CLARA

Climate forecasts enabled knowledge services

Economic assessment of flood risks: advancements and lessons learnt

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CLARA GRANT AGREEMENT N° 730482

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Key take-home messages

- Why is the economic assessment of climate-related risks useful?
- How are we getting better at predicting and estimating climate risks?
- How can we better serve society through the provision and development of climate services?

Economic assessment of climate-related risks

Serves multiple purposes

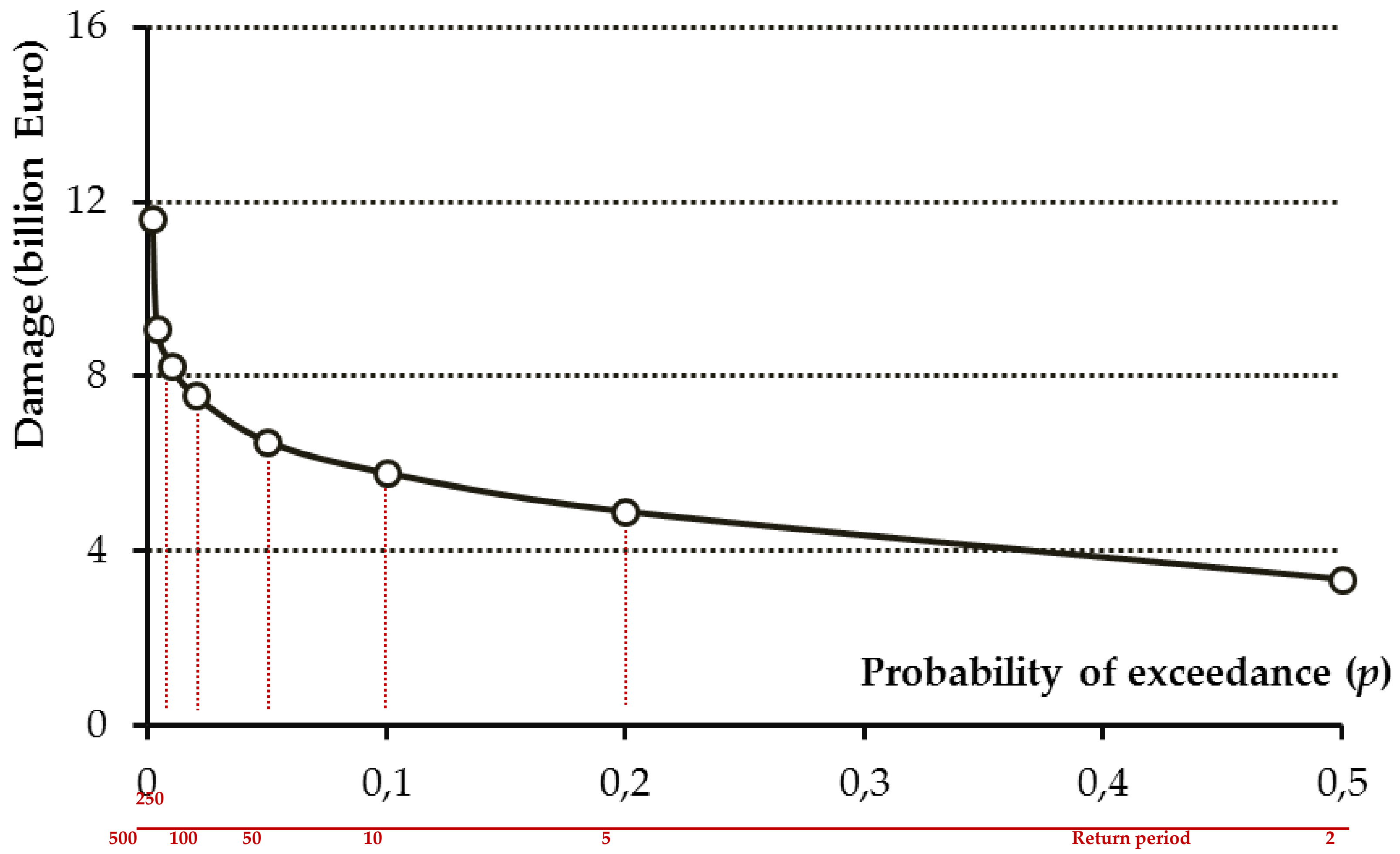
- Effectiveness and efficiency of reducing and financing disaster risk, and adapting to changing climate.
- Risk-sensitive development, social protection systems, economic cohesion and solidarity.
- Fosters climate (and also meteorological and hydrological) services, by exploiting the value embedded in the Copernicus Earth observation program.
- Micro- and macro-prudential regulation, economic policy coordination and internal security.

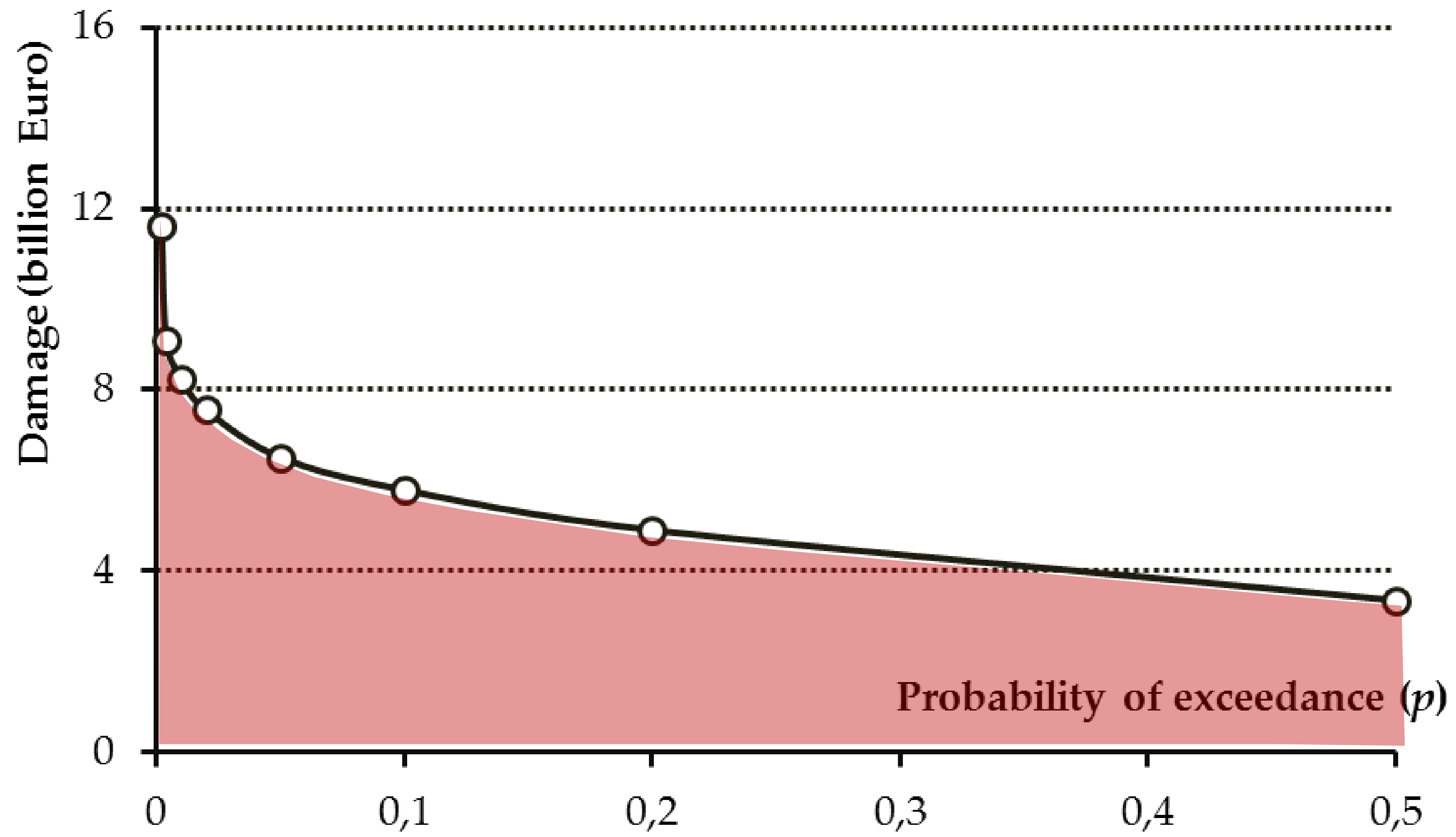
Better understanding of climate risks has economic and financial value, and hence market.

Advancements of climate risk analysis

- **High performance computing** has enabled new generation of climate models that are better capable of simulating climate extremes. Robust estimates are possible also for longer period return values.
- **Multi-model ensembles** with high spatial resolution capable of exploring model uncertainty and better inform public policy choices.
- **Detection and attribution** more reliable when based consistent evidence from observations and numerical models capable of replicating the event.
- Near-term (multi-year to decadal) **predictions** reliability.
- Improved **modelling capability**, including multi-hazard assessment, empirical corroboration of damage models, impact propagation through networks, stress testing of critical infrastructure components. Improved availability of hazard data (e.g. flood hazard and risk prone areas)
- High resolution exposure data including population, gross added value, gross domestic/regional product, buildings, infrastructure, industrial facilities
- Better record of existing risk mitigation measures
- Working in partnerships

Modelling economic losses





- Loss exceedance probability (EP) is probability of exceeding given damage/loss threshold in one year. E.g. loss 8 billion represents the 99 percentile of the annual damage/loss distribution. The probability of exceeding 8 billion in one year is 1%.
- Expected annual damage (EAD) and loss (EAL) is a mean value of a damage/loss exceedance probability (EP) distribution; the expected loss per year.

Market-based climate services

Climate innovation and piloted climate services produce action-oriented knowledge that rally transformational change

- spurred by multilateral frameworks such as UN Sustainable Development Agenda, Sendai Framework for Disaster Risk Reduction, and UNFCCC Paris Agreement on Climate Change.

Climate services are knowledge-intensive business services

- advanced technological and professional knowledge; both users and purveyors play a vital role in co-designing and co-producing the service solutions

Instead of a definition

- Historic climate records, catalogues of extreme events, reanalyses, forecasts, projections and indices used in outlooks, early warnings, vulnerability and risk assessments, monitoring and reporting schemes, and financial protection instruments ….
- …. enable higher agricultural productivity, more efficient use and allocation of water, greater financial security and returns on investments, more reliable access to and production of renewable energy, and more effective protection of vulnerable communities and ecosystems.

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Main objective » to develop a set of climate services building upon the Copernicus C3S seasonal forecasts and sectorial information systems, demonstrate their value and ensure their viability.

