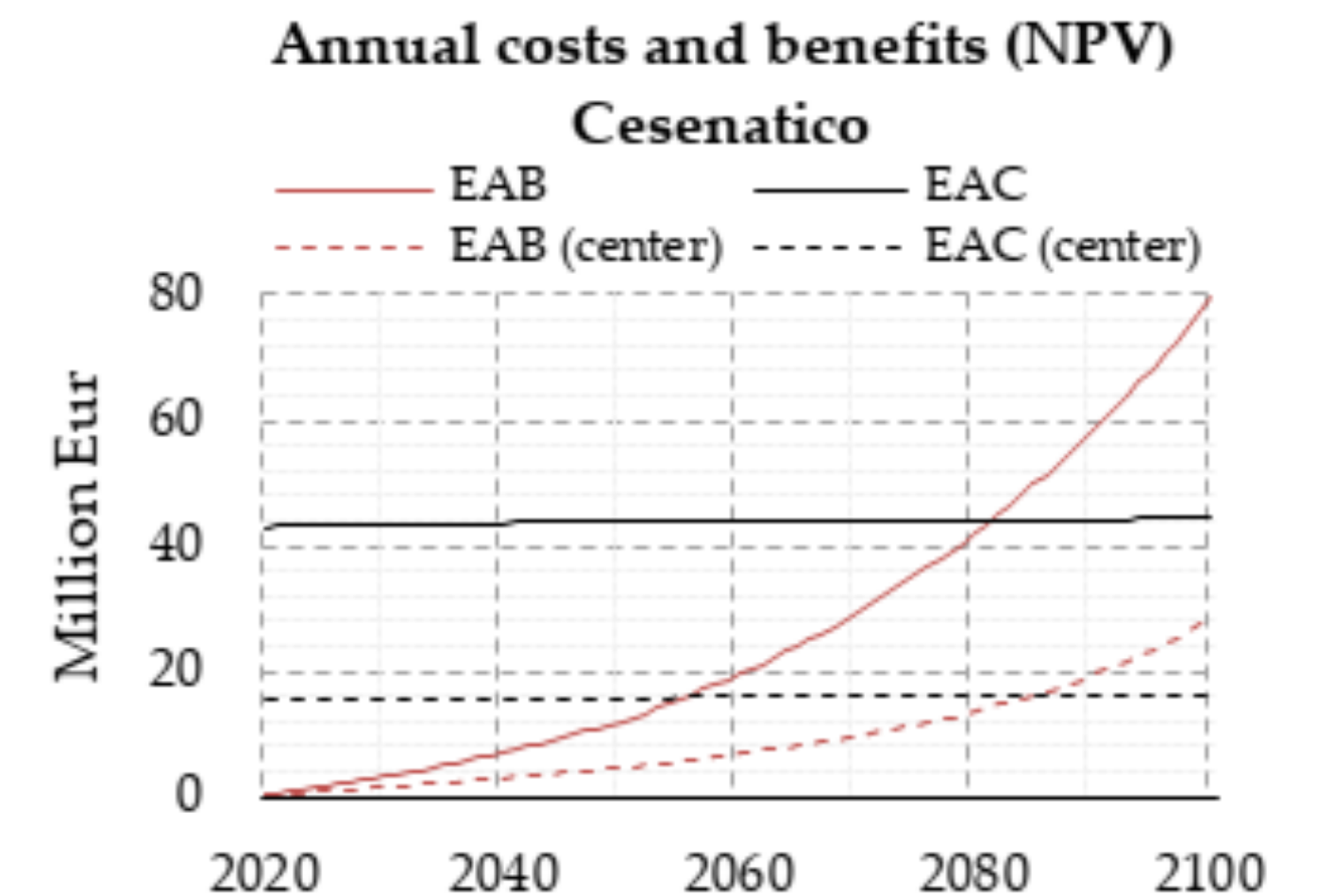
