# Integrated solutions for water, energy, food and ecosystems

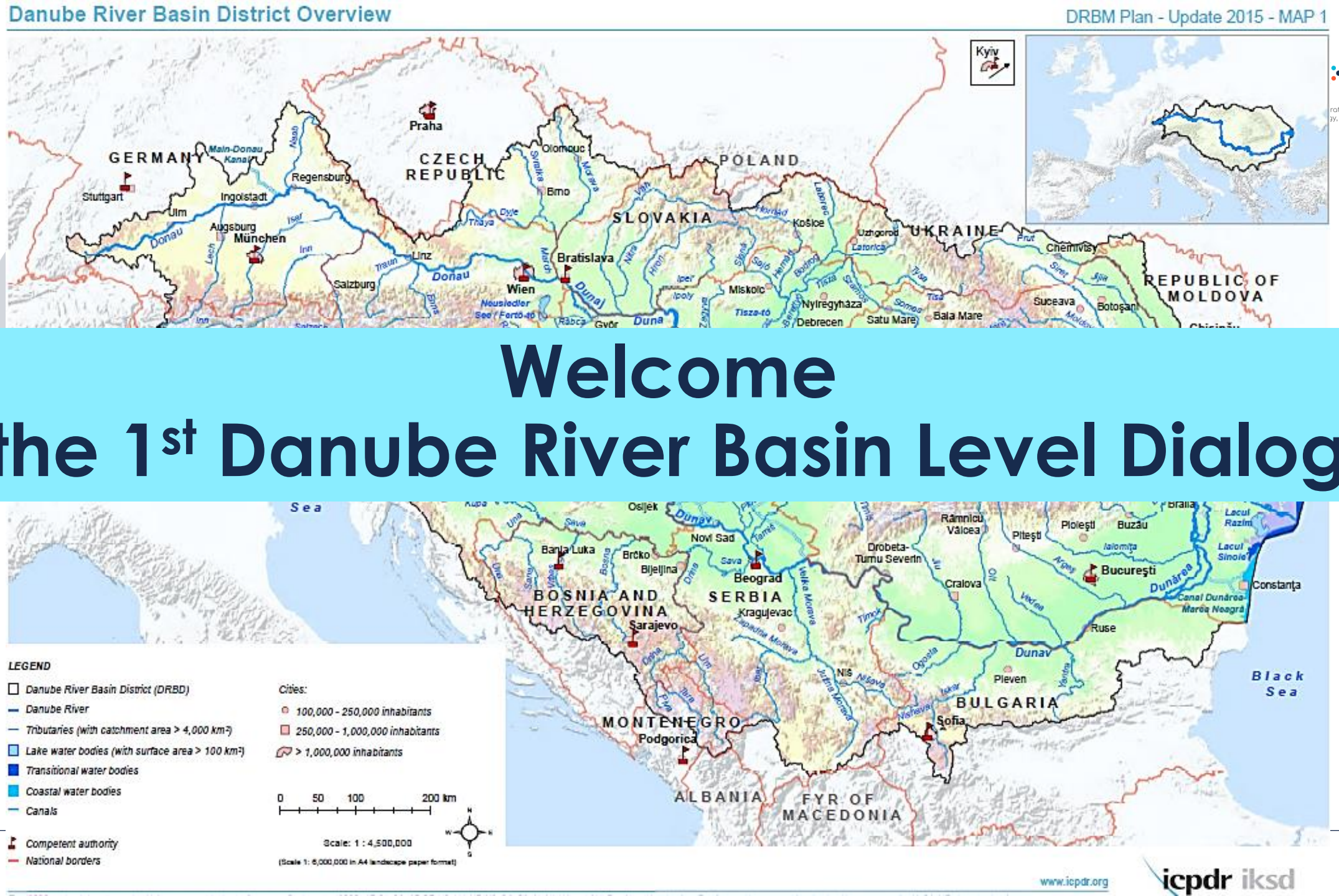
## The 1st Danube Basin Level Nexus Dialogue

Welcome and introduction

János Fehér, FAMIFE Consulting Ltd.

GoNEXUS has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement number 101003722.

www.gonexus.eu




# Welcome
# to the 1st Danube River Basin Level Dialogue

# Welcome and introduction

## Rules of the meeting

- If not done so far, please rename yourselves to **include your full name and organization's** acronym.
- **All microphones** should stay muted – apart from when speaking
- Please use **the raise hand function** using a button within "Reactions" at the bottom of the Zoom window if you'd like to contribute to the discussion.

  When you speak for the first time, please introduce yourself briefly.
- **Although the meeting will be recorded, the Chatham House Rule** will be used in this dialogue workshop to encourage inclusive and open dialogue.
  The recording will only be used for preparing the meeting report and will be deleted a month after the workshop at the latest.

# Welcome and introduction

## The Chatham House Rule

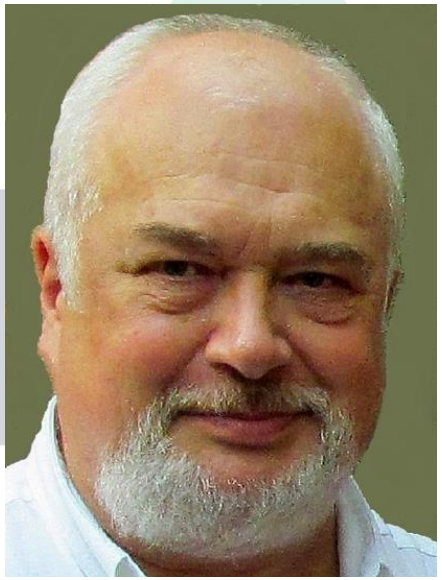
The Rule reads as follows:

*"When a meeting, or part thereof, is held under the Chatham House Rule, participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed."*

# Goals of the 1st Danube Basin Dialogue of the GoNEXUS project

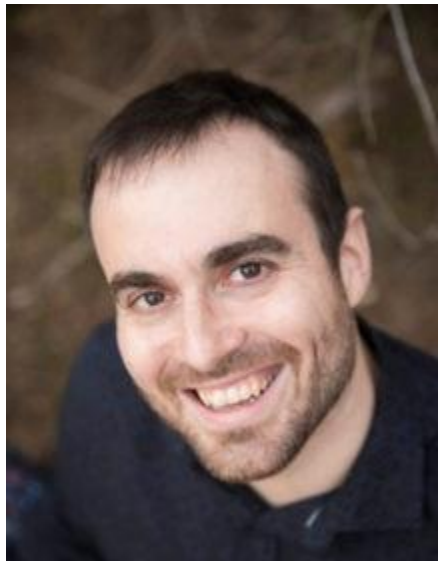
1. To introduce the project in general to stakeholders (objectives, methodology and expected results)
2. To establish cooperation with stakeholders in the Danube Basin, in particular:
   - to jointly understand conflicts & trade-offs, sectoral policies, synergies, and uncertainties,
   - to co-design scenarios, indicators, modelling actions, and solutions for the Danube River Basin Case Study

# GoNEXUS Speakers



János Fehér

Michaela Matauschek



Hector Mácian-Sorribes

Rens van Beek

Beáta Pataki

GuidoSchmidt

# Detailed programme

Part 1 – about GoNEXUS

1. Welcome and introduction János Fehér (FAMIFE)
2. Question 1 and its evaluation. Michaela Matauschek (Fresh Thoughts)
3. The GoNEXUS project – general overview

   Manuel Pulido Velázquez and Hector Macián Sorribes

   (Universitat Politecnica de Valencia)
4. Modelling framework of the Danube River Basin Case Study

   Rens van Beek (Universiteit Utrecht)

COFFEE BREAK

# Detailed programme

Part 2 - Challenges

5. Identified nexus challenges on the Danube River Basin
   Beáta Pataki, Attila Lovas, János Fehér (FAMIFE)
6. Question 2 - ranking challenges, and evaluation. Michaela Matauschek (Fresh Thoughts)
7. General discussion 1 - What GoNEXUS is aiming for with the dialogues?
   Guido Schmidt (Fresh Thoughts)
8. Question 3 and 4 – about the challenges. Michaela Matauschek (Fresh Thoughts)
9. General discussion 2 – Selection of key nexus challenge
   All stakeholders and the GoNEXUS team and evaluation results of Question 3 and 4
10. Wrap-up – with way forward, next steps, cooperation János Fehér (FAMIFE)

# Wrap-up of the Dialogue

**What is next:**

- two more dialogues in November 23 and 24 (sub-basin level, local level)
- evaluation of the results of the dialogues – report
- updating the modelling work program based on the dialogue results
- cooperation with stakeholders
- preparation of the 2nd round of dialogues
- 2nd dialogues in May-June 2023