» H2020 innovation action (IA), 06/2017 – 05/2020

» 10 partners from academy, business and public administration

» Develop new and enhance existing climate services

» Analyse and demonstrate the **economic and social value** unleashed by climate forecast enabled climate services and corroborate their direct and indirect benefits

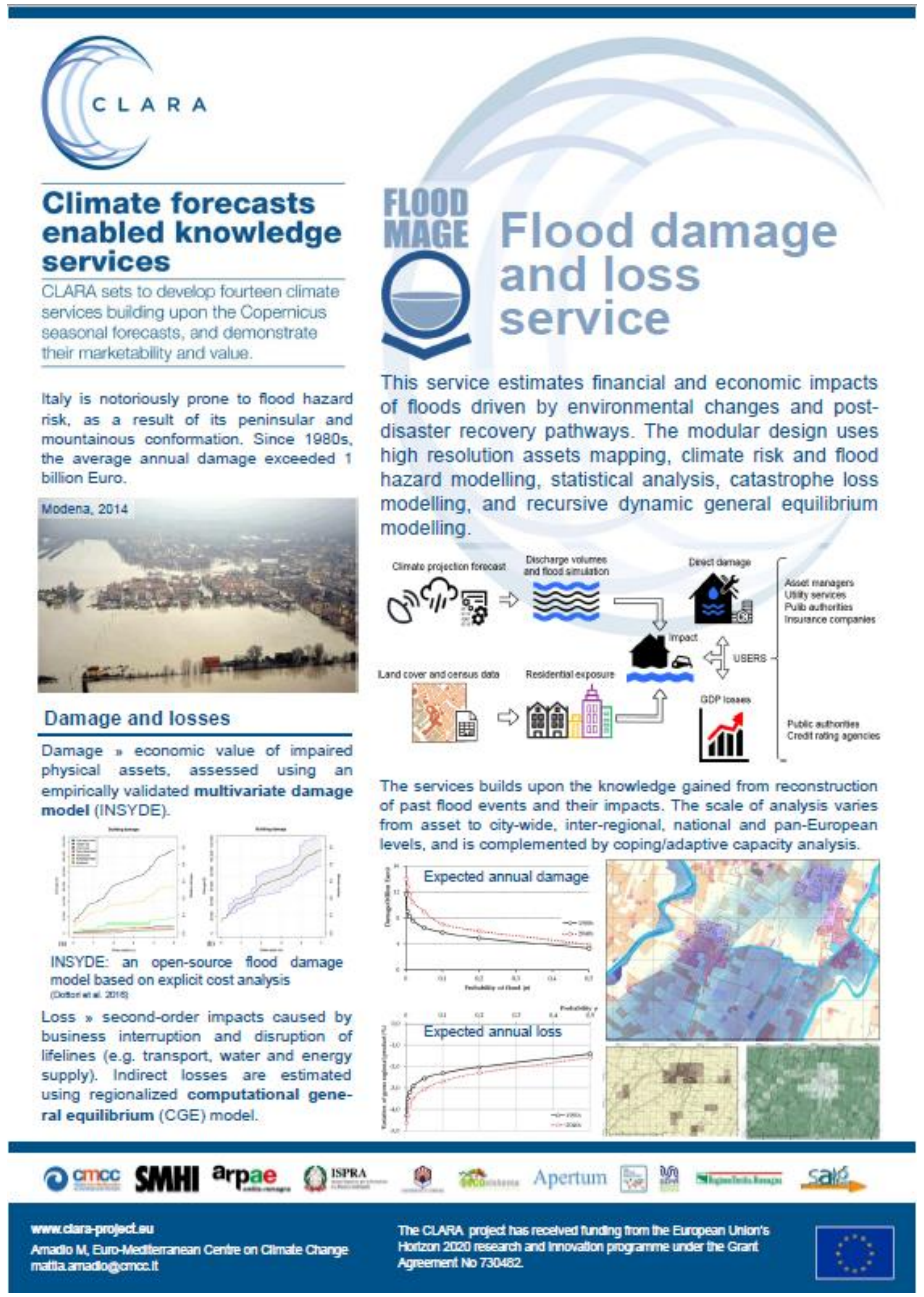
» Engage service developers, purveyors and end-users in **mutually beneficial collaboration and partnerships**

» Contribute to advancing the European **innovation, competitiveness and market performance** for climate services

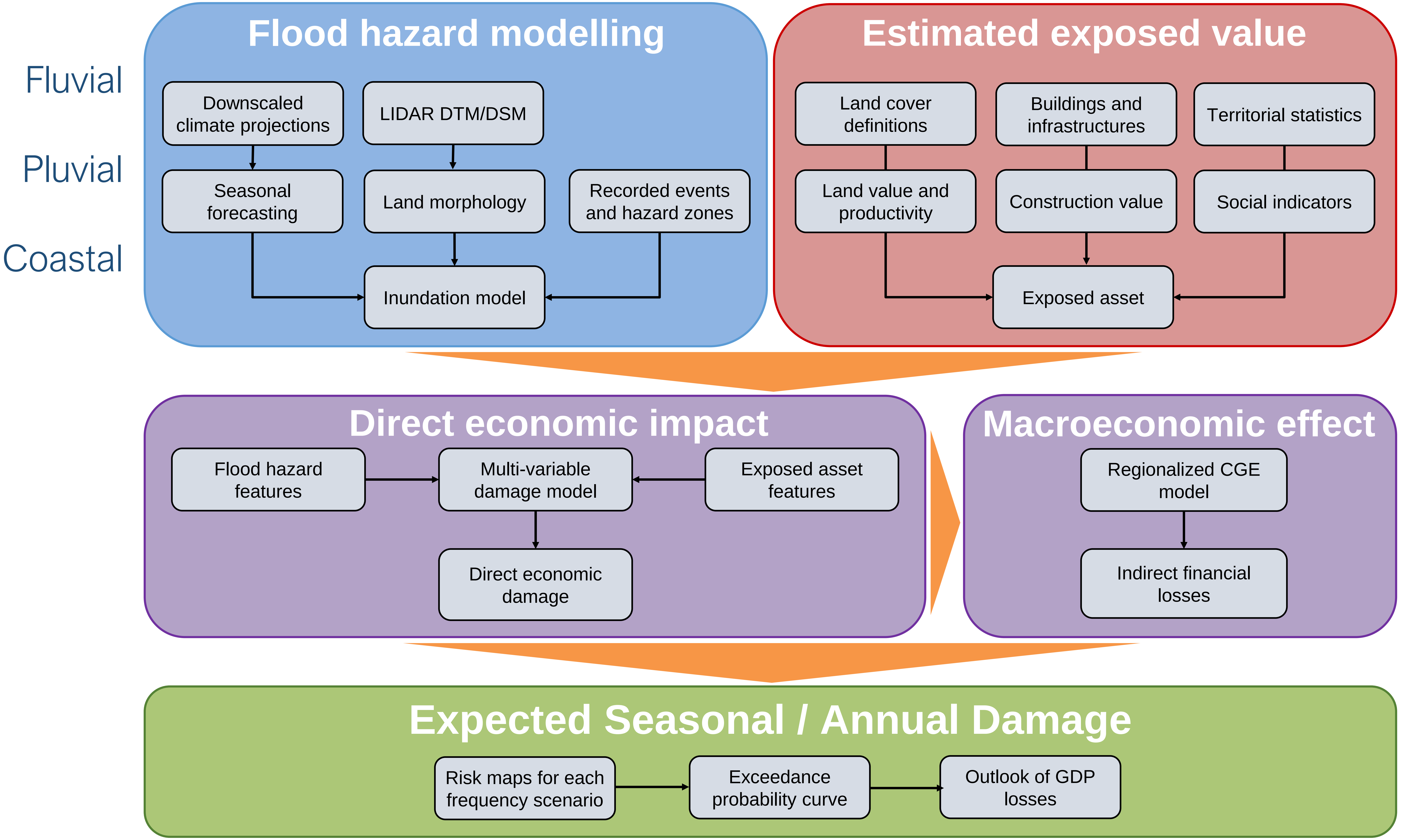
14 climate services from among the GFCS priorities