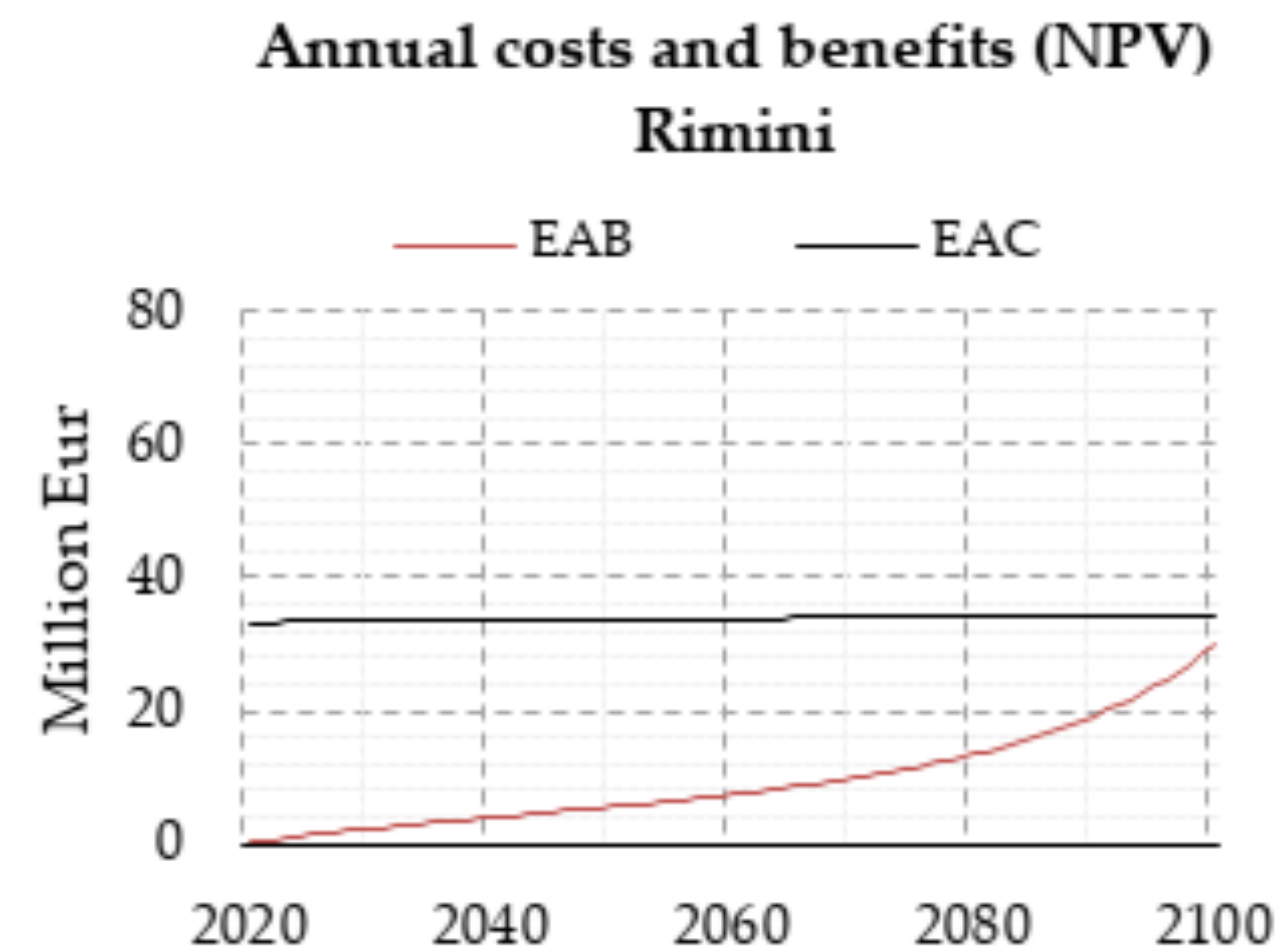
## FLOODMAGE (web, leaflet)