GoNEXUS
Integrated solutions for water, energy, food and ecosystems

# Integrated solutions for water, energy, food and ecosystems

A presentation on GoNEXUS

Manuel Pulido-Velazquez and Hector Macian-Sorribes (IIAMA-UPV)

mapuve@hma.upv.es, hecmasor@upv.es

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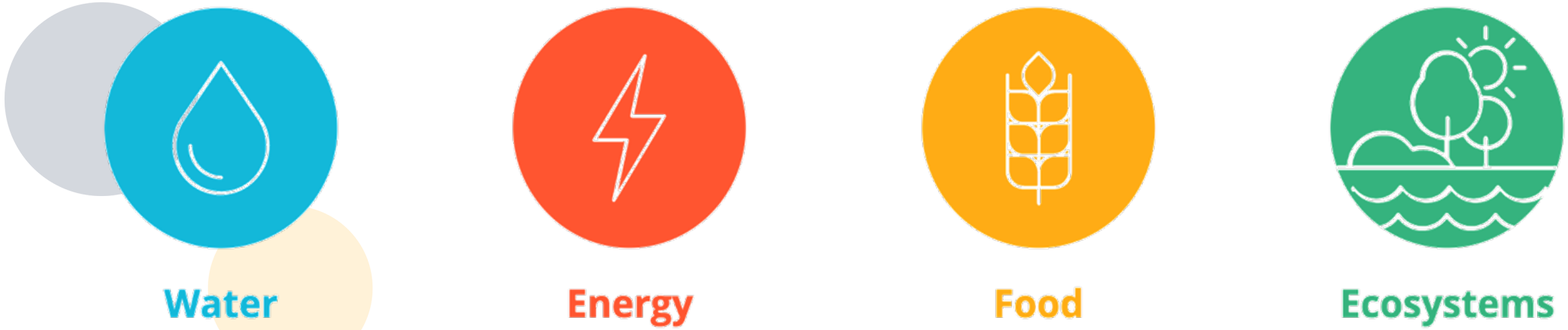
www.gonexus.eu

# The WEFE nexus




- tightly interlinked but mostly managed and regulated separately
- Current EU directives:
  - not well aligned
  - challenging local implementation

# GoNEXUS goals

- Re-balance water, food, energy and ecosystems to maximise our planet's environmental security

- Develop innovative tools and solutions for governing the water-energy-food-ecosystems NEXUS

# Project Partners













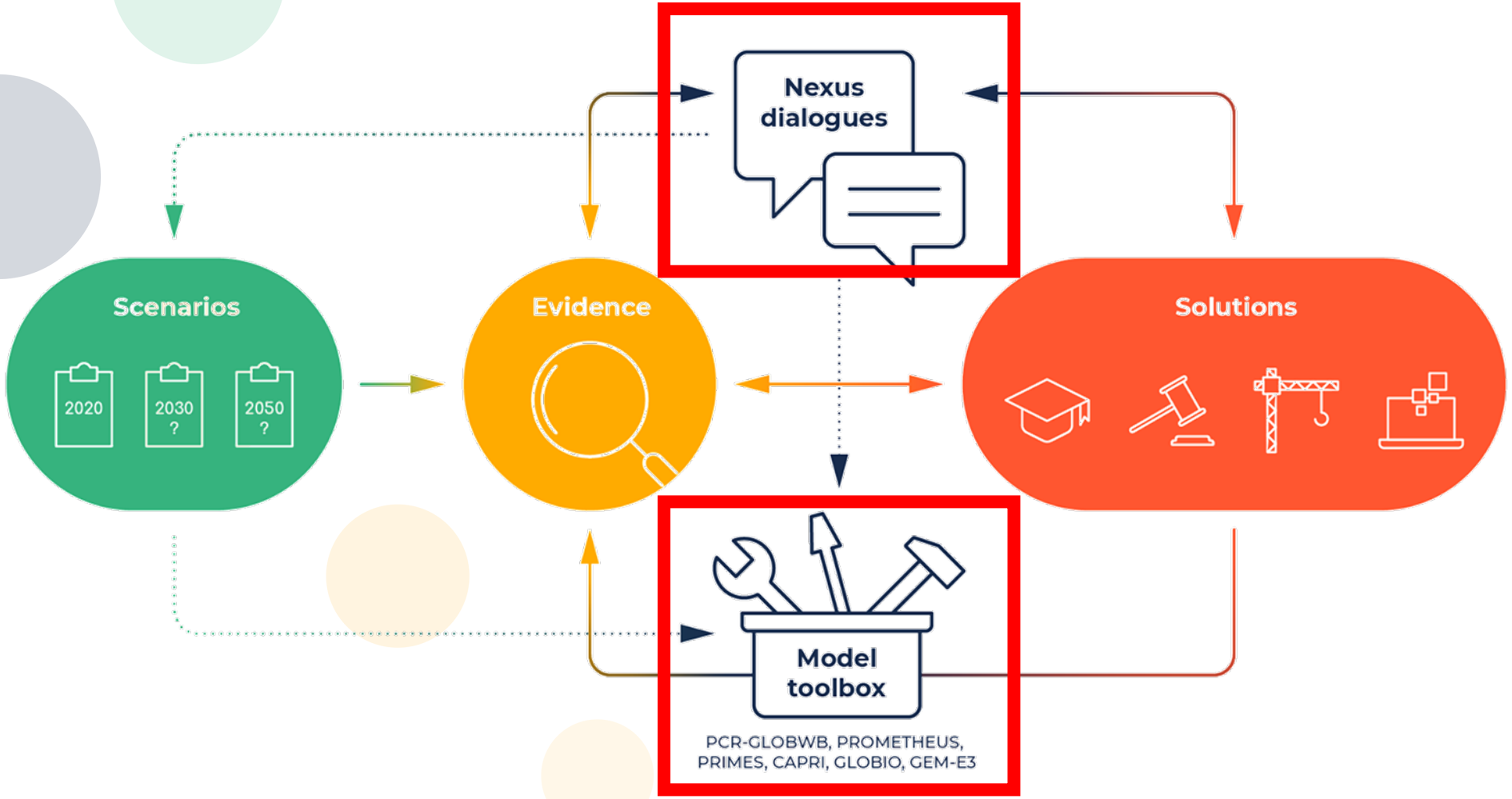








# Methodology



# 8 unique case study areas

1. Global
2. Europe
3. **Danube river basin**
4. Lake Como river basin
5. Jucar river basin
6. Senegal river basin
7. Tagus and Segura river basins and water transfer
8. Zambezi watercourse

# Lake Como River Basin

**Objective:** To address 4 key challenges facing Lake Como:

- seasonal allocation of water for food and energy production, and ecosystem preservation
- new management for drought events
- climate change in the Alpine catchment
- adoption of novel financial tools to hedge risk

**Expected Impact:**

- Solutions to improve each of the challenge areas

# Jucar River Basin

**Objective:** Assess equilibrium between resources and demands

**Expected Impacts:**

- Solutions to balance climate change impacts on WEFE
- Improved Jucar river operating rules
- Co-development and assessment of climate change adaptation measures accounting for the WEFE

# Tagus and Segura river basins and water transfer

**Objectives:**

Improved management of the Tagus-Segura transfer to reconcile agriculture, hydropower, and environmental status in both rivers

**Expected Impact:**

- Mapping future evolution of regional and international conflicts
- Solutions for improved management

# Zambezi river basin and watercourse

**Objective:** To address the ecosystem components of the WEFE at river corridor scale by monitoring agriculture and energy security

**Expected Impacts:**

- Improved food and energy security
- Determining how basin development plans relate to global and regional drivers
- Improved governance and water diplomacy solutions

# Senegal River Basin

**Objective:** Improved understanding of conflicting visions on new dams, flood pulse, role of floodplains and link between climate trends and conflicts

**Expected Impacts:**

- Governance solutions for the river basin
- Sequencing of investments in new hydropower plants
- Impacts of a more regulated flow regime
- Influence of agriculture and development policies on ethnic conflicts

# EU case study

**Objective:** More sustainable policies and solutions for the efficient and sustainable management of the WEFE nexus in Europe

**Expected impacts:**

- Link EU water policy objectives with sustainable objectives
- Assess the impacts of EU regulatory framework
- Reduce institutional fragmentation --> increased cross water, energy, food collaboration and multi-stakeholder engagement