LOGO							
PARTNER	CMCC	ARPAE	ARPAE	GECOS	SMHI	UCO	GECOS
ACRONYM	FloodMage	PWA	WRI	IRRICLIME	Aqua	ROAT	SCHT

LOGO							
PARTNER	UCO	SMHI	ARPAE	TCDF	CMCC	SMHI	UCO
ACRONYM	SHAT	AirCloud	AQCLI	PPDP	Clime	Hydro Gwh	SEAP



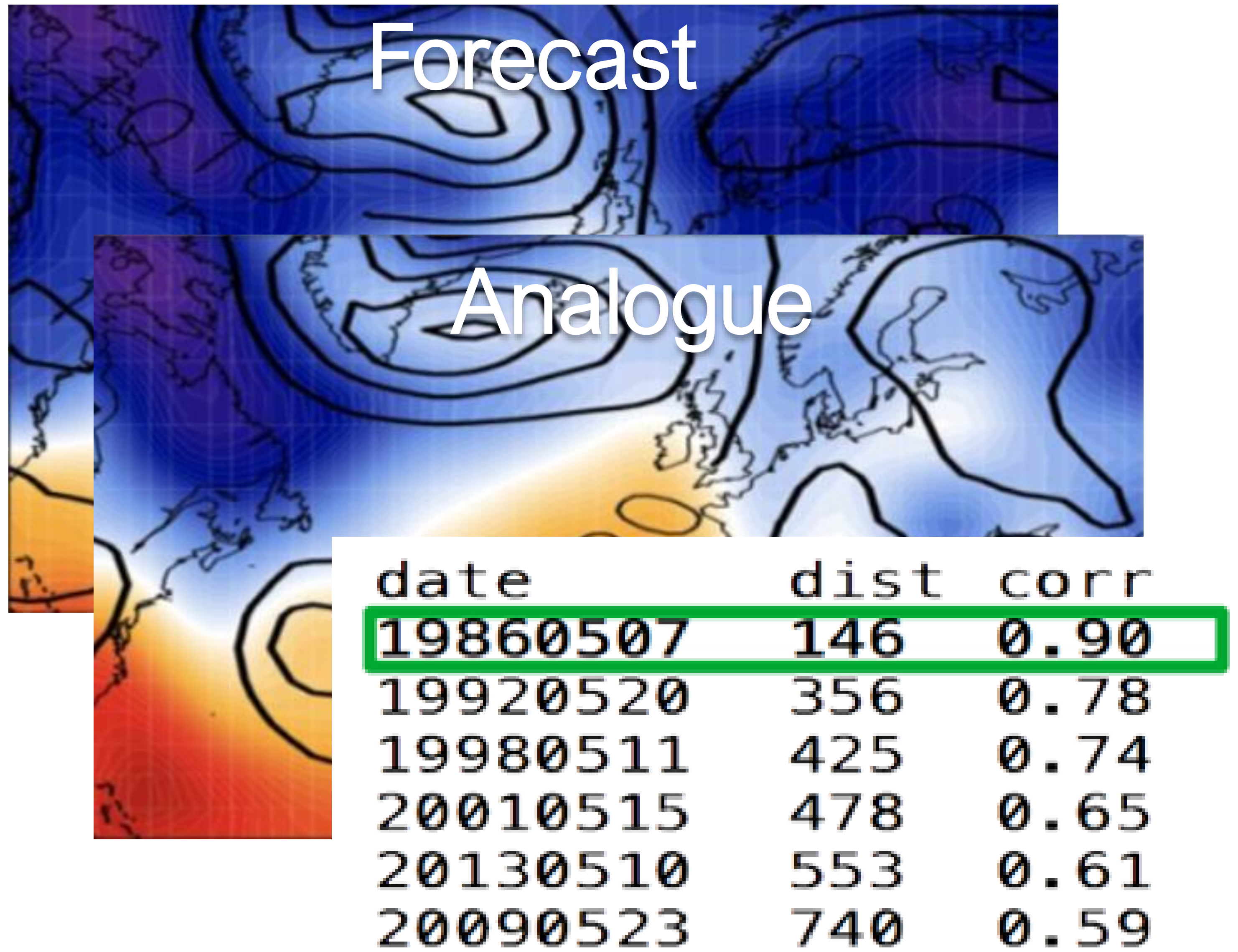
FLOODMAGE: Modelling framework



Climate Service tools for downscaling

Analogues

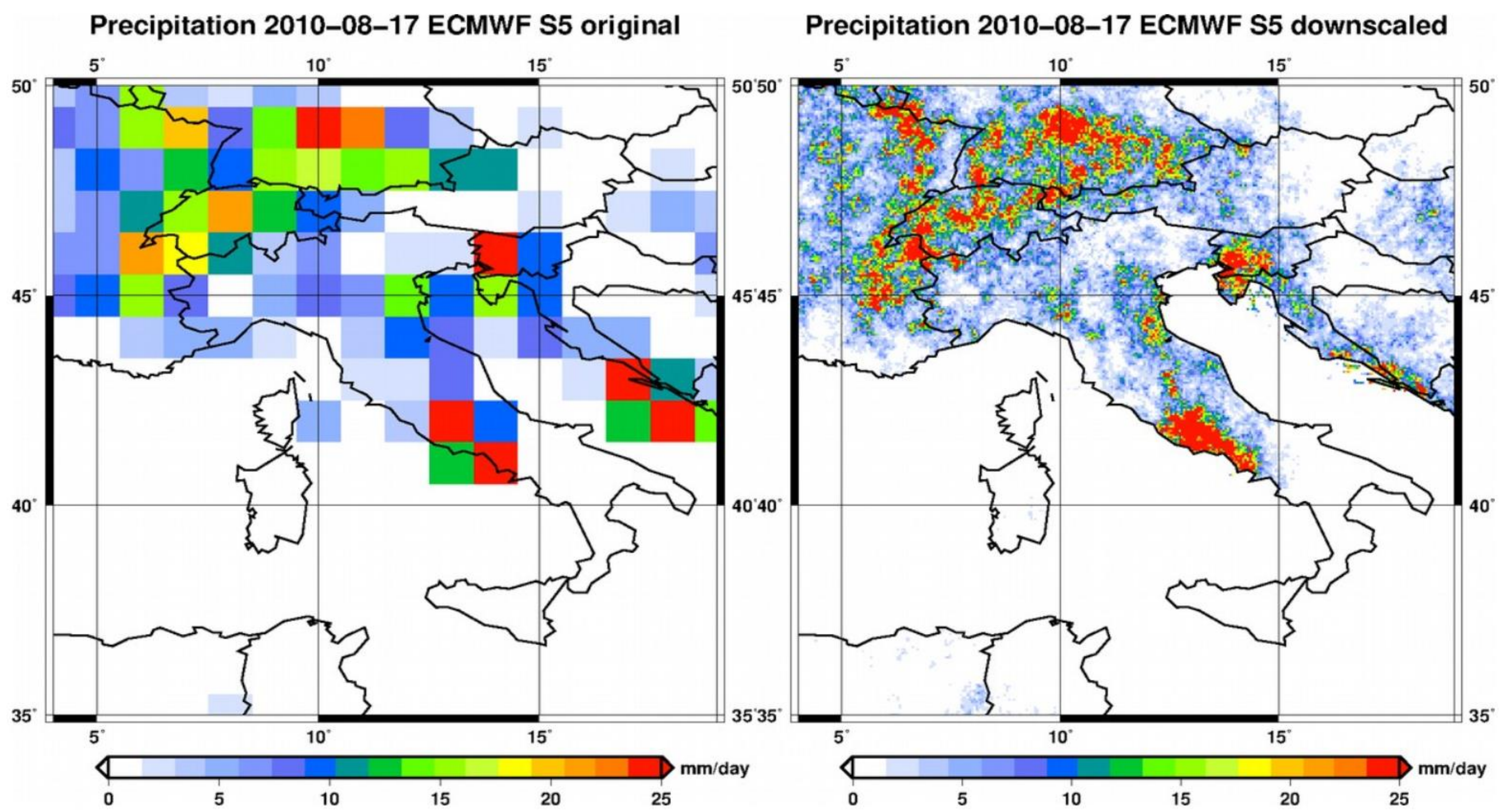
Analysis of ***climate analogues*** identifies days in the past that had similar climate indices compared to the period of forecast. It provides daily weather boundary conditions according to which the probability of extreme events can be estimated on a 5-10 km grid.



Orographic Precipitation

RainFARM is a stochastic precipitation downscaling method at fine resolution (1 km) from large-scale spatio-temporal precipitation grids.

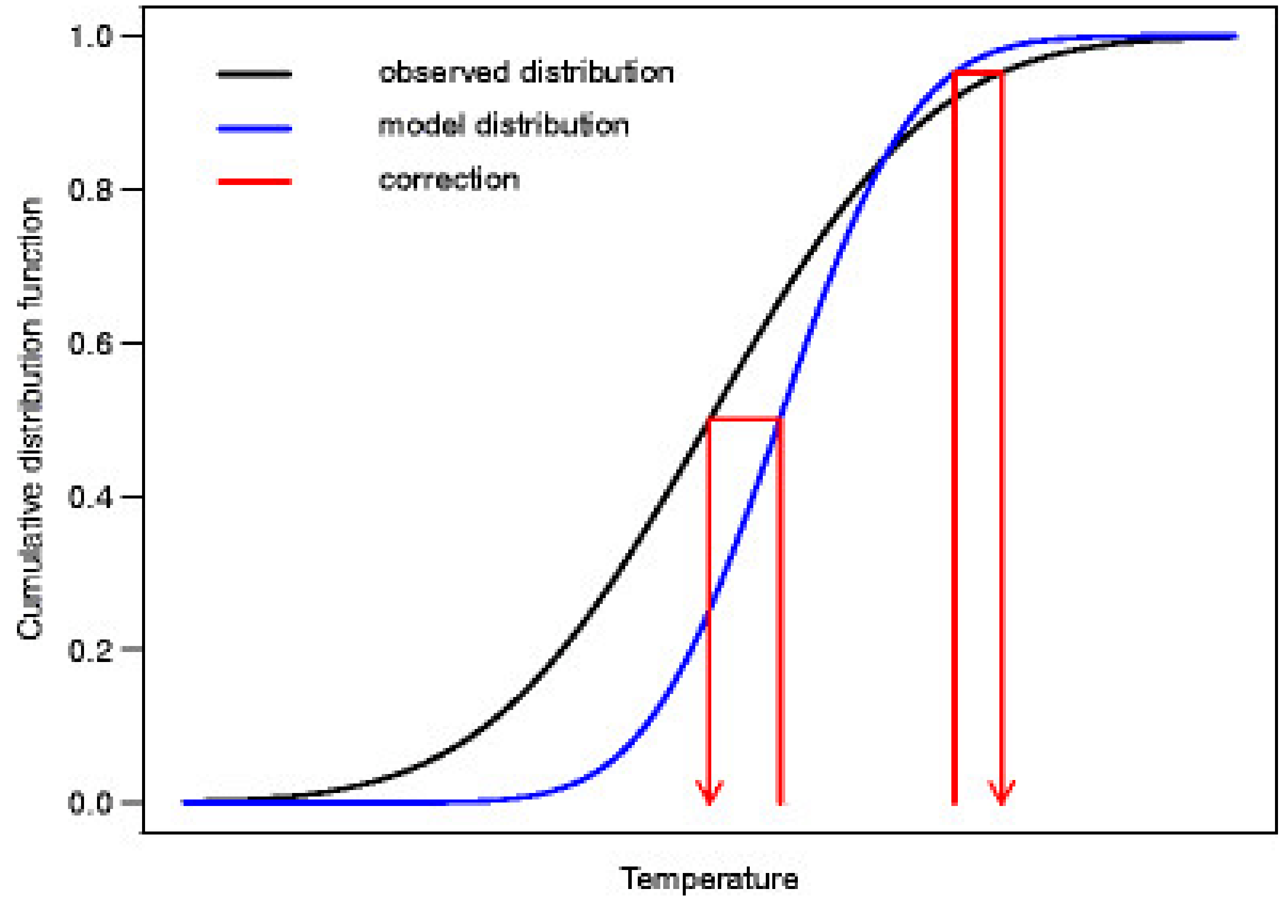
It distributes precipitation over complex orography using weights based on existing fine-scale precipitation climatology.



Bias Correction

This function performs a ***quantile mapping*** based on a nonlinear approach. The function computes two dynamical properties (distance and persistence) of the underlying attractor (SLP/SST).

Those proxies are then used to classify the data in terciles. Once the data is classified, a quantile mapping approach is applied.



Modelling approaches

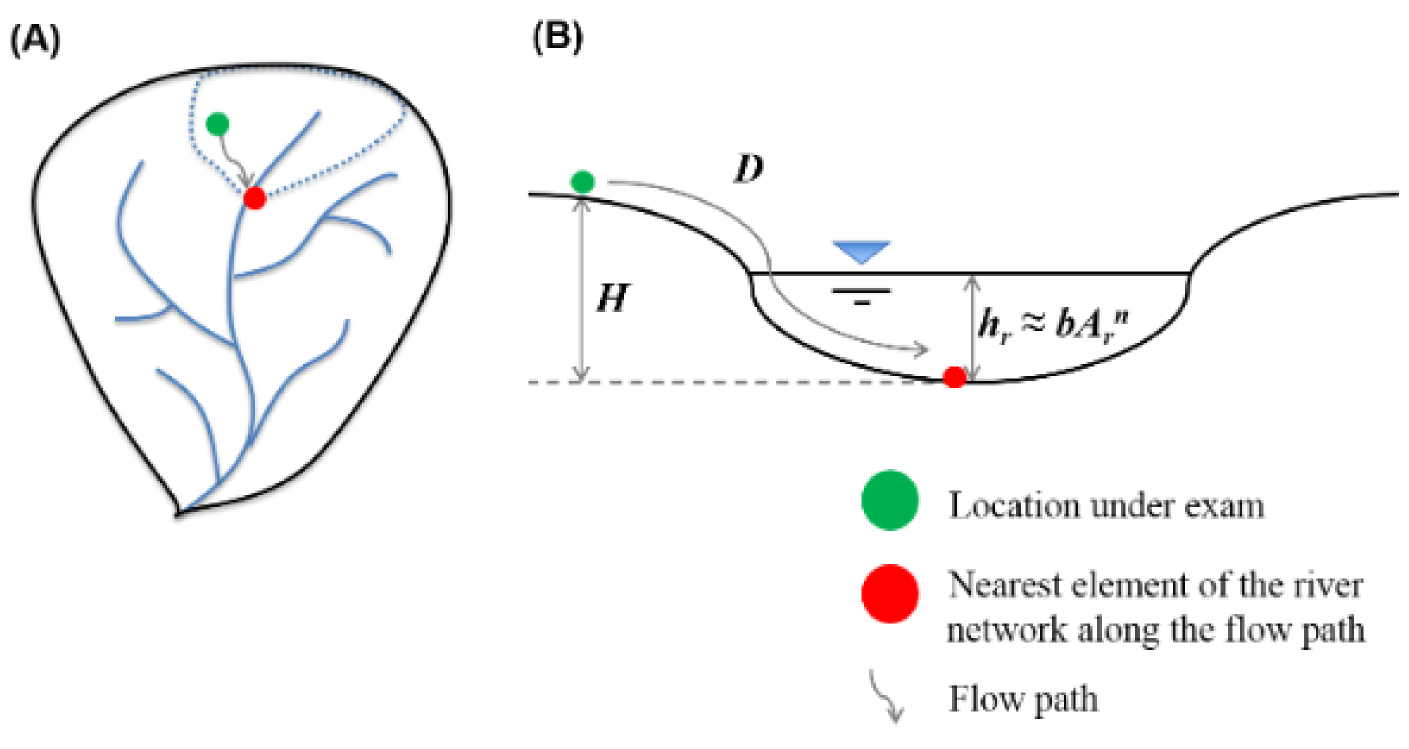
Fluvial

Static modelling:

GFI-based approach performs a linear binary classification of flood-prone and flood-free areas by combining the GFI with flood hazard information derived by existing inundation maps.

Dynamic modelling:

Both **LISFLOOD-FP** and **ANUGA** are able to simulate the overflow of water from rivers and canals to the floodplain, generating a hazard map (water depth).

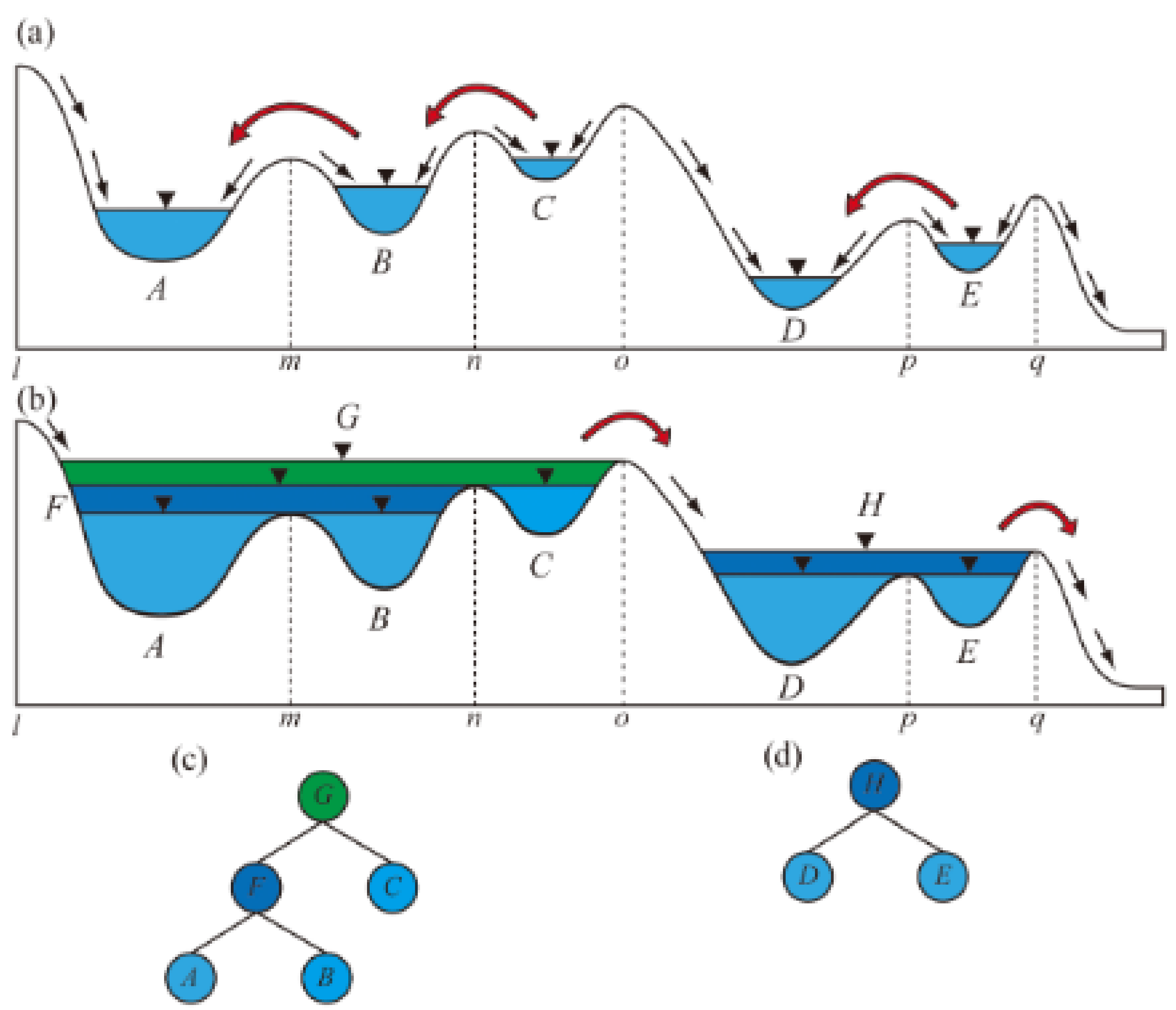


Pluvial

Static modelling:

Fill&Spill aims to identify pluvial-flooded areas on the basis of surface depressions in the DEM and their relative structure.

The volume of rainfall is accumulated in depressions (blue-spots) and, as they are filled, water starts to flow in depressions located at lower altitudes.



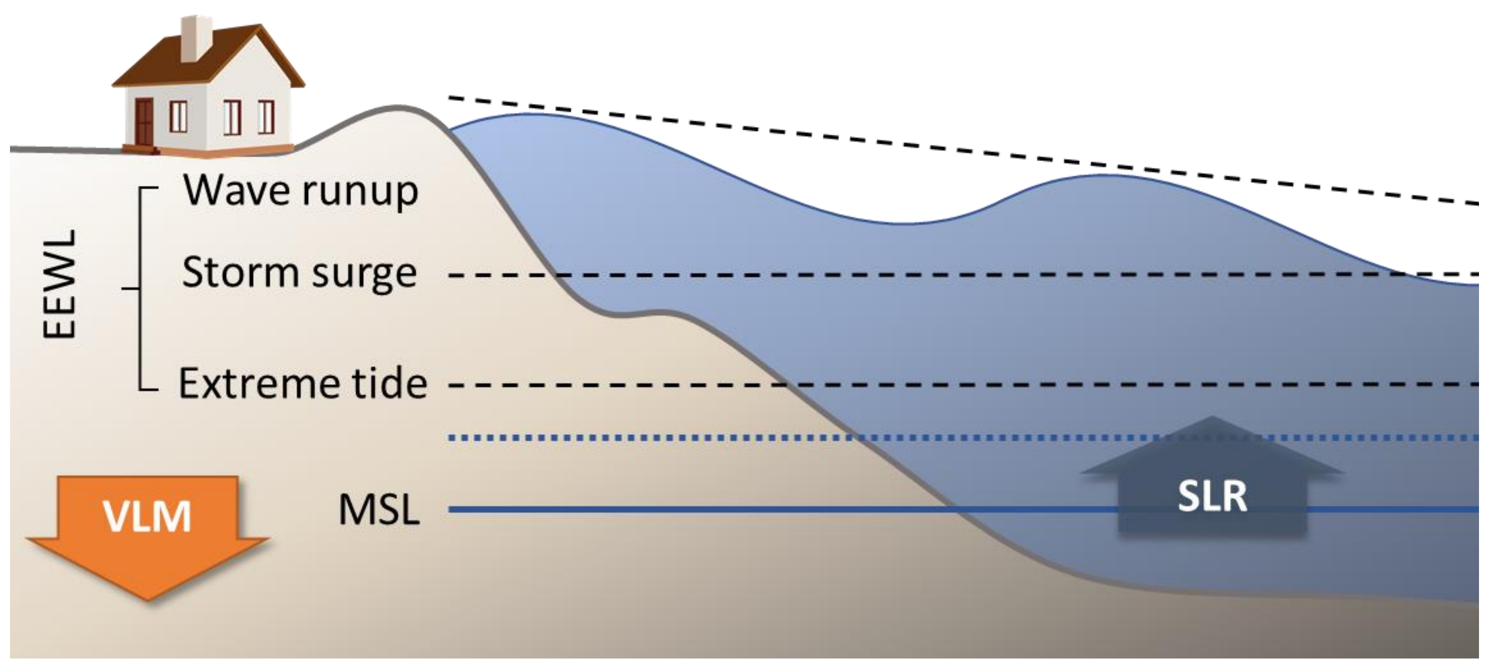
Coastal

Static modelling:

Region-growing flood model aims to map the extent of a flood event through the spreading of water level using gravity and the DEM as main inputs.

Dynamic modelling:

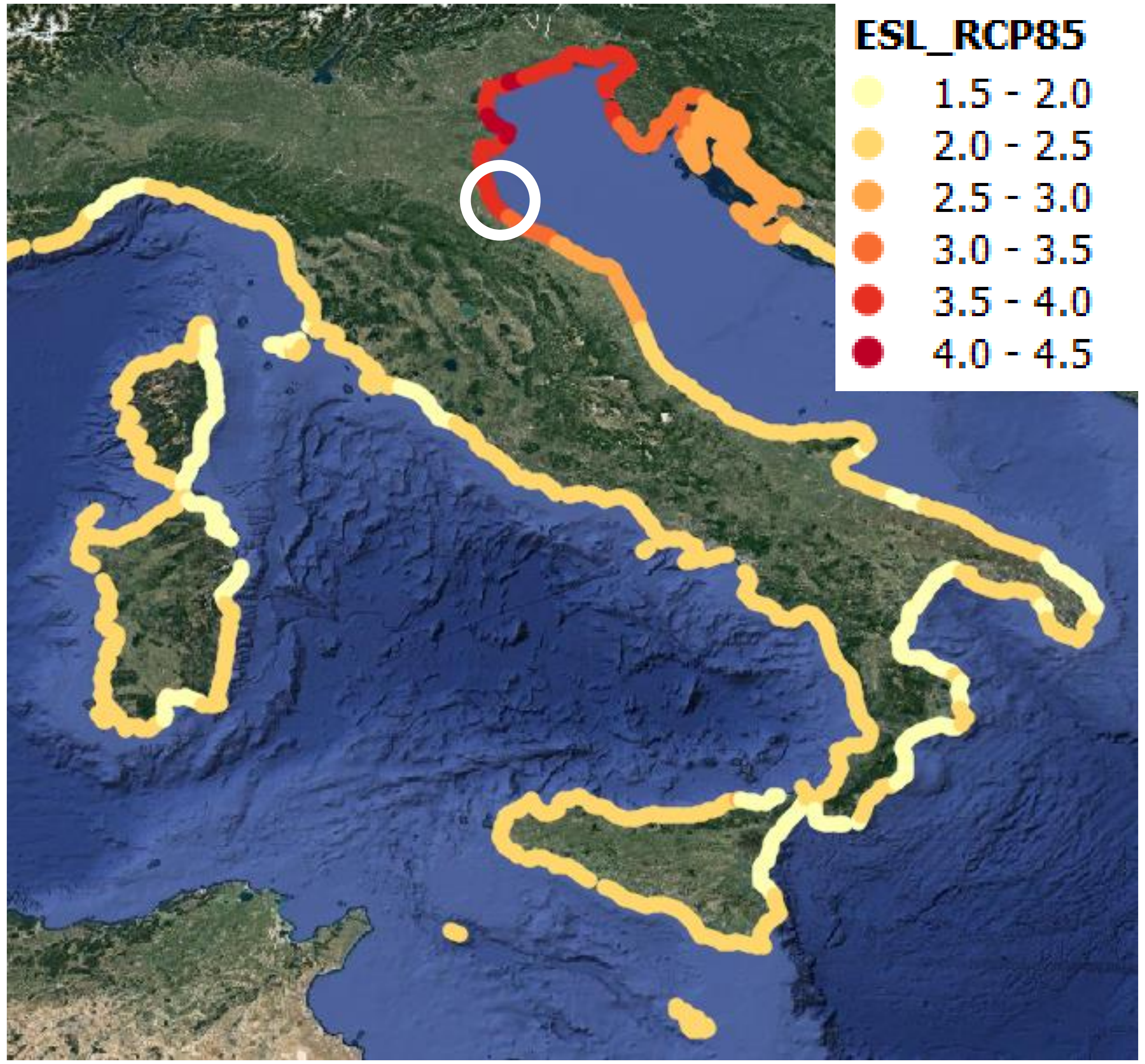
ANUGA is a 2D hydrodynamic model based on a finite-volume method for solving the shallow water wave equations. ANUGA is capable of simulating the extent, depth, duration, and velocity of a flood event.



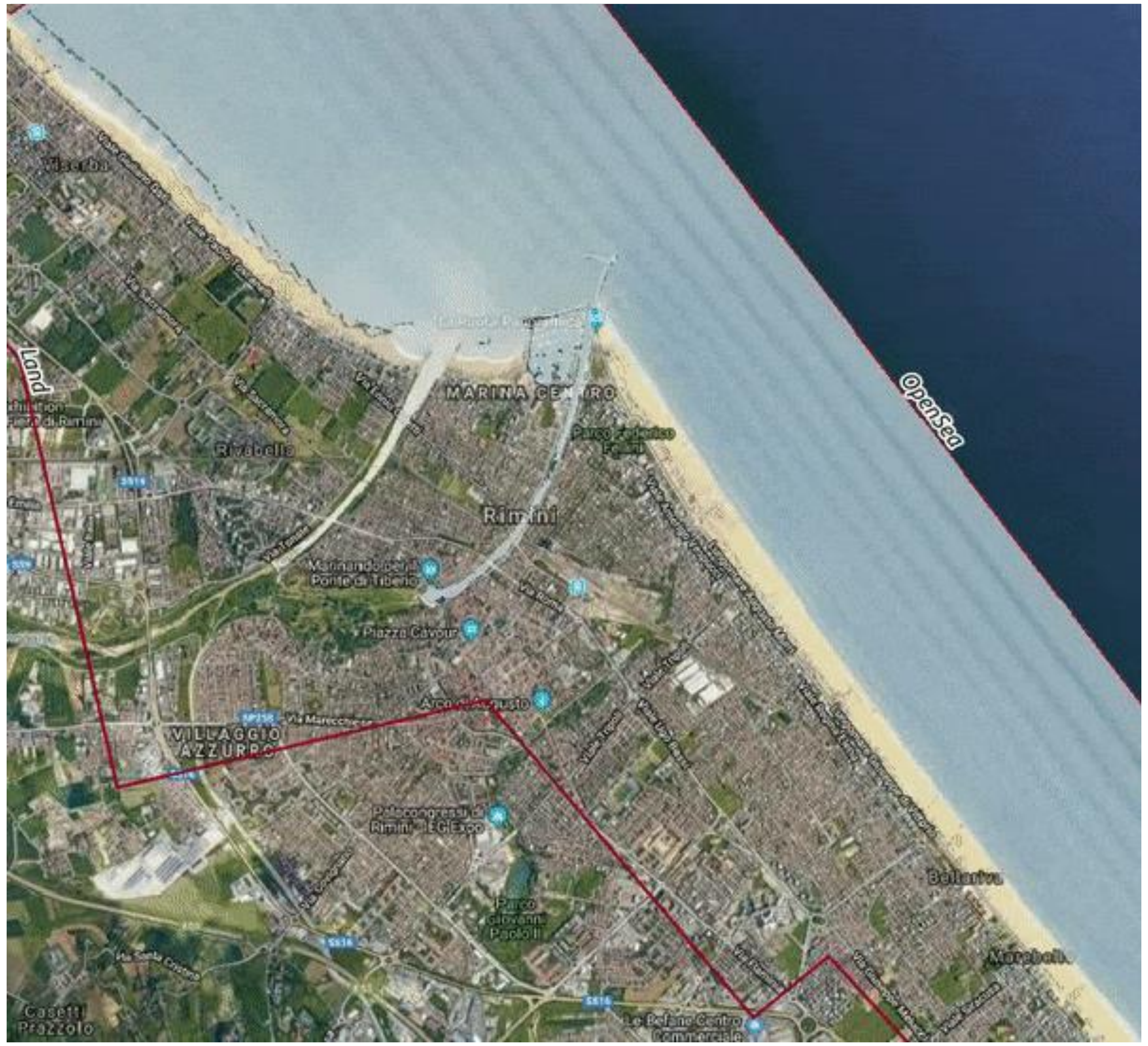
Coastal inundation hazard

Coastal flood hazard is affected by wind and tides more than precipitation extremes; projections are based Extreme Sea Level from LISCOAST (JRC) and improved considering the Vertical Land Movement rate up to 2100.

LISCOAST Extreme Sea Level



ANUGA Hydrodynamic model



Pluvial flood scenarios

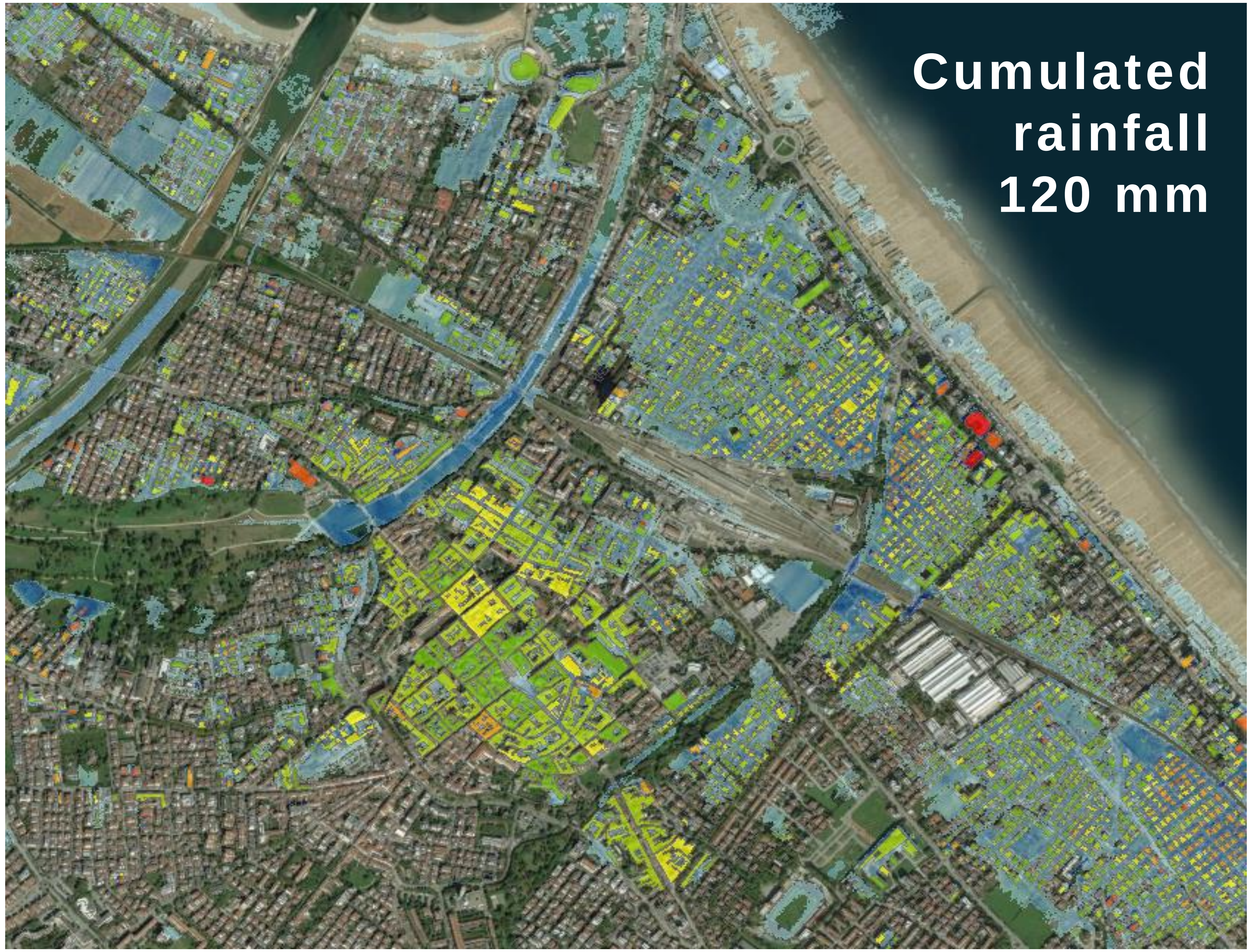
A rainfall probability grid based on past records (ARPAE) is used to spatially distribute rainfall based on climate scenarios of extreme precipitation events.

Flash-floods are short-lived events (often less than 1 hour), causing the drainage system to easily overload.

The fill-&-spill model distributes water based on ground altimetry obtained from Lidar DEM (2x2m or 1x1m).