From forensic analysis of the drivers of risks to economic and social benefits of improved climate risk assessments.

From in-depth asset-level to community & regional to national risk assessments.

### Examples of applications:

- Cost benefit assessment of restored natural dunes to protect coastal residential areas,
- Pluvial urban hazard and risk assessment and management through urban green





**Adaptation services** - supporting assessment of vulnerability in a wider perspective and include the design and appraisal of adaptation strategies in a multi-stakeholder setting (Gooden et al.).

Active brokerage and mediated transfer of knowledge between public and private actors, face-to-face collaboration between providers and clients (“front office”), and integration of social, economic and non-climate environmental challenges with climate risks (Swart et al)

**Resilience services** – focus on determinates of vulnerability, role of citizens and organisations as agents of individual and social change, forging new commitments and knowledge, and innovative mechanisms of engaging people throughout the process. **Shared vision and pathways to realize that vision.**

**Resilience has become a new 'compass' for EU policies** (Strategic foresight report, 2020).

Resilience dashboards aim to provide a holistic assessment of resilience in the EU and Member States in relation to ongoing societal transformations and challenges ahead

Union Civil Protection Mechanism (UCPM) introduced resilience goals. European Climate Adaptation Strategy (‘Forging a climate-resilient Europe’) and the European Climate Law that promotes resilience, as a part and target of climate adaptation efforts in line with the Paris Agreement on Climate Change. Horizon Europe Mission on climate adaptation and societal transformation laid out an ambitious goals of least 150 European regions and communities to become climate resilient by 2030.



# Embracing Transformative Change for a more resilient world





# Desperately needed but elusive difficult to define and measure

Detrimental global environmental change is not merely a side effect, but a characterising trait of modern societal development.

Bold and transformative actions is needed to address the root causes that generate and reproduce economic, social, political and environmental problems and inequities.

There is a sizeable conceptual and methodological diversity on which features - depth, breadth, form, spatial and temporal scales, levers, outcomes, evolution and permanence - make a

Transformative turn – exponentially growing number of peer-reviewed articles using transformation-related terms & concepts but mostly without explicit definition (Moore et al 2021 Wires <https://doi.org/10.1002/wcc.738>)

Comparison of transition vs transformation Hölscher et al 2018 <https://doi.org/10.1016/j.eist.2017.10.007>

Types and mechanisms of change

- Innovation: Unleashing Novel Activities and New Applications
- Expansion: Scaling Up Activities to Greater Intensity and Scope
- Reorganization: Overhauling Governance Structures for Adaptation
- Reorientation: Reshaping Social Values and Relations in Response.



# Mission oriented research and innovation

## EU Horizon Europe

The mission-oriented research & innovation is a part of Horizon Europe, the proposed EU Research and Innovation Framework Programme 2021-2027.

- Bold and Inspirational Missions with Broad Societal Relevance
- Clear Framework: Targeted, Measurable, and Time-Bound Goals
- Establishing Realistic yet Impact-Driven Objectives
- Mobilizing Resources at EU, National, and Local Levels
- Fostering Interdisciplinary Collaboration and Integration
- Enhancing Public Understanding of Research and Innovation's Value

Each mission will operate as a portfolio of actions – such as research projects, policy measures or even legislative