# Global case study

**Objective:**

Increased solutions and policies for WEFE nexus around the globe

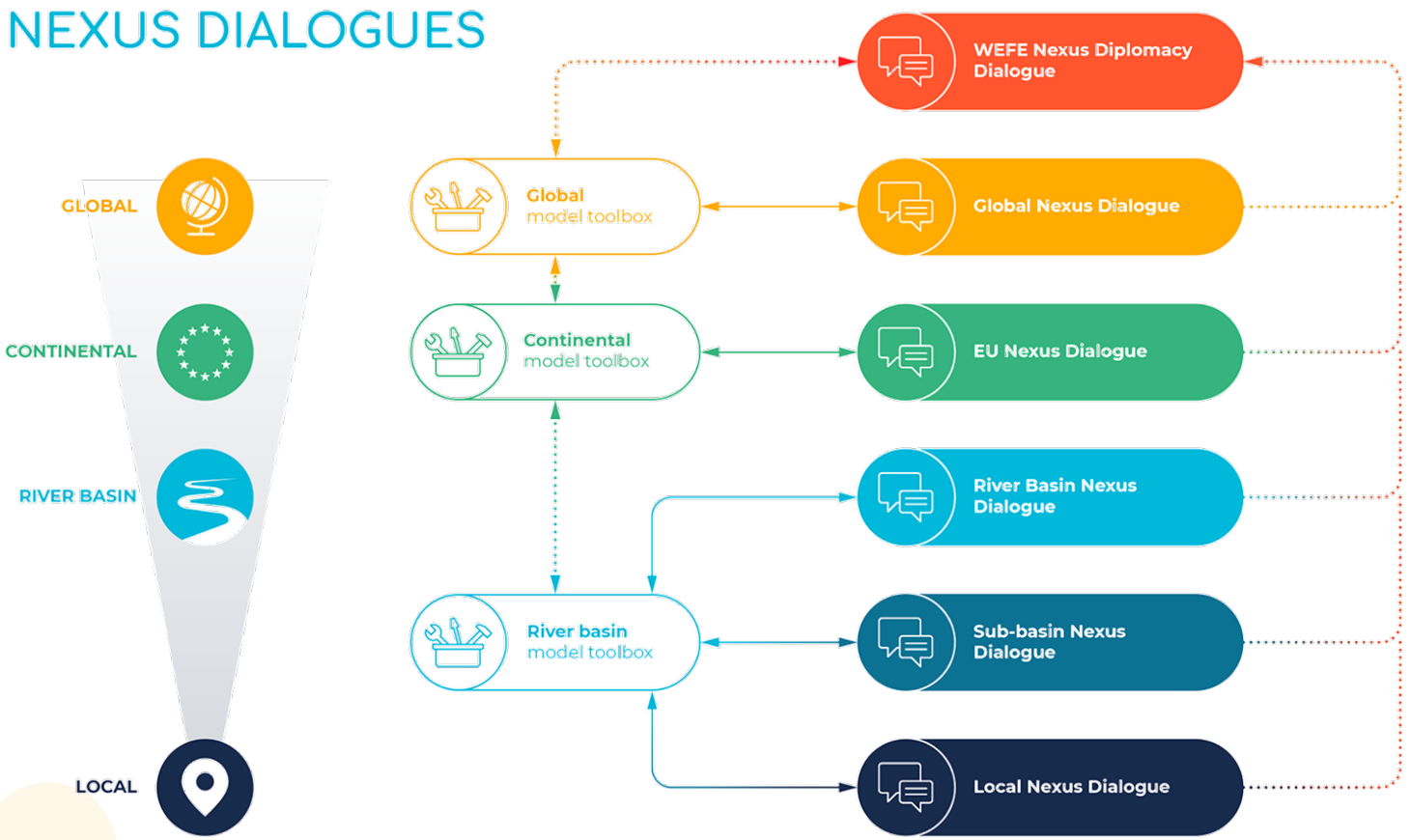
**Expected Impacts:**

- Tailored climate change scenarios generated using global projections
- Multi-model approach created using global climate models
- Cross-cutting solutions

# NEXUS dialogues

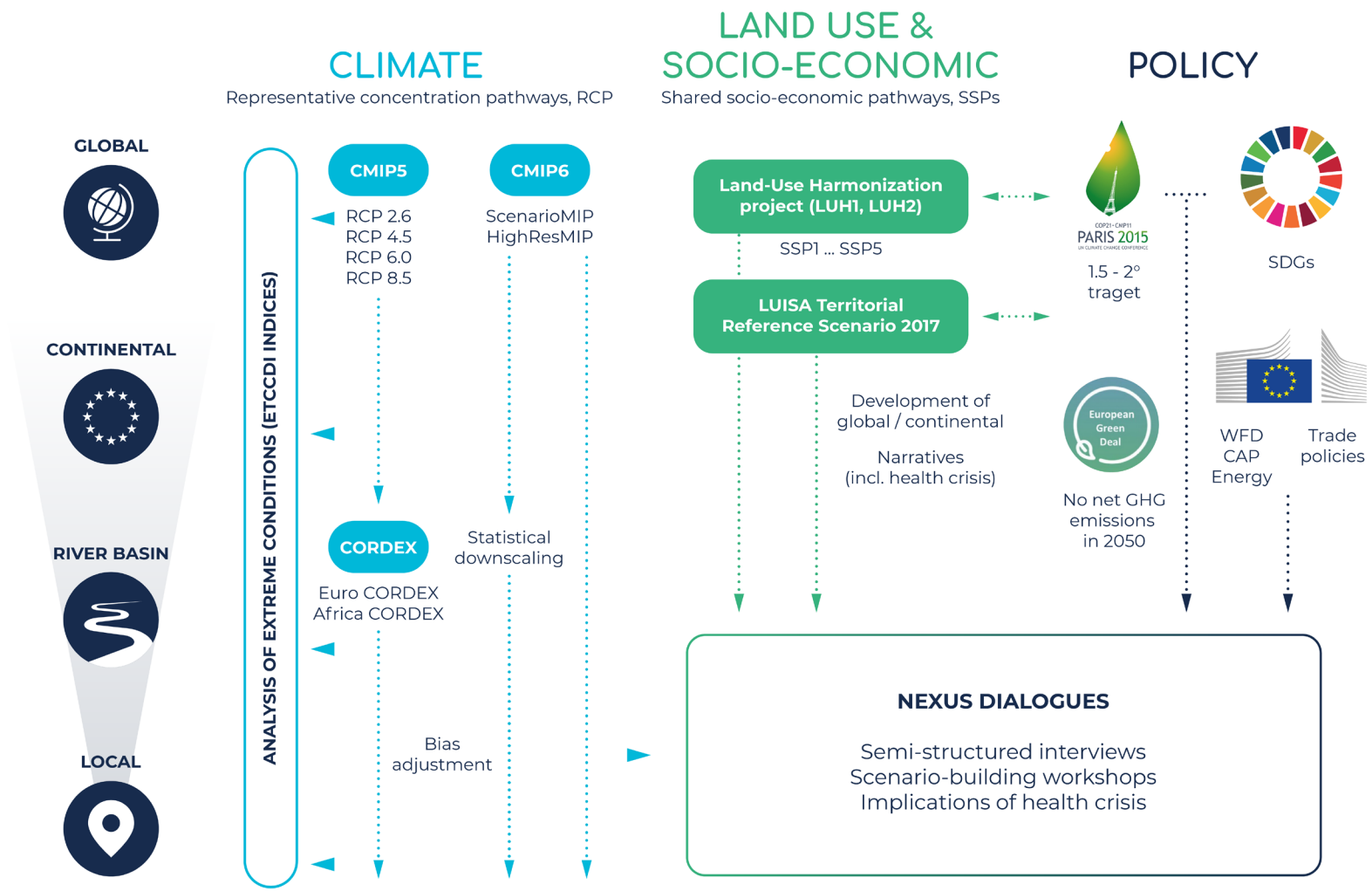
Stakeholder meetings to co-design scenarios, models, indicators and solutions