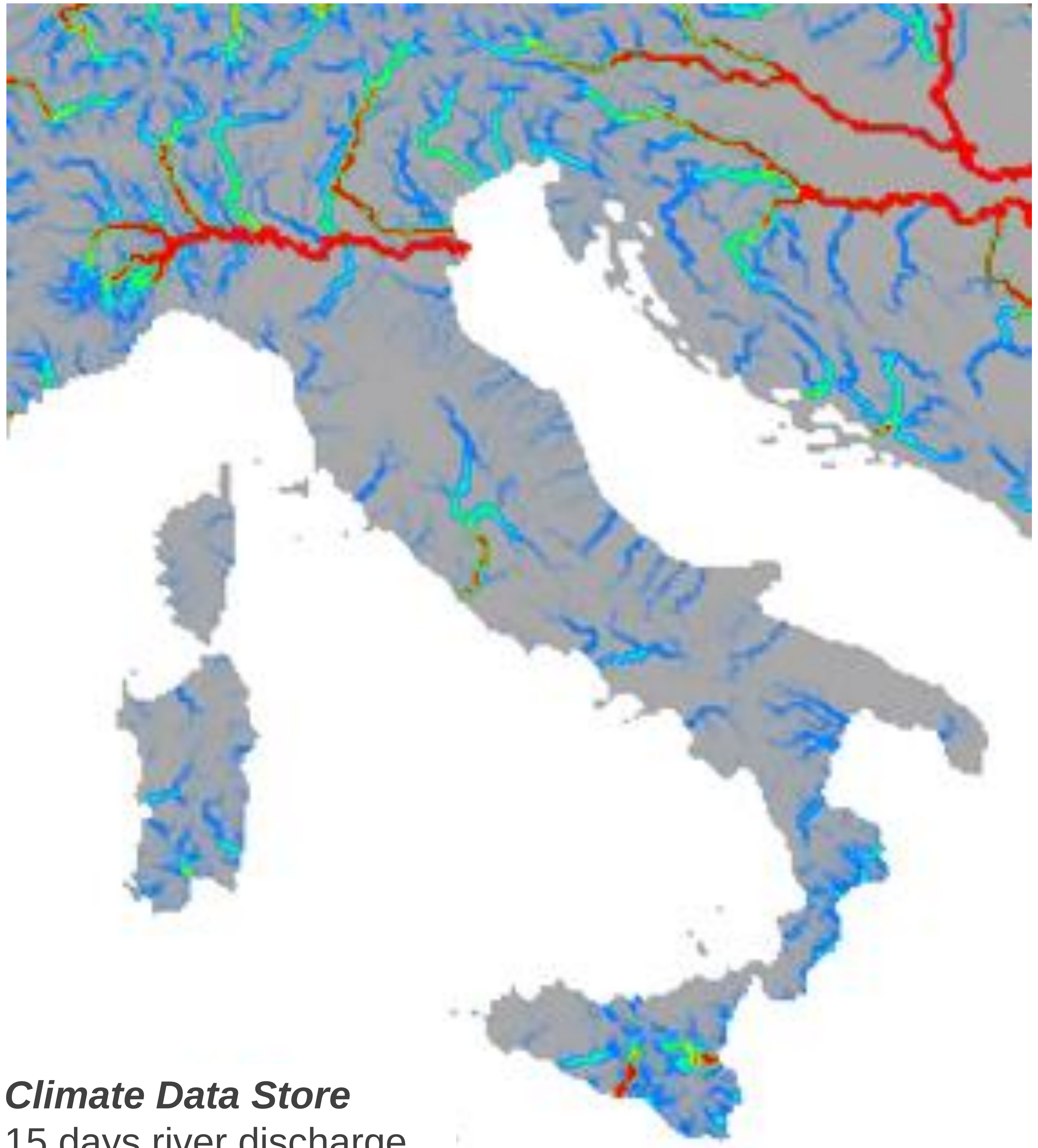
Without accounting for urban drainage, simulation of historical event seems to overestimate water depth.

We aim to refine the model accounting for drainage and absorption and to perform calibration over recorded data (2013).



River flood scenarios

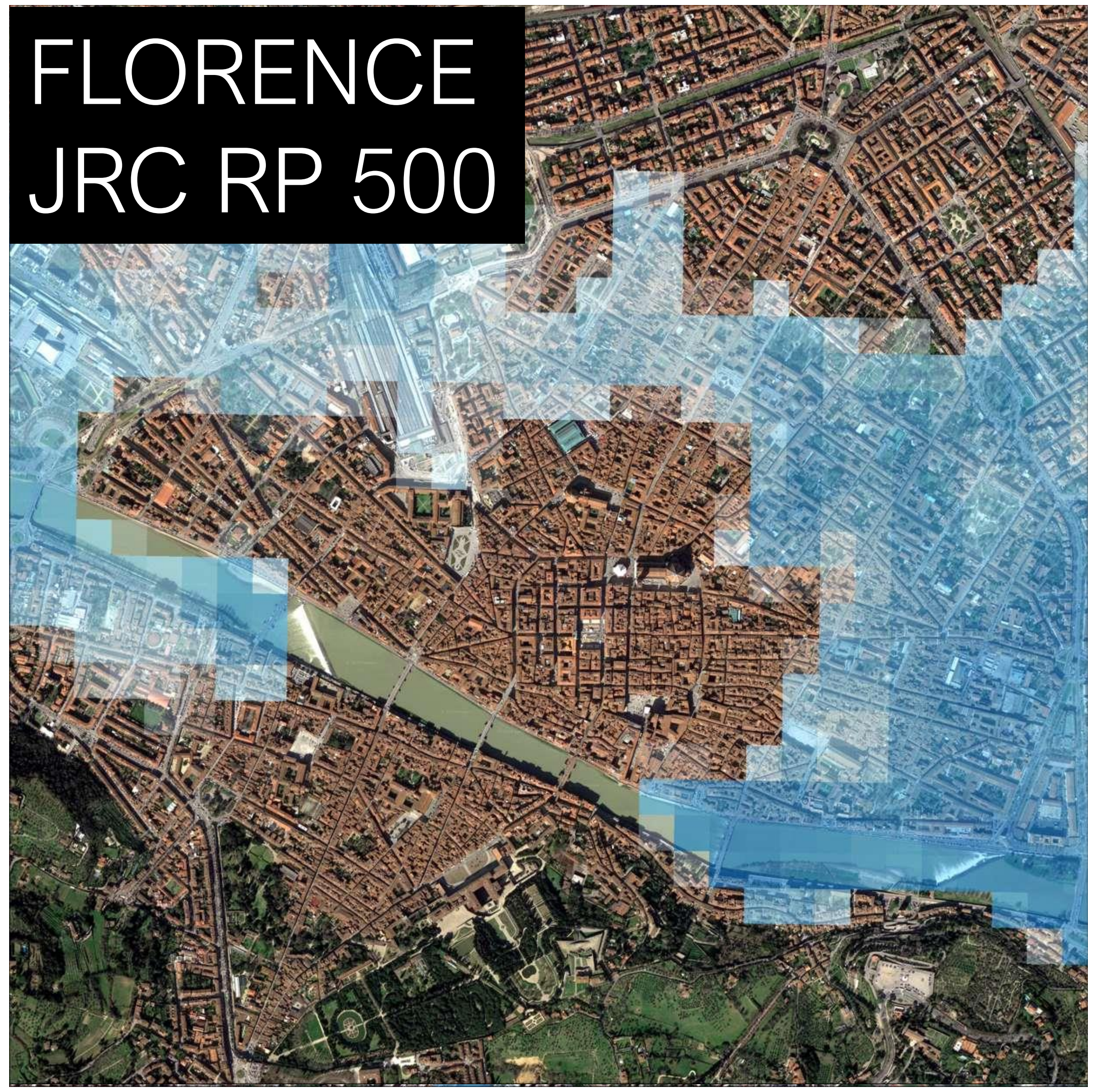
River discharge forecasts from EFAS are modelled into flood probability scenarios.

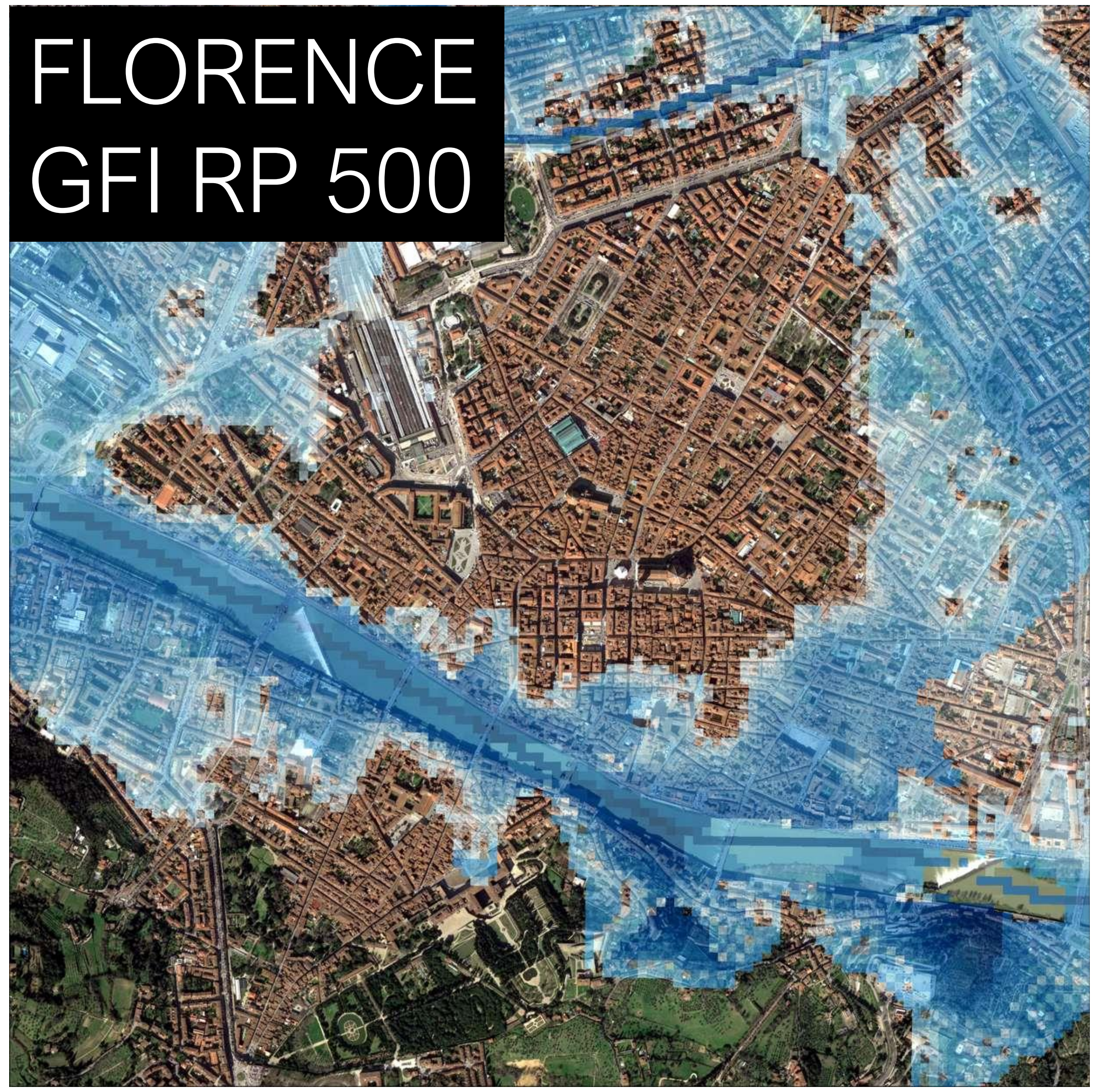


Climate Data Store
15 days river discharge

An intensity/time threshold based on records is used to identify events that may trigger over-washing or breaching of embankments.