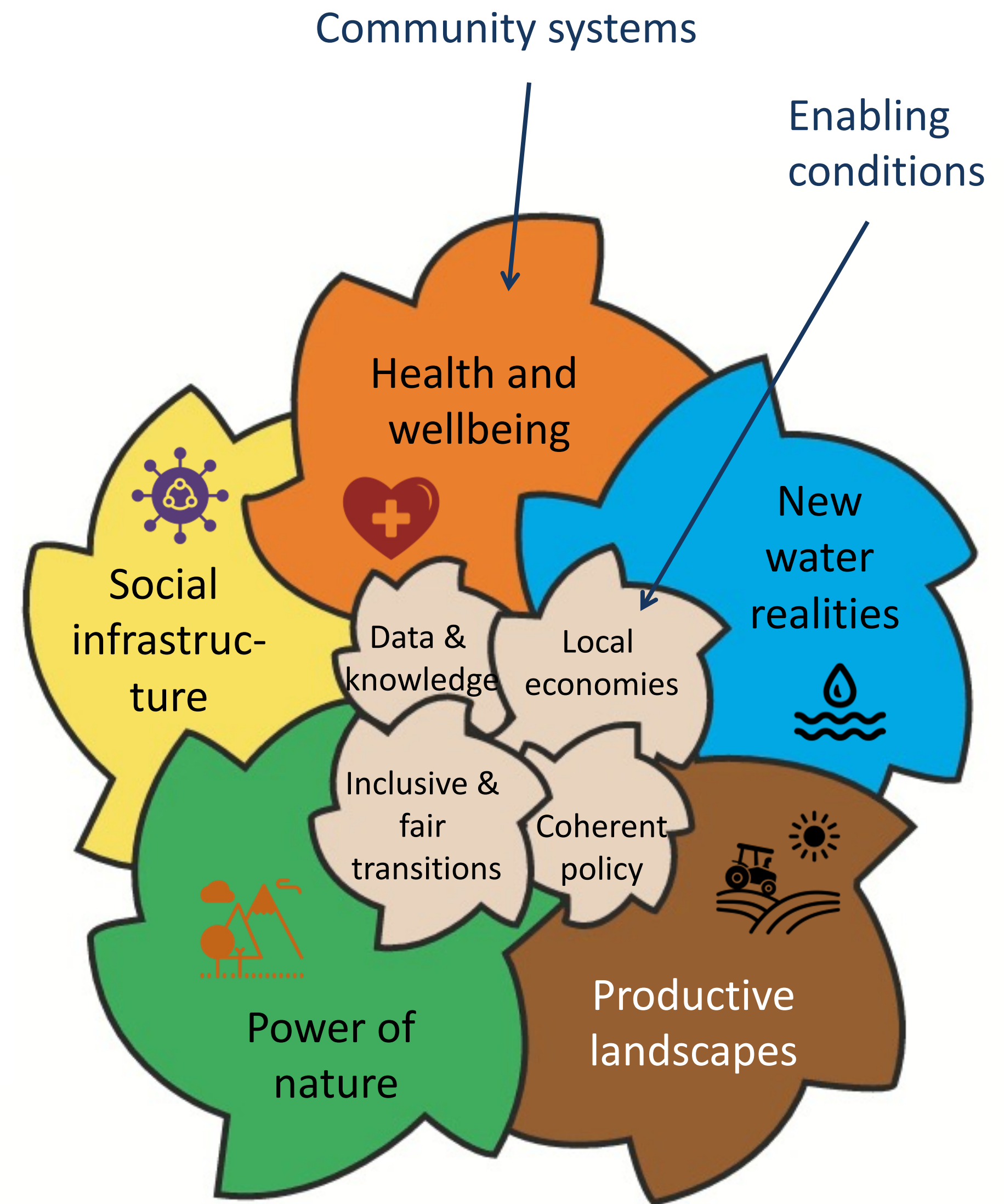