**Goal :** understand conflicts & trade-offs, sectoral policies, synergies, and uncertainties



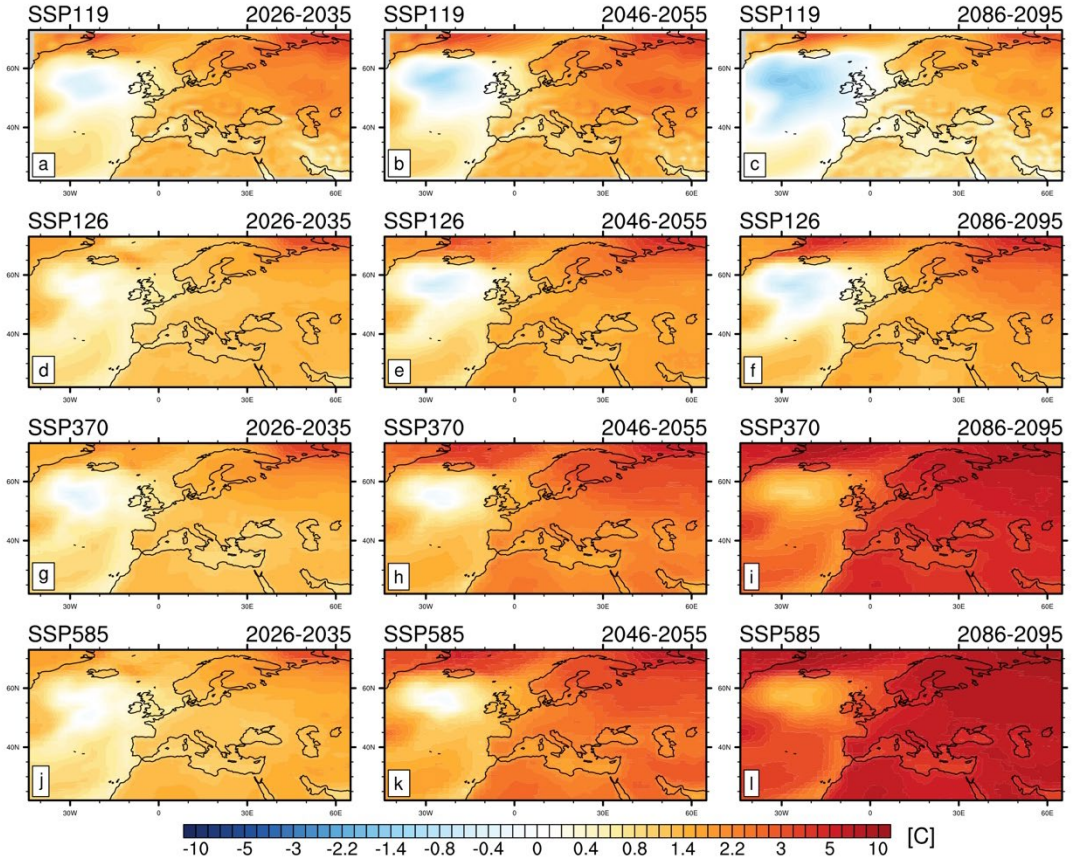
# NEXUS dialogues


# Future projection scenarios

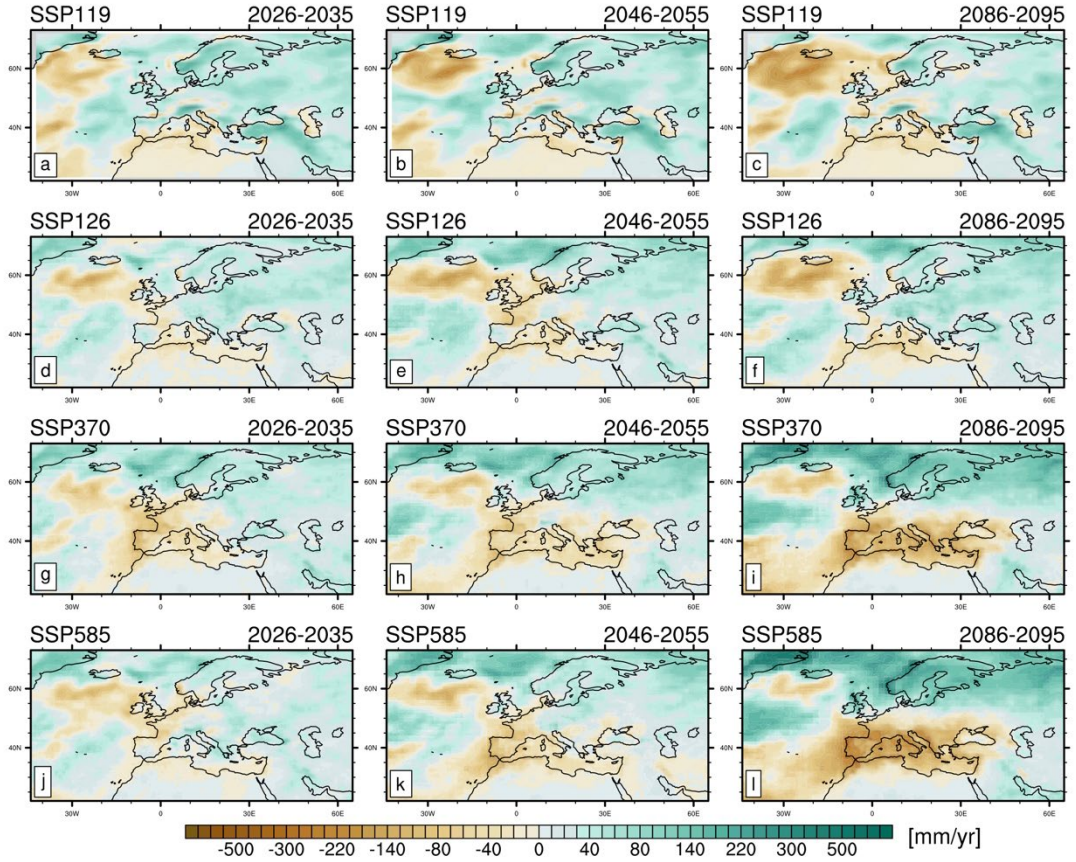


# Future projection scenarios

Near Surface Air Temperature Anomaly

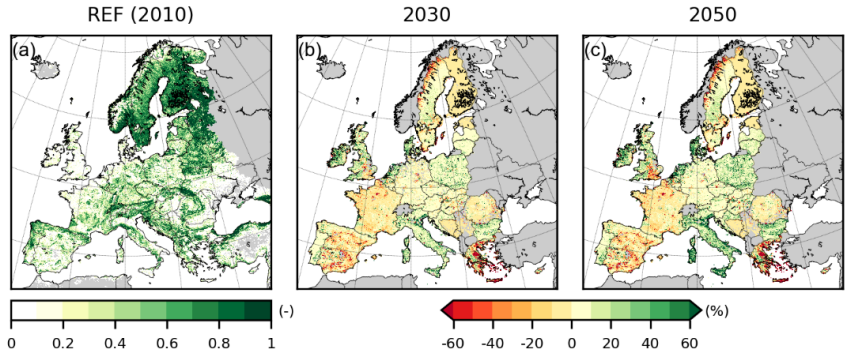



Total Precipitation Anomaly

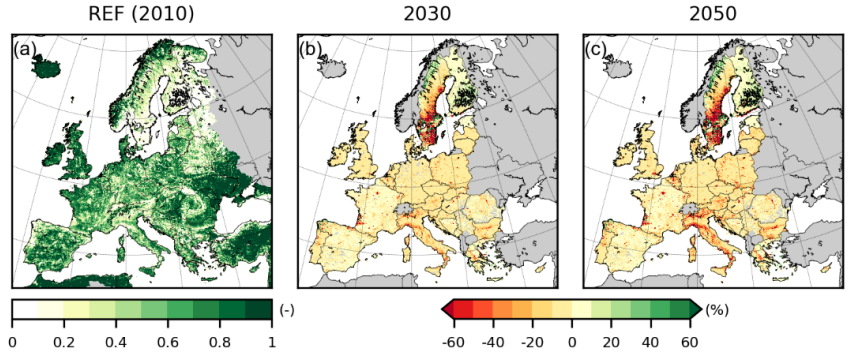


# Future projection scenarios

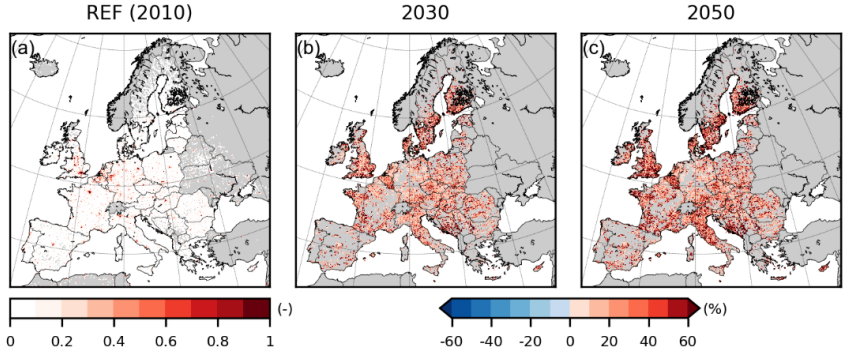
Forests




Arable land

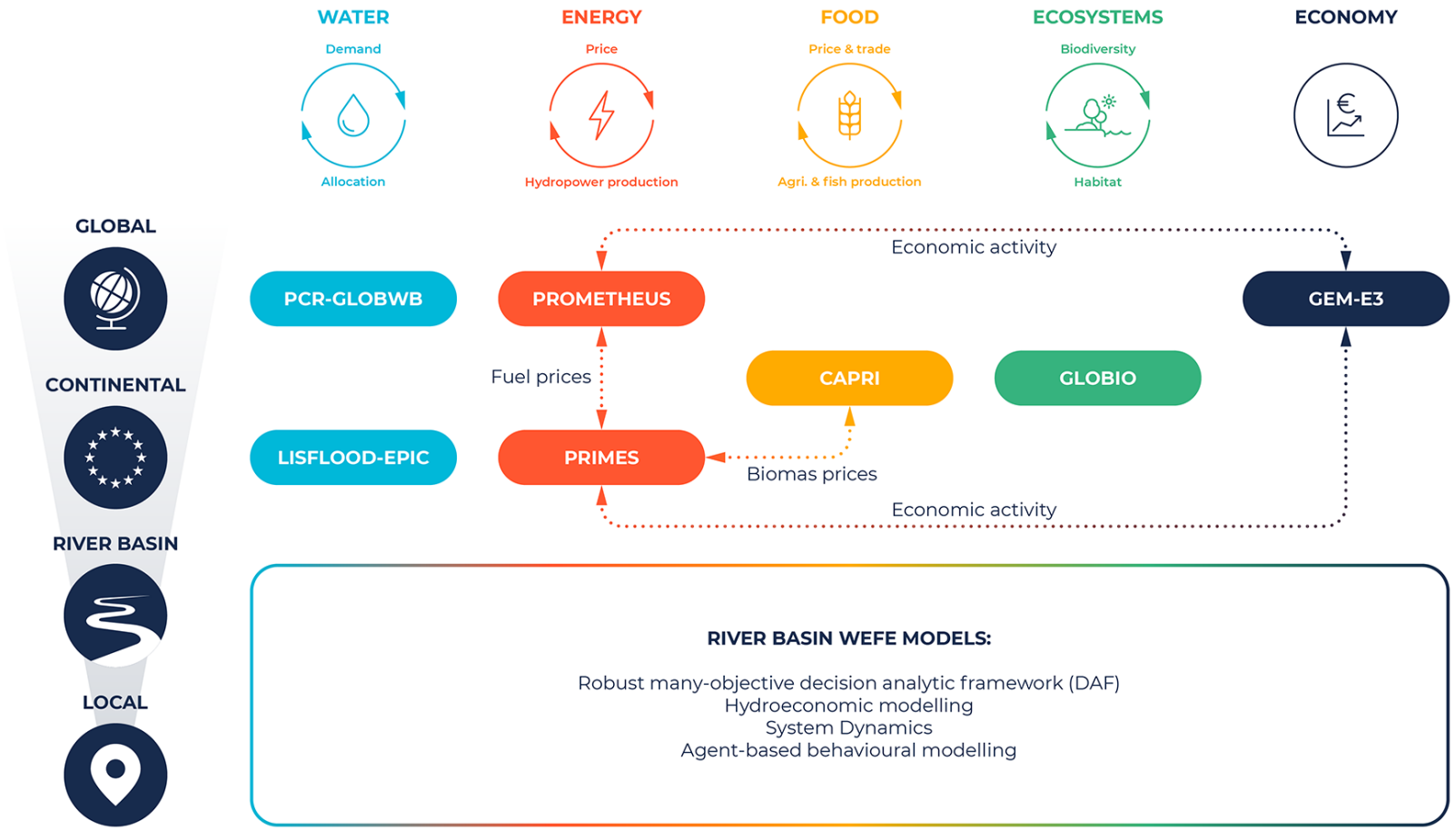



Urbanized areas



# Models and model toolbox

The model toolbox will consolidate models used throughout the project's research phase