We tested fast DEM-based approach (Geomorphic Flood Index), which appear to perform well compared to hydraulic modelling (LISFLOOD-FP).

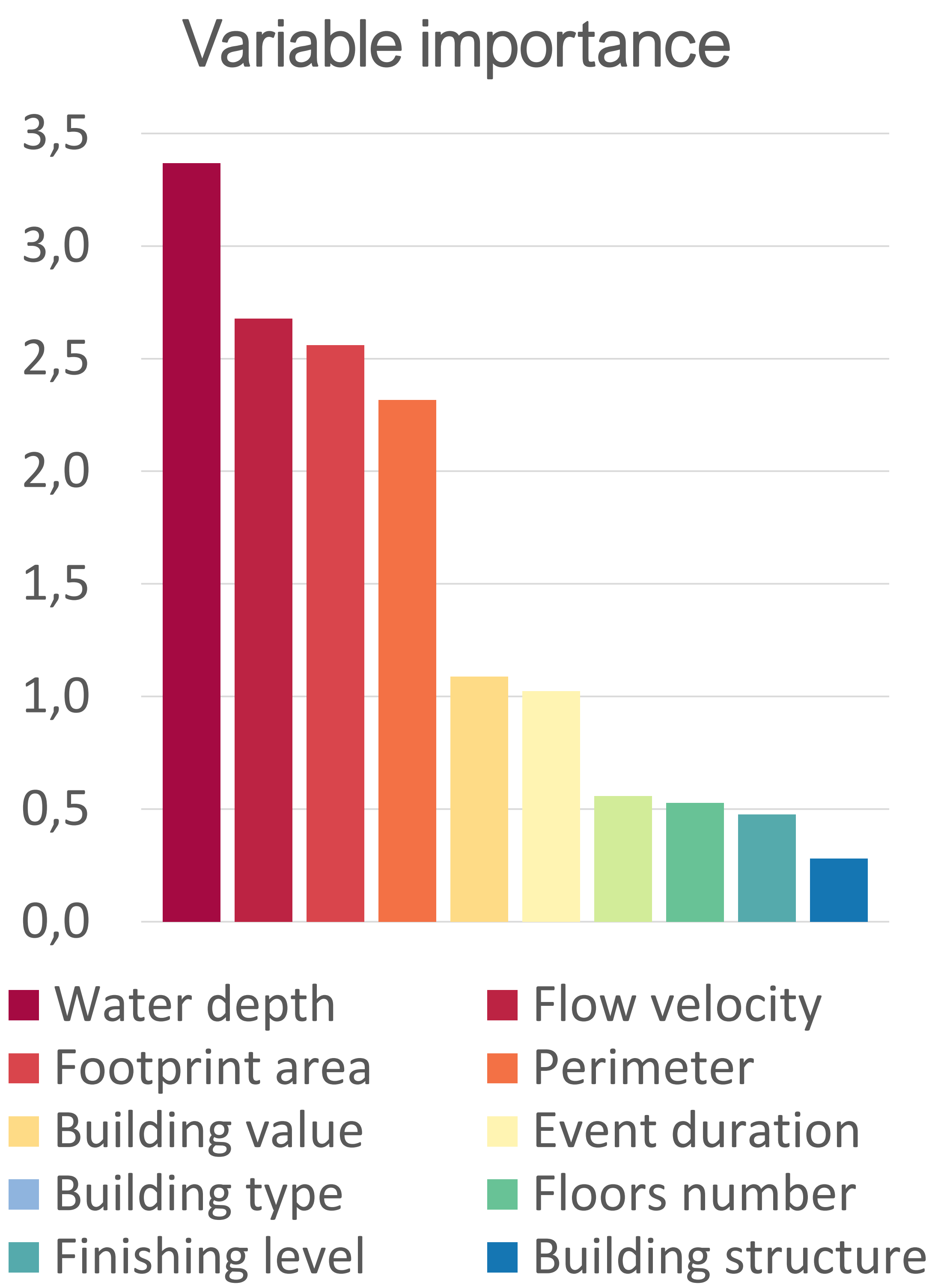


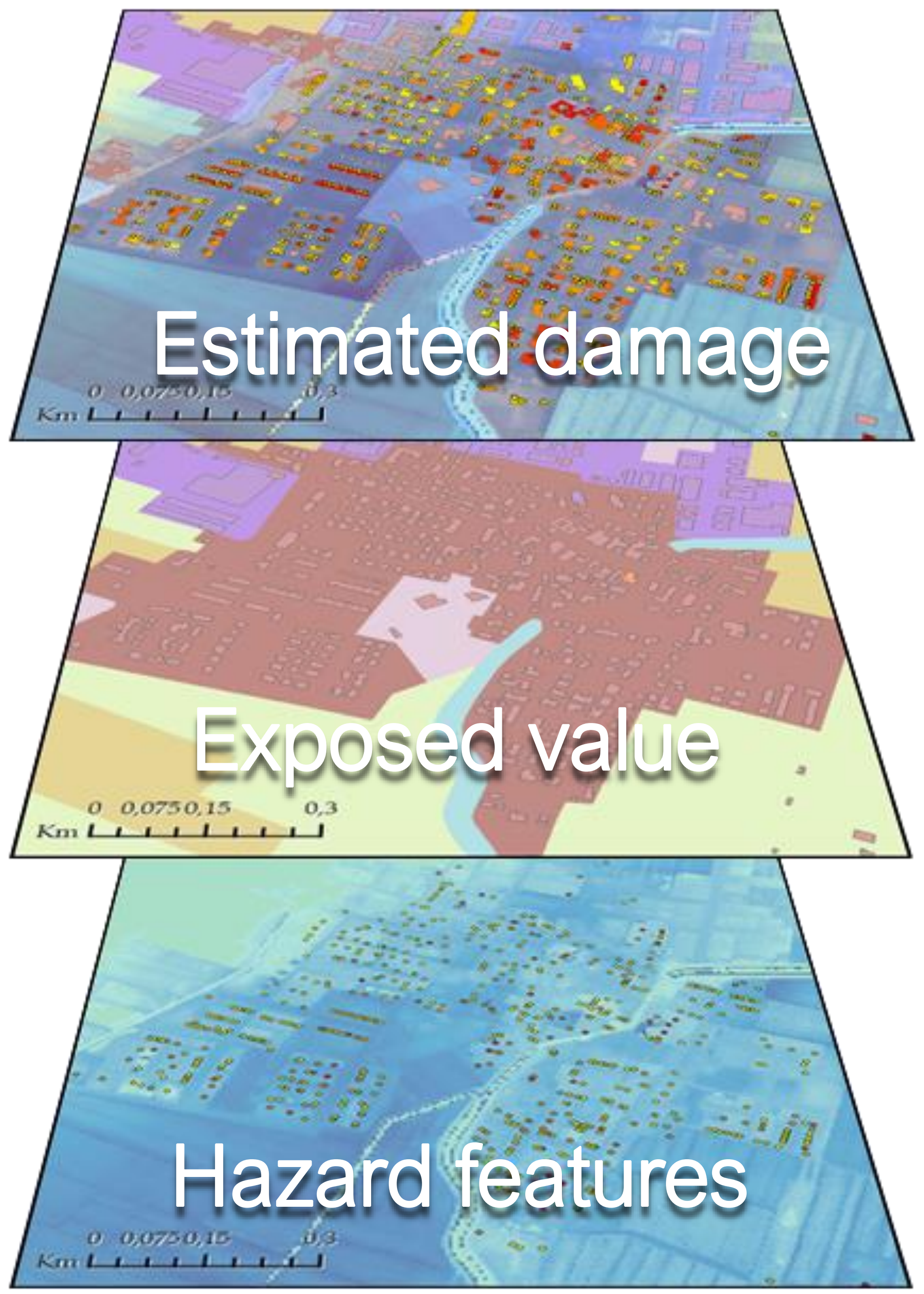


Damage and loss model

Direct Damage to Asset

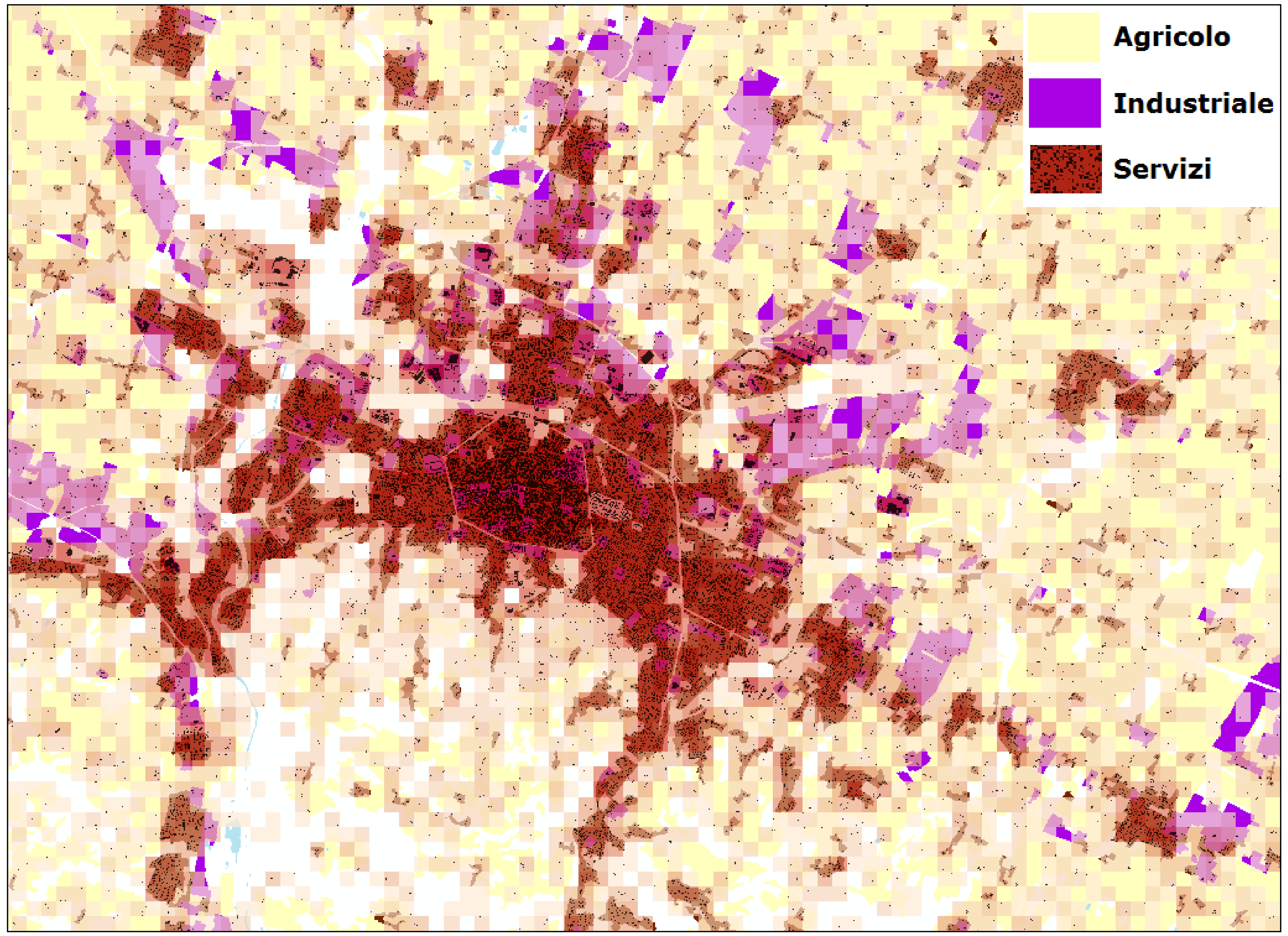
Uni-variable and multi-variable damage models validated for Italy on empirical data are employed to estimate direct economic impact on the physical asset.