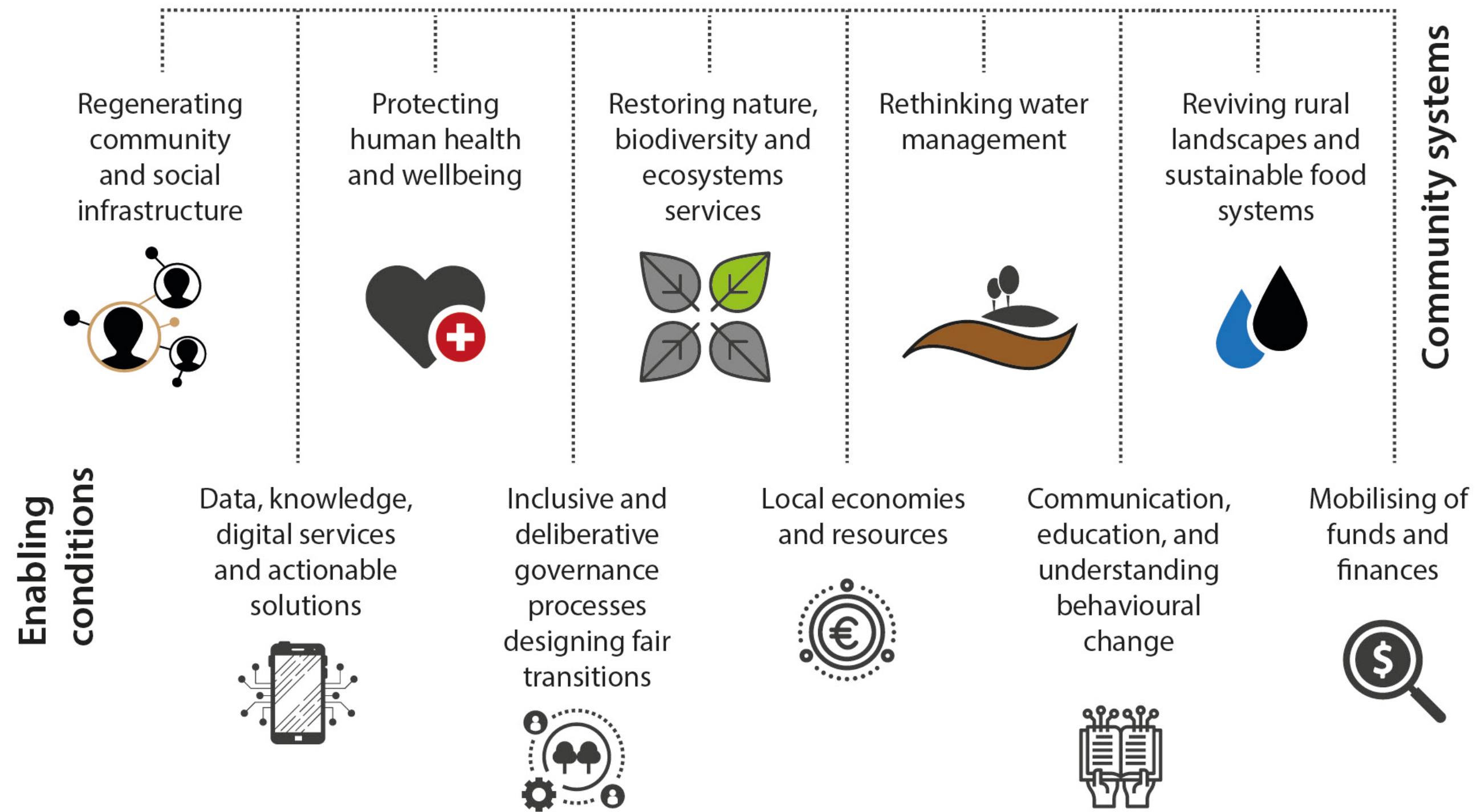
[For more information](#)