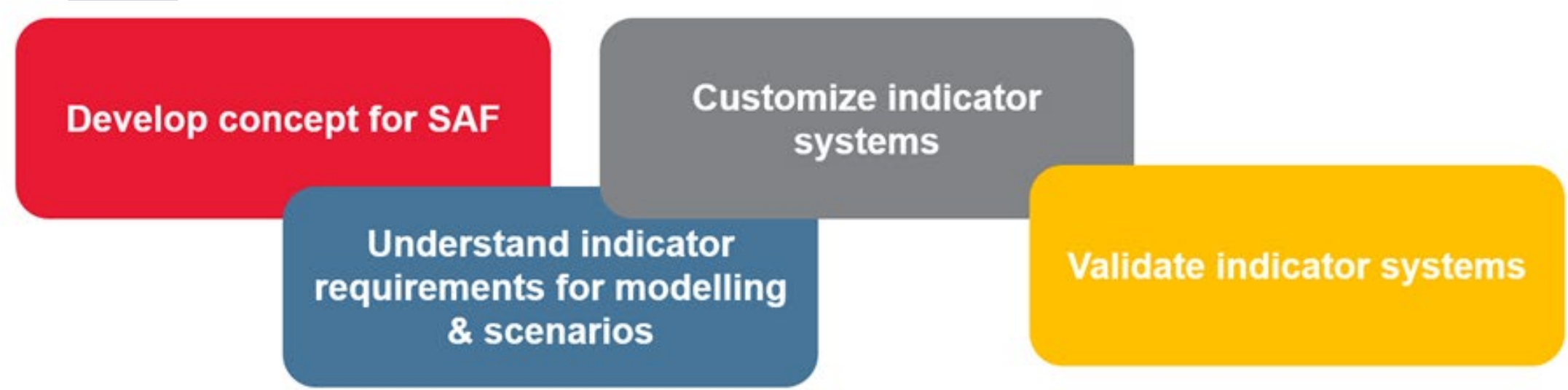


# Sustainability Assessment Framework (SAF)

- a hierarchical set of indicators to enable a holistic evaluation
- WEFE indicators and sustainability indicators to provide a solid evidence
- Case-study tailored and co-developed within the Nexus Dialogues

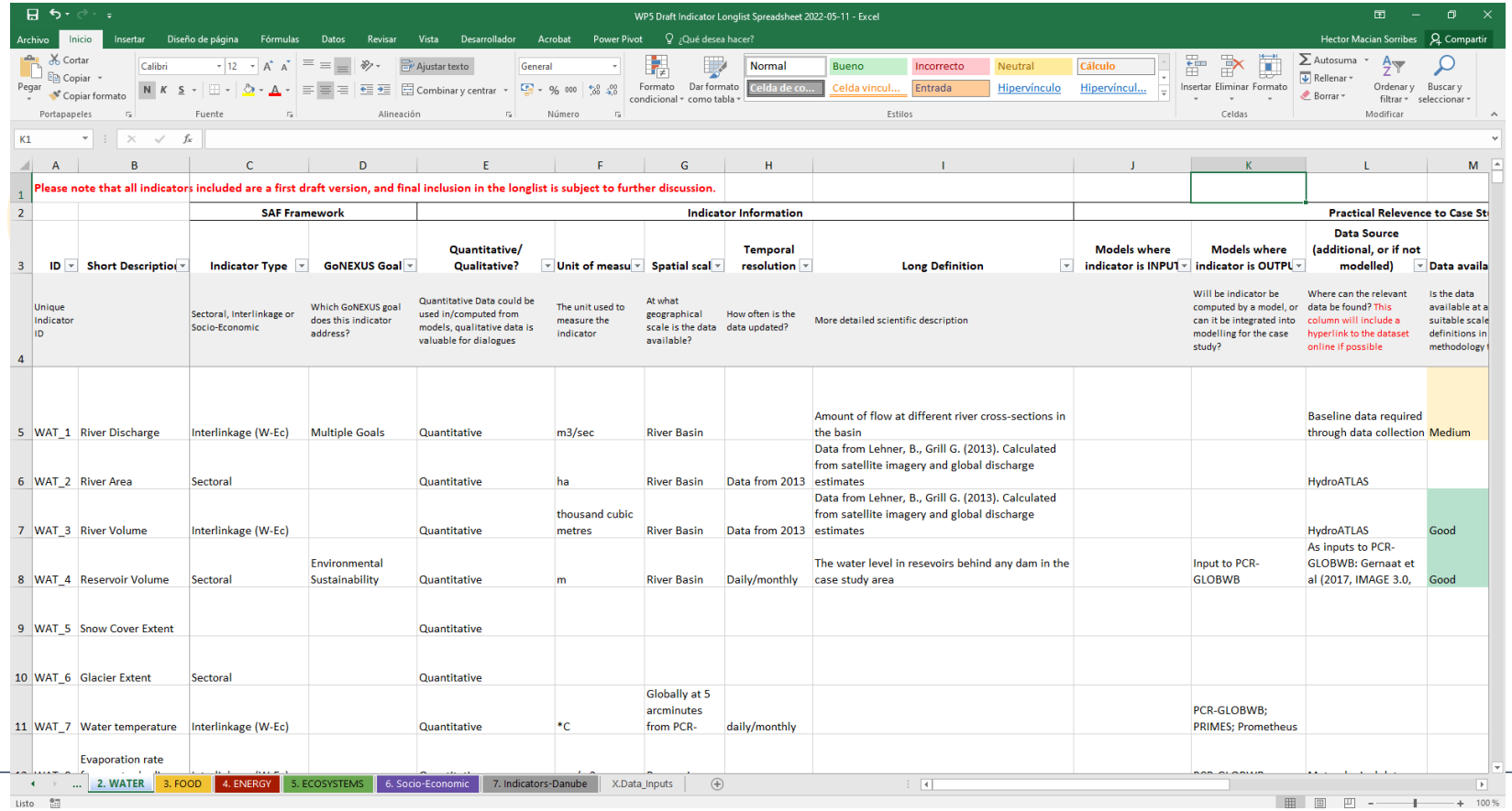
# Sustainability Assessment Framework (SAF)

Timeline for SAF development



# Sustainability Assessment Framework (SAF)

## Preliminary indicator lists



WP5 Draft Indicator Longlist Spreadsheet 2022-05-11 - Excel

Please note that all indicators included are a first draft version, and final inclusion in the longlist is subject to further discussion.