Regional GDP Losses

A regionalized version of macro-economic model (Computable General Equilibrium) estimates how the economic shock triggered by flood damage impacts labour and capital exchange with other Regions.



Goals and challenges

- Climate downscaling techniques to be applied on the pilot area as soon as CS tools are released.
- Pluvial risk model under refinement to calibrate over hazard event observations.
- Testing of ANUGA for 2D floodplain modelling (river floods).

2017

Collection and standardisation of datasets to measure exposed asset and population

Evaluation of impact models for direct damage and indirect losses

2018

Development and testing of damage models

Investigating hazard modelling approaches

Downscaling of climate indicators

2019

Elaboration of seasonal hazard scenarios based on climate indicators

Seasonal risk assessment from three types of flood hazard for demonstrator (Rimini)

2020

River flood hazard 2d floodplain modelling

Consolidation of hazard simulations database (coverage)

Integration of machine learning for hazard forecasting

Adaptation options

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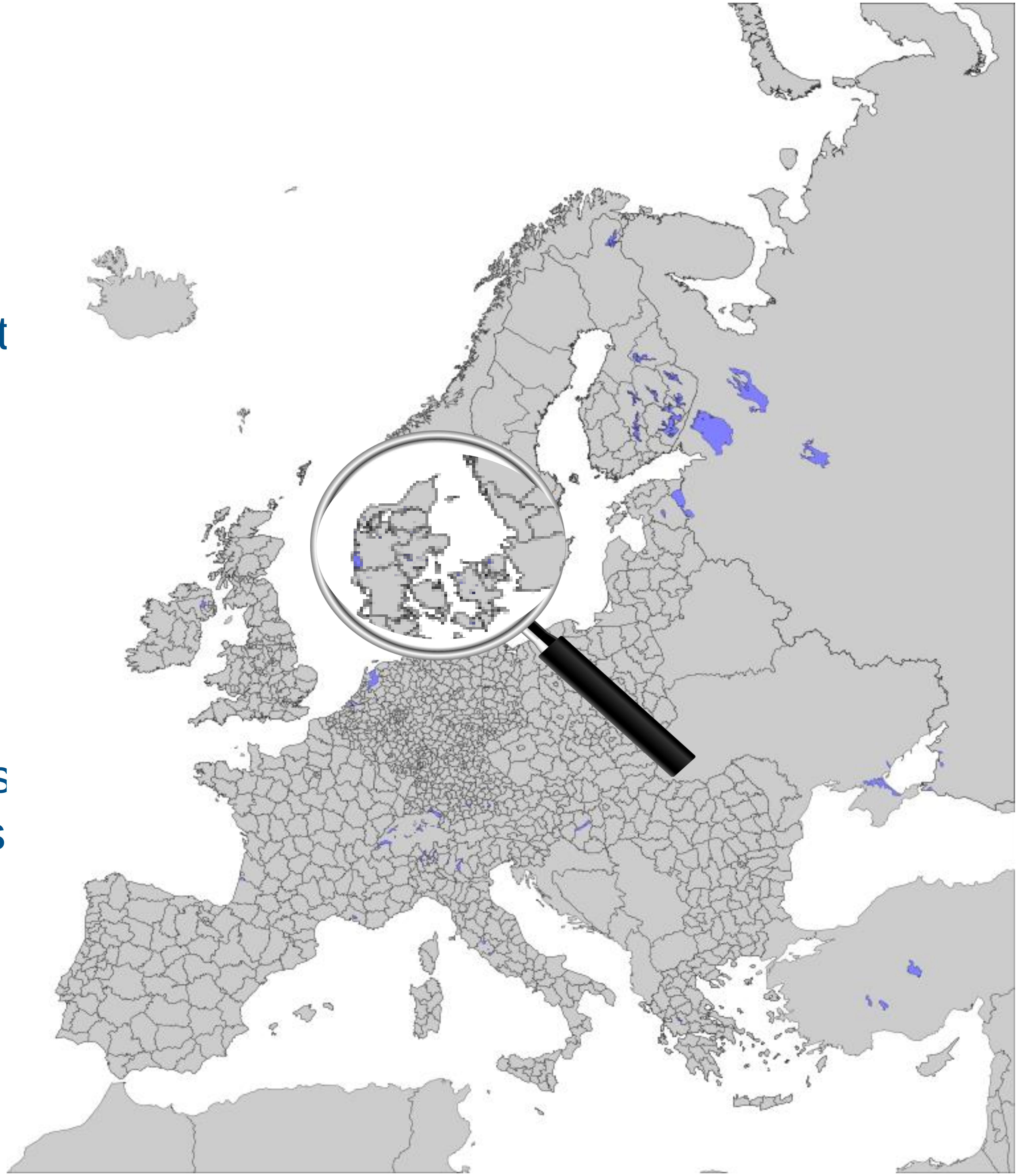
C3S_430: focus on urban areas

The Copernicus contract «Sectoral Information System to support Disaster Risk Reduction» (C3S_430) aims at developing a service from C3S data and to support the risk assessment of extreme events.

The contract runs from June 2019 up to May 2021 (24 months).

It provides spatially explicit and high resolution datasets on top of offering new generation tools to evaluate risks posed by pluvial flooding.

The contract looks at urban areas (20 test cases) at daily and sub-daily levels



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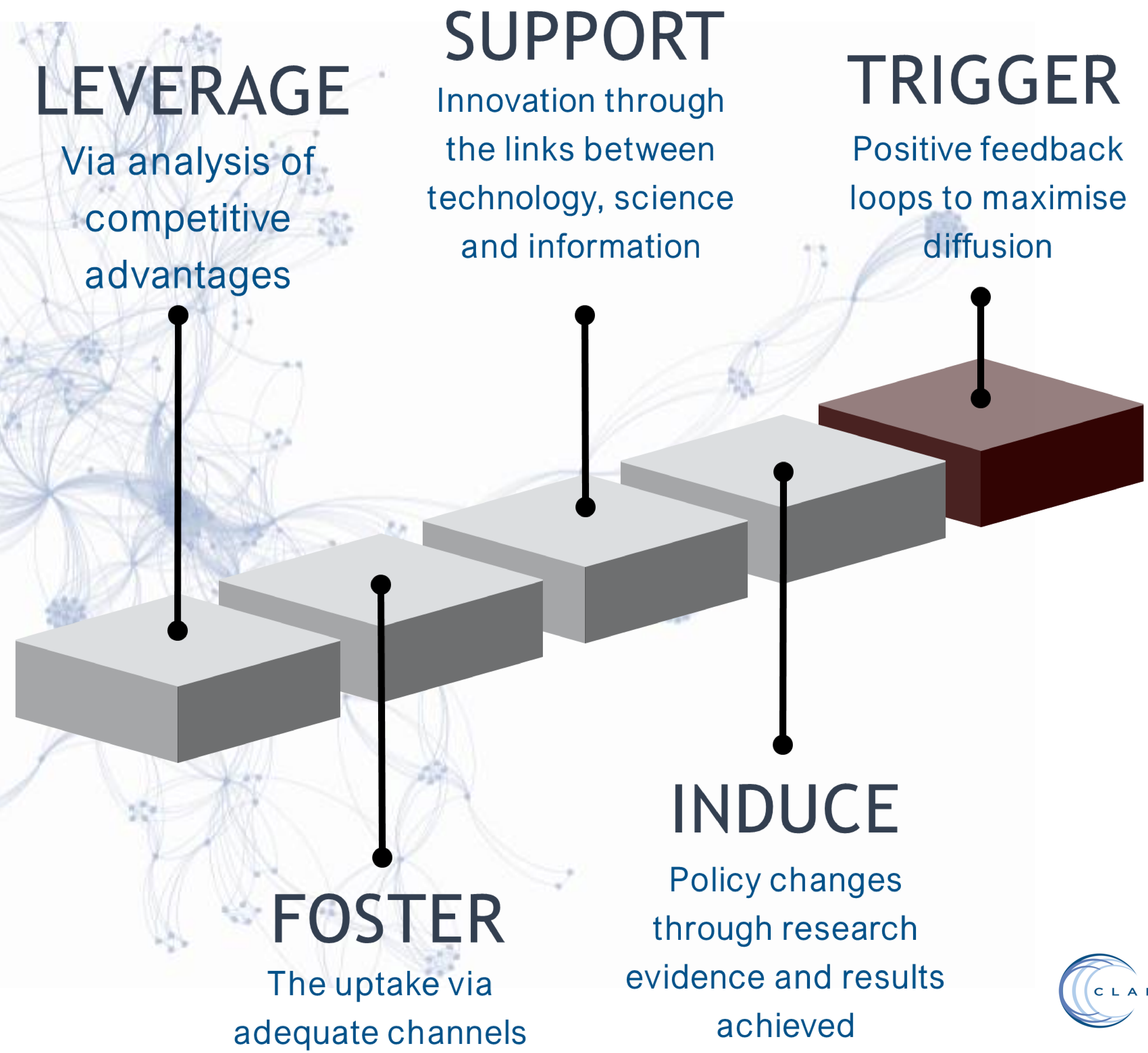
What’s next? From scientific advancements to services

Moving from scientific research to fully operational bespoke services implies the integration of multiple disciplines and the inclusion of a business and economically sounded logic in the co-generation approach:

- Value assessment of each service
- Business model elaboration and definition
- Adequate communication



Talking climate: MUF – The Multi-User Forum

The CLARA Multi-User Forum – MUF is a **platform** for **user engagement**, co-generation of climate services and **mutual learning** involving providers and users.

MUF promotes **workshops**, organised per taskforce, to facilitate the dialogue between providers and users.

MUF-1
Co-generation
03/2018

MUF-2
Value added
11/2018

MUF-3
Market
09/2019

The **Impact and Stakeholder Committee**'s members (6) operate as 'users' engagement and impact champions' ensuring that Work Package leaders take into account and respond to MUF's recommendations.

Thank you for your attention!

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More information about the CLARA Project can be found here:

http://www.clara-project.eu/ #CLARA_H2020, #Clara_MUF
@ClaraProject

The CLARA project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement No. 730482.

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