# EU Mission: Adaptation to Climate Change

#MissionClimate

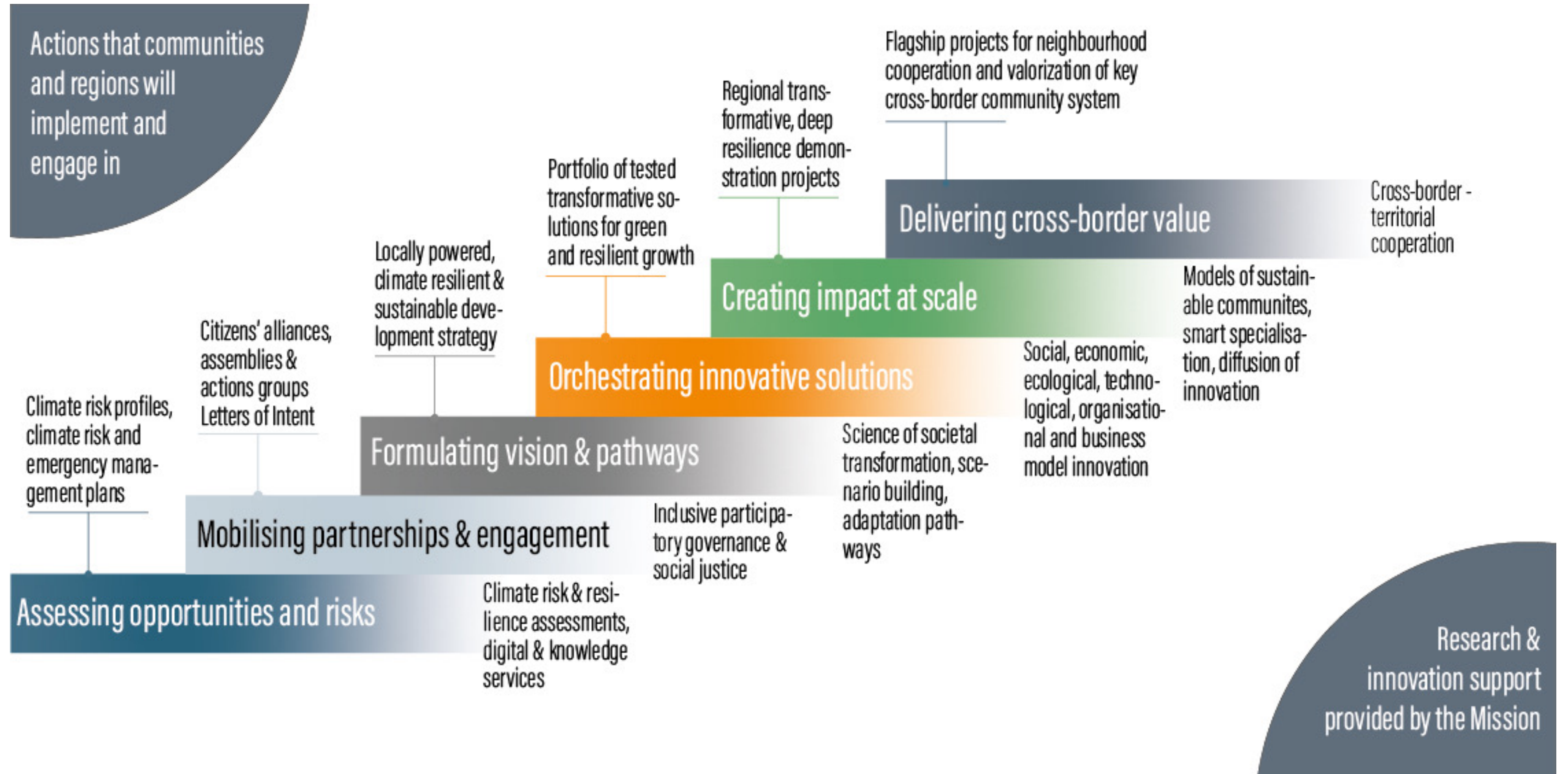
## Innovation with and within





# EU Mission: Adaptation to Climate Change

#MissionClimate





# Three Goals and converging paths

## Three Goals and converging paths

### **Objective 1: Prepare and Plan for Climate Resilience**

Provide support to enhance understanding, preparation, and management of climate risks and opportunities.