| | | | SAF Framework | | Indicator Information | | | | | | | Practical Relevence to Case St | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | Short Descriptio | Indicator Type | GoNEXUS Goal | Quantitative/ Qualitative? | Unit of measu | Spatial scal | Temporal resolution | Long Definition | Models where indicator is INPUT | Models where indicator is OUTPU | Data Source (additional, or if not modelled) | Data availa |
| Unique Indicator ID | | Sectoral, Interlinkage or Socio-Economic | Which GoNEXUS goal does this indicator address? | Quantitative Data could be used in/computed from models, qualitative data is valuable for dialogues | The unit used to measure the indicator | At what geographical scale is the data available? | How often is the data updated? | More detailed scientific description | | Will be indicator be computed by a model, or can it be integrated into modelling for the case study? | Where can the relevant data be found? This column will include a hyperlink to the dataset online if possible | Is the data available at a suitable scale definitions in methodology |
| WAT_1 | River Discharge | Interlinkage (W-Ec) | Multiple Goals | Quantitative | m3/sec | River Basin | | Amount of flow at different river cross-sections in the basin | | | Baseline data required through data collection | Medium |
| WAT_2 | River Area | Sectoral | | Quantitative | ha | River Basin | Data from 2013 | Data from Lehner, B., Grill G. (2013). Calculated from satellite imagery and global discharge estimates | | | HydroATLAS | |
| WAT_3 | River Volume | Interlinkage (W-Ec) | | Quantitative | thousand cubic metres | River Basin | Data from 2013 | Data from Lehner, B., Grill G. (2013). Calculated from satellite imagery and global discharge estimates | | | HydroATLAS | Good |
| WAT_4 | Reservoir Volume | Sectoral | Environmental Sustainability | Quantitative | m | River Basin | Daily/monthly | The water level in resevoirs behind any dam in the case study area | | Input to PCR-GLOBWB | As inputs to PCR-GLOBWB: Gernaat et al (2017, IMAGE 3.0, | Good |
| WAT_5 | Snow Cover Extent | | | Quantitative | | | | | | | | |
| WAT_6 | Glacier Extent | Sectoral | | Quantitative | | | | | | | | |
| WAT_7 | Water temperature | Interlinkage (W-Ec) | | Quantitative | *C | Globally at 5 arcminutes from PCR- | daily/monthly | | | PCR-GLOBWB; PRIMES; Prometheus | | |
| | Evaporation rate | | | | | | | | | | | |

Sheets: 2. WATER | 3. FOOD | 4. ENERGY | 5. ECOSYSTEMS | 6. Socio-Economic | 7. Indicators-Danube | X.Data_Inputs

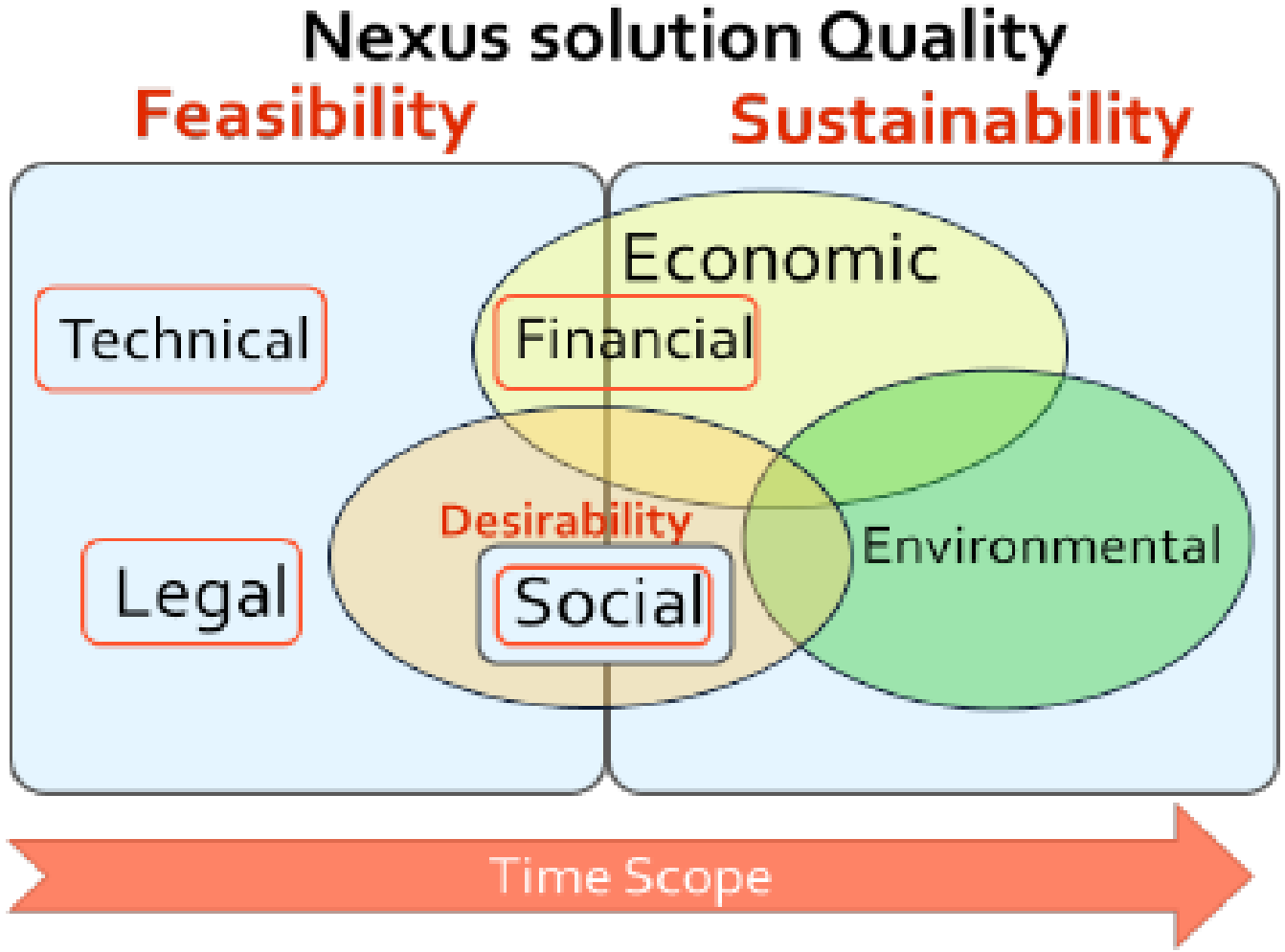
# Evidence and solutions

- WEFE nexus management solutions will be co-designed and tested using the **Solutions Evaluation Framework**.

Including:

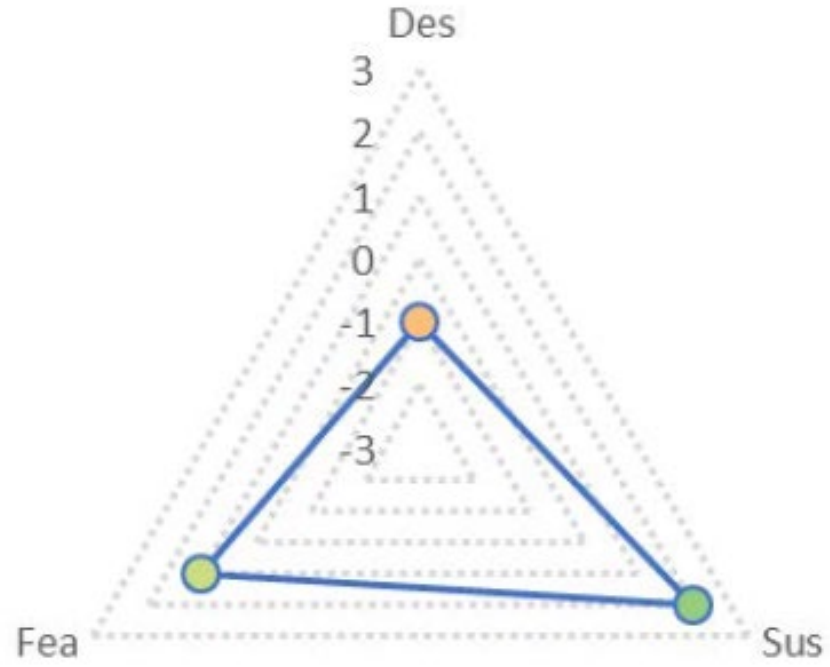
- Technical and operational solutions
- Risk-hedging instruments
- Institutional changes
- Policy changes

# Evidence and solutions

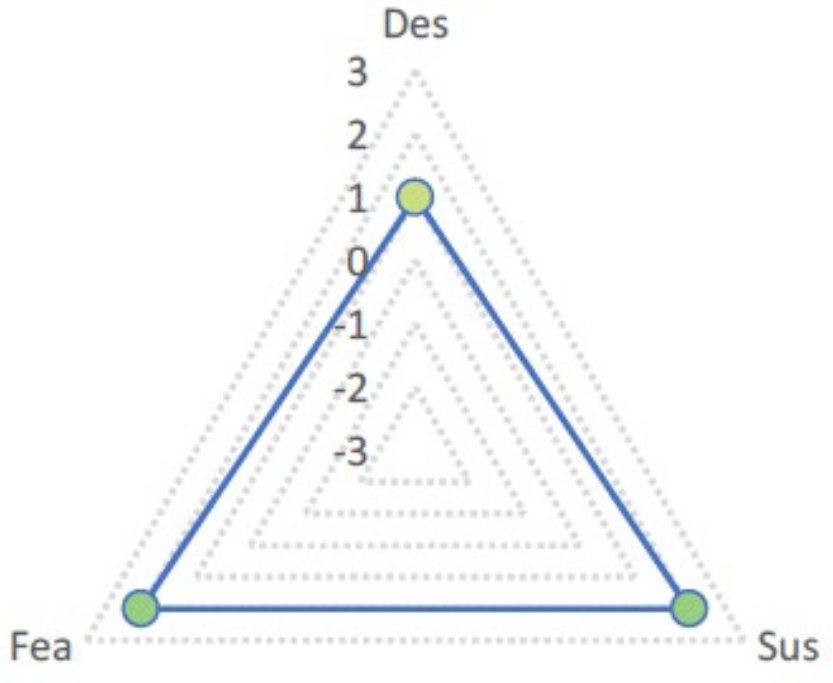


# Evidence and solutions

Solution X (feasible, sustainable, not desired)