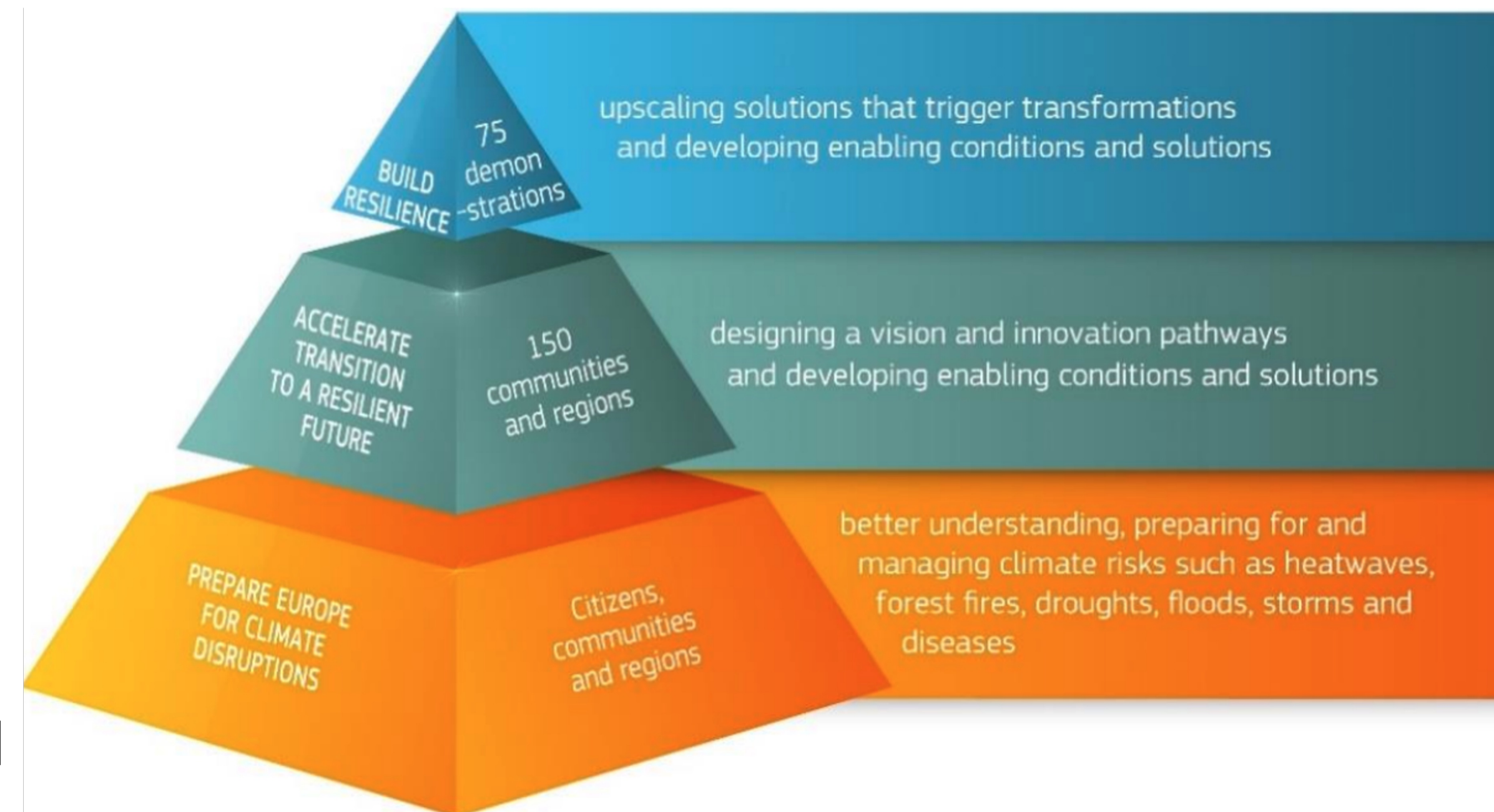
### **Objective 2: Accelerate Transformations to Climate Resilience**

Collaborate with over 150 regions and communities to expedite their transition towards a climate-resilient future.

Support the co-creation of innovation pathways and the testing of solutions.

### **Objective 3: Demonstrate Systemic Transformations to Climate Resilience**

Deliver a minimum of 75 large-scale demonstrations showcasing systemic transformations to climate resilience across European regions and communities.





# Role of climate risk assessment unleashing action and leveraging change

Regional and local climate risk assessments are critical for collective decision-making on how to adapt to climate risks, prioritise goals and visions, and coordinate adaptation processes across various aspects of community living.

They are not solely defined by the spatial scale they cover. Instead, they are primarily focused on ensuring the prosperity and resilience of the communities in the region, as well as the safety and integrity of the environment in which they reside.

Risk assessments may examine how climate variability and change affect farming and food production in rural areas dominated by agriculture, as an example. A regional climate risk assessment does not stop at evaluating the impact on individual farms, but rather it delves deeper to analyse how changes in farm profitability and viability may have a ripple effect on local employment, fiscal revenues and social services that rely on these revenues

Specific for key community systems most vulnerable to climate change:

- health and social care systems,
- critical infrastructure and entities,
- water supply,
- landscape productivity and



# Principles

## Tailored CRA Framework & toolbox

Regional climate risk assessments stimulated by the Mission Adaptation should integrate with and enrich existing risk assessments, contributing to their continuous improvement.

The scope, design, and ambition of regional climate risk assessments should reflect regional and local preconditions, priorities, and desired levels of ambition.