Solution Y (feasible, sustainable, desired)



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GoNEXUS

Tools and solutions for governing the nexus

# Integrated solutions for water, energy, food and ecosystems

*Modelling capabilities for the Danube River Basin Case Study*


Rens van Beek – Utrecht University (r.vanbeek@uu.nl)

*with contributions of*

*Kristina Govorukha* – *E3-Modelling*

*Aafke Schipper* – *PBL*

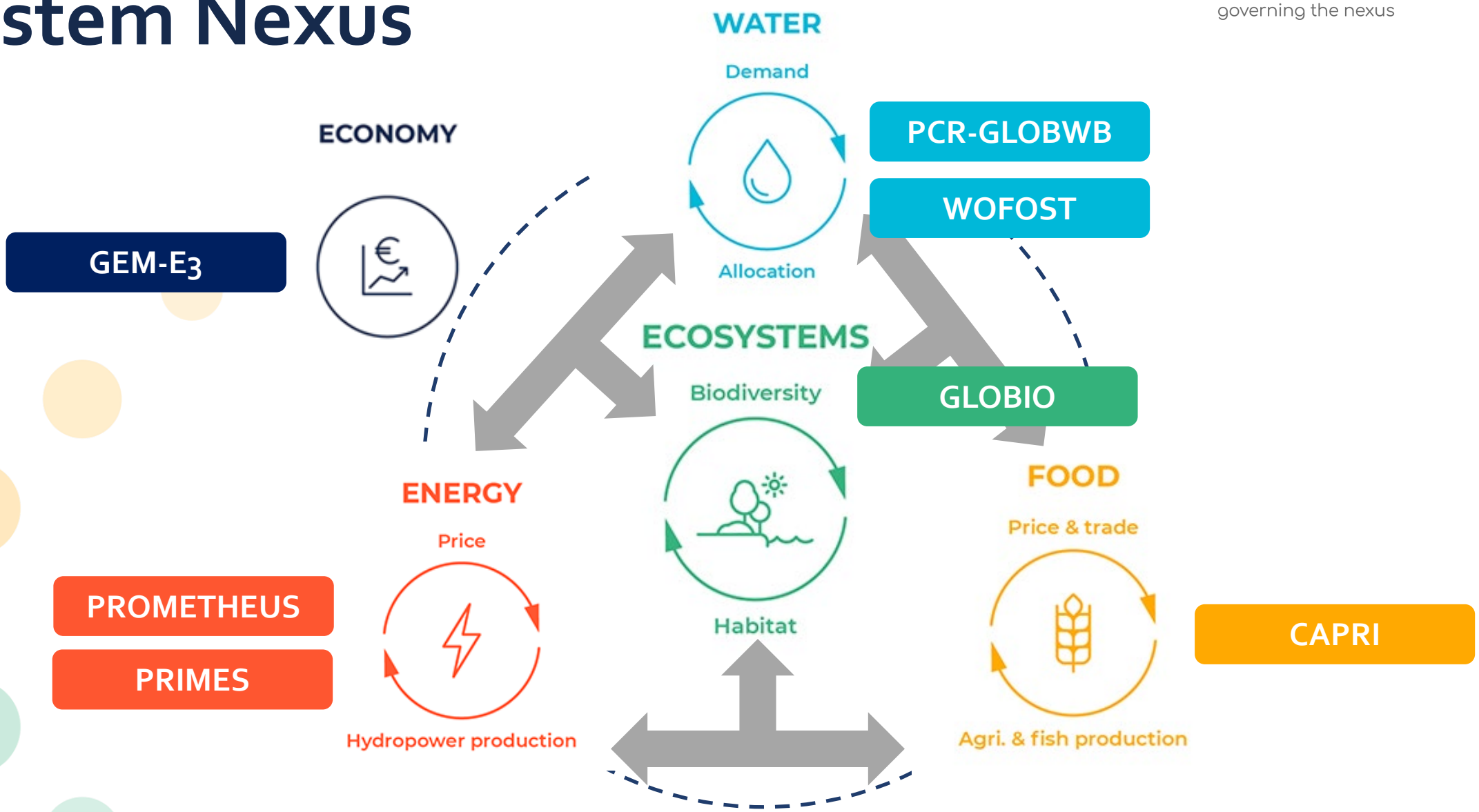
*Imen Arfa* – *Universidad Politécnica de Madrid*



GoNEXUS has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement number 101003722.