Regional climate risk assessment serves strategic purposes, being action and policy oriented, driven by risk assessment policies, and responsive to ethical principles of just resilience & transition, and leaving no one behind

Regional and local communities, authorities, and wider stakeholders hold ownership of the risk assessment processes and outcomes. Public authorities are accountable to citizens for policy choices based on assessment results. Climate risk assessments supported by the Mission Adaptation should be flexible and responsive to local conditions and priorities, while promoting comparability across European regions and facilitating transparent monitoring and evaluation of progress.

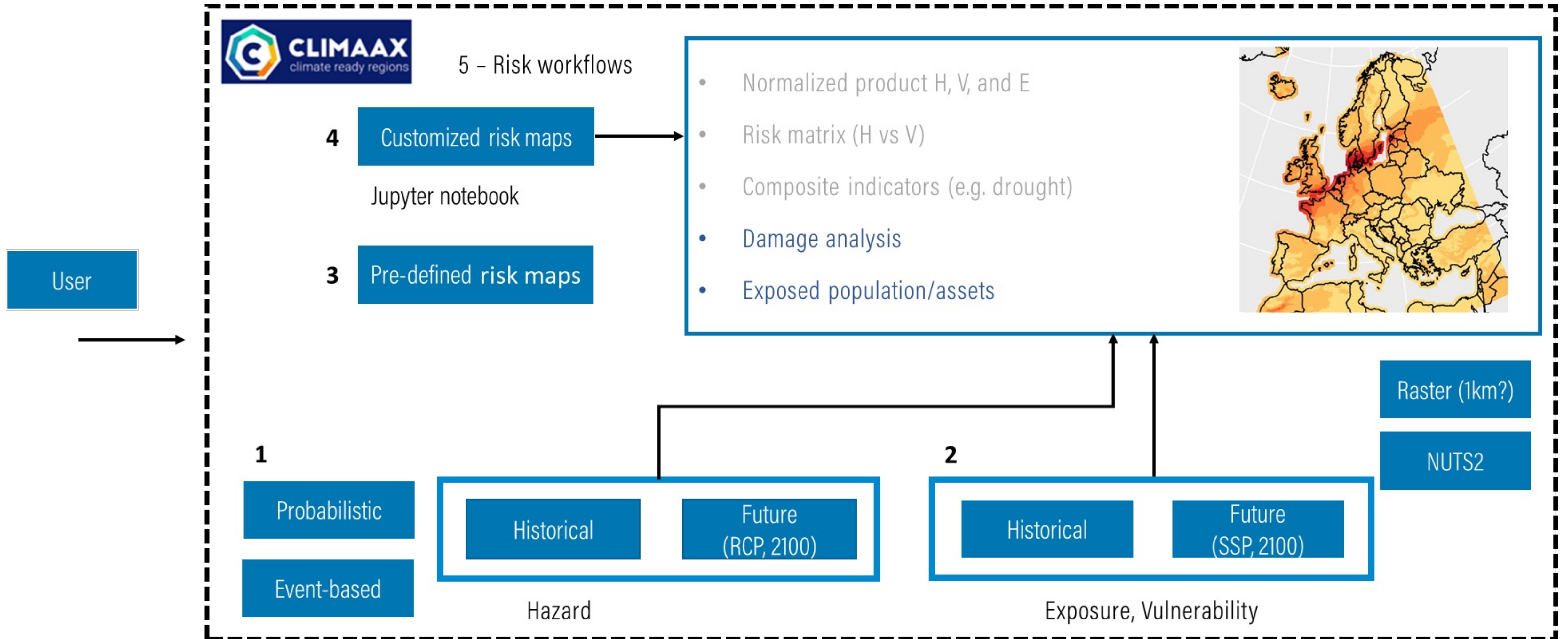
Regional climate risk assessments guide decision-makers in enhancing the region's resilience and sustainability. They provide valuable insights for the development of strategic policies, regulations, and guidelines within the competence of regional authorities. These competences vary across EU regions and between regional and local territorial governance levels.

Regional climate risk assessments should be closely linked to and built upon existing national and regional disaster and climate risk assessments. This integration is crucial for leveraging the emerging trends in systemic and multi-hazard risk methodologies



# Principles

## Tailored CRA Framework & toolbox





**Thank you for your attention**

[jaroslav.mysiak@cmcc.it](mailto:jaroslav.mysiak@cmcc.it)