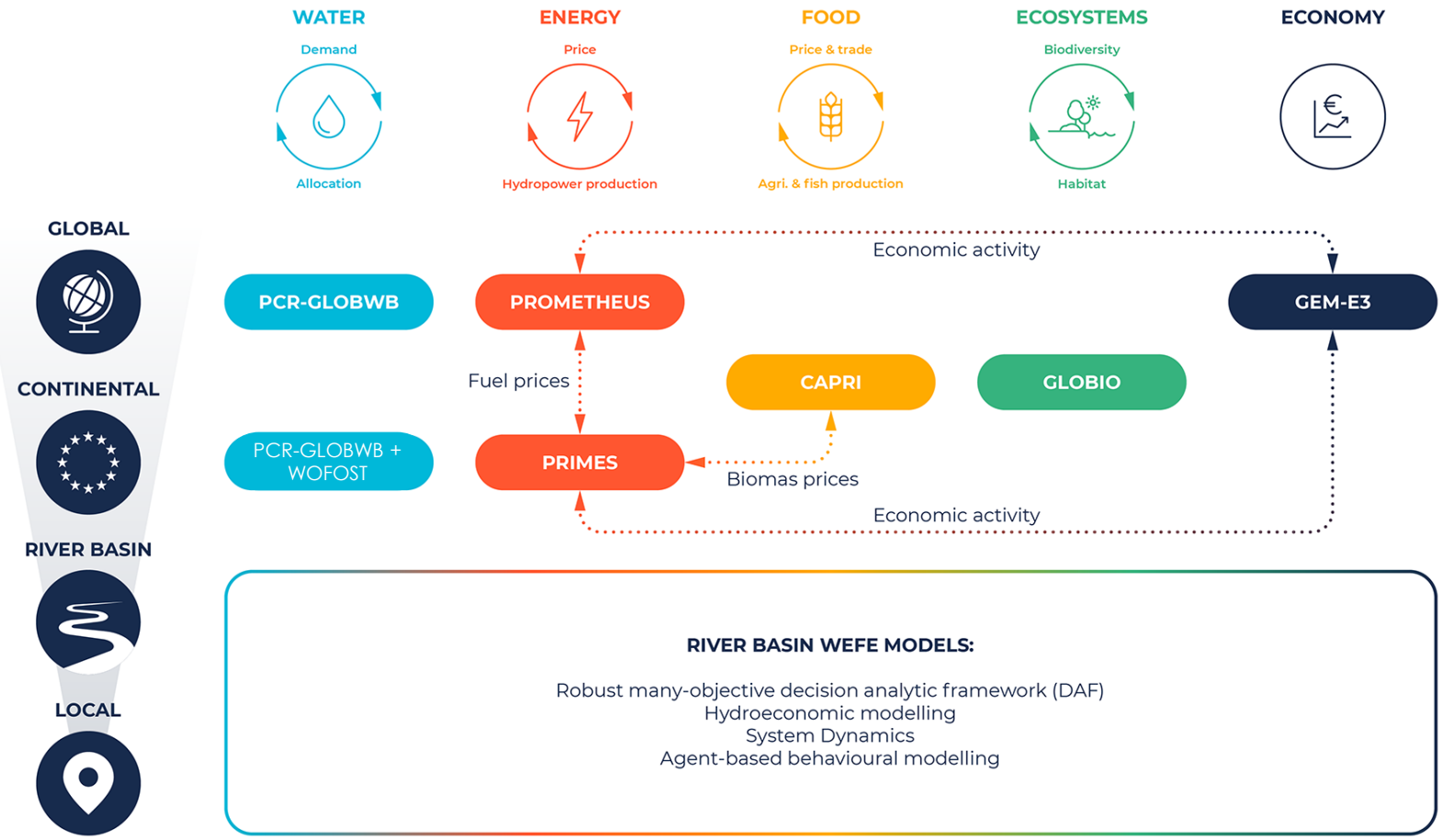
# Water-Food-Energy-Ecosystem Nexus

GoNEXUS
Tools and solutions for governing the nexus



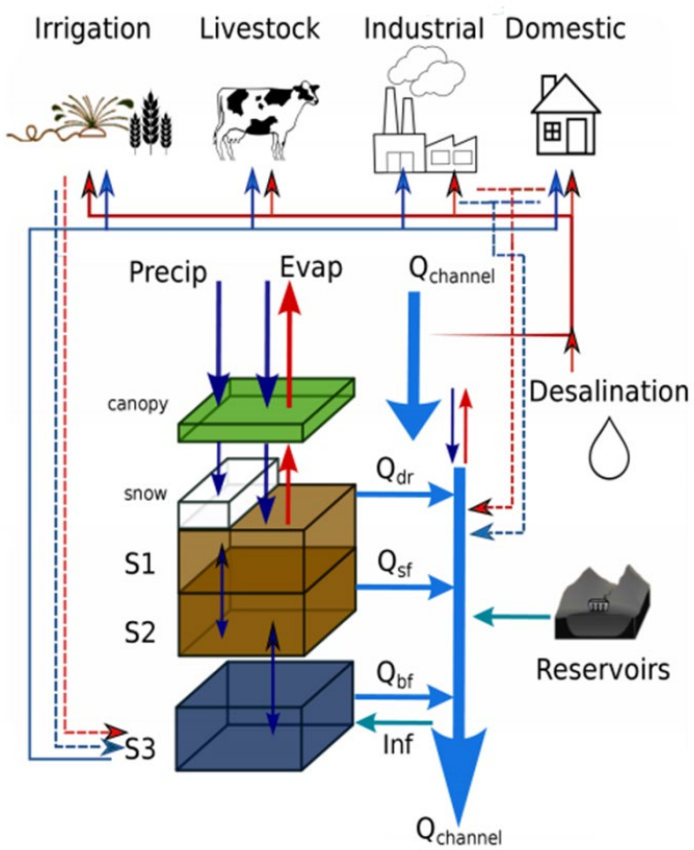
# Models and model toolbox

- Introduce the thematic models;
- Highlight capabilities and model linkages;
- Tailor scenarios to the challenges and adaptation measures;
- List the opportunities and limitations.



# Hydrological model set-up and projections

PCR-GLOBWB + WOFOST




GLOBAL

CONTINENTAL

RIVER BASIN

LOCAL

ANALYSIS OF EXTREME CONDITIONS (ETCCDI INDICES)

## CLIMATE

Representative concentration pathways, RCP

**CMIP5**

RCP 2.6
RCP 4.5
RCP 6.0
RCP 8.5

**CMIP6**

ScenarioMIP
HighResMIP

**CORDEX**

Euro CORDEX
Africa CORDEX

Statistical downscaling

Bias adjustment

## LAND USE & SOCIO-ECONOMIC

Shared socio-economic pathways, SSPs

**Land-Use Harmonization project (LUH1, LUH2)**

SSP1 ... SSP5

**LUISA Territorial Reference Scenario 2017**

Development of global / continental Narratives (incl. health crisis)

## POLICY

PARIS 2015

1.5 - 2° traget

SDGs

European Green Deal

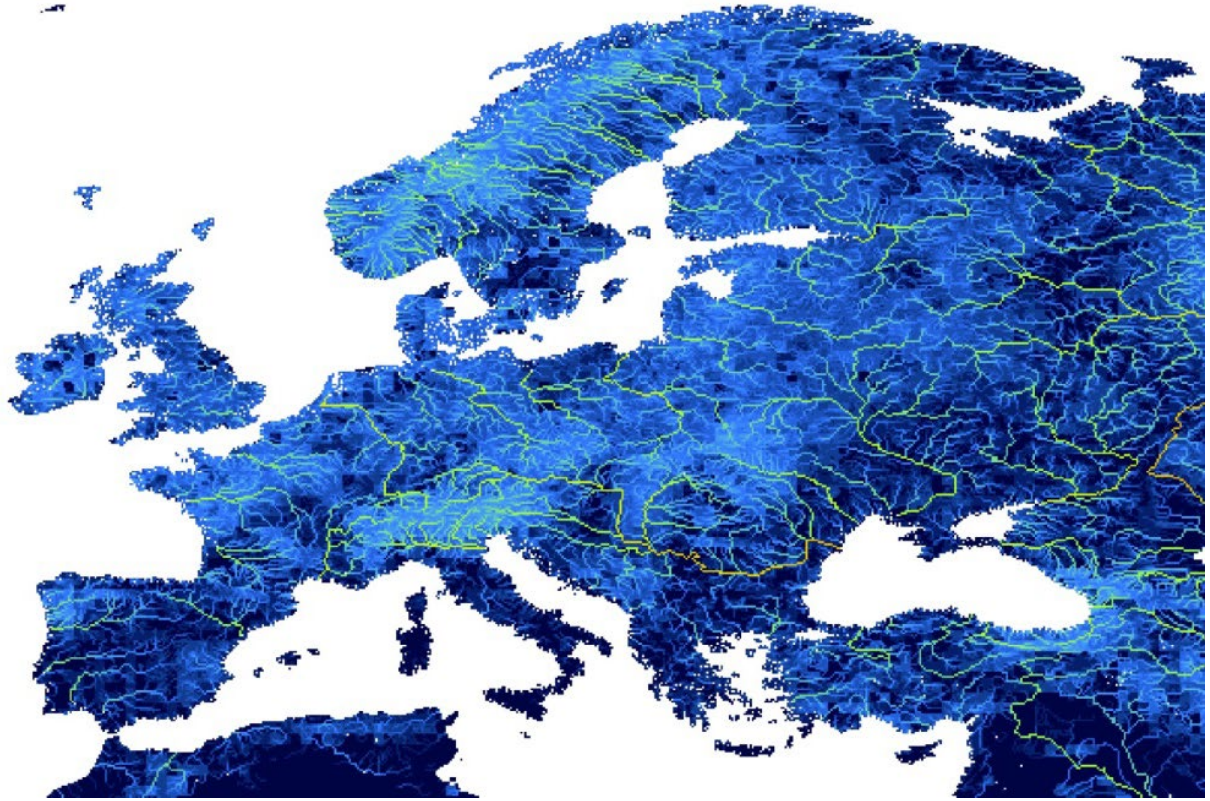
No net GHG emissions in 2050

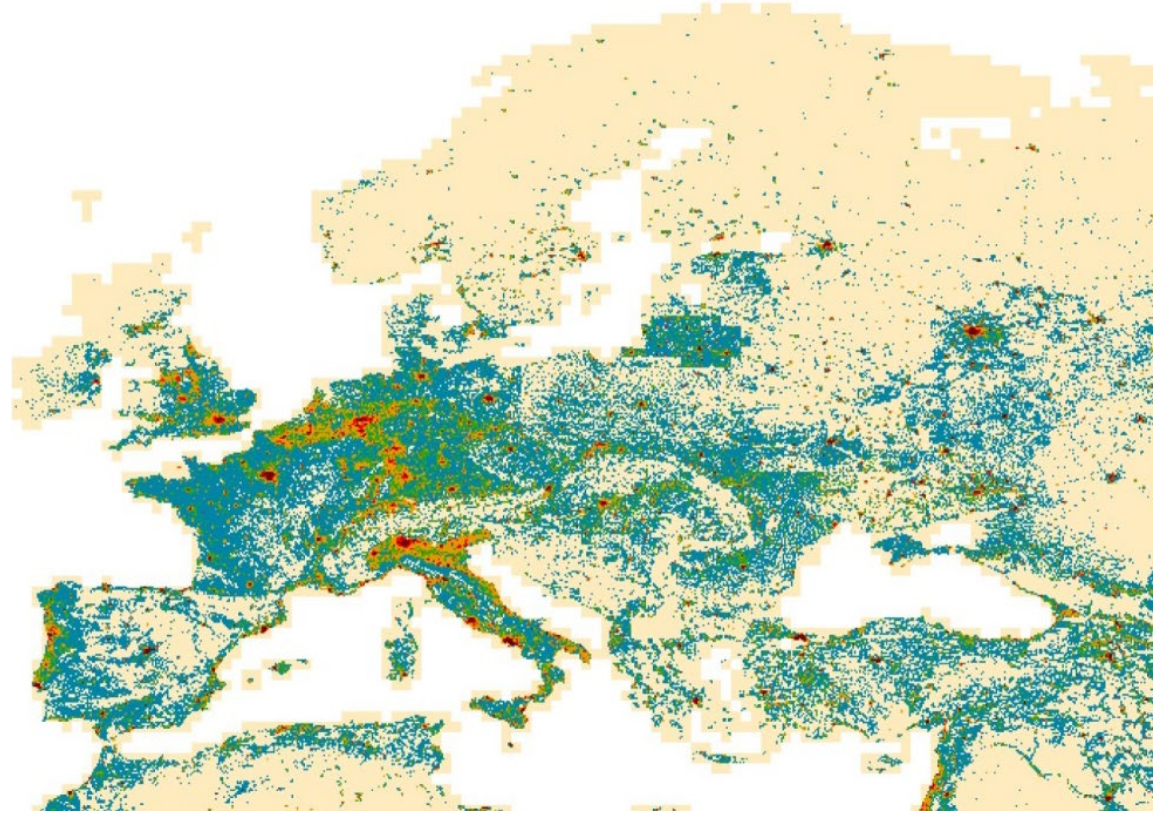
WFD
CAP
Energy

Trade policies

**NEXUS DIALOGUES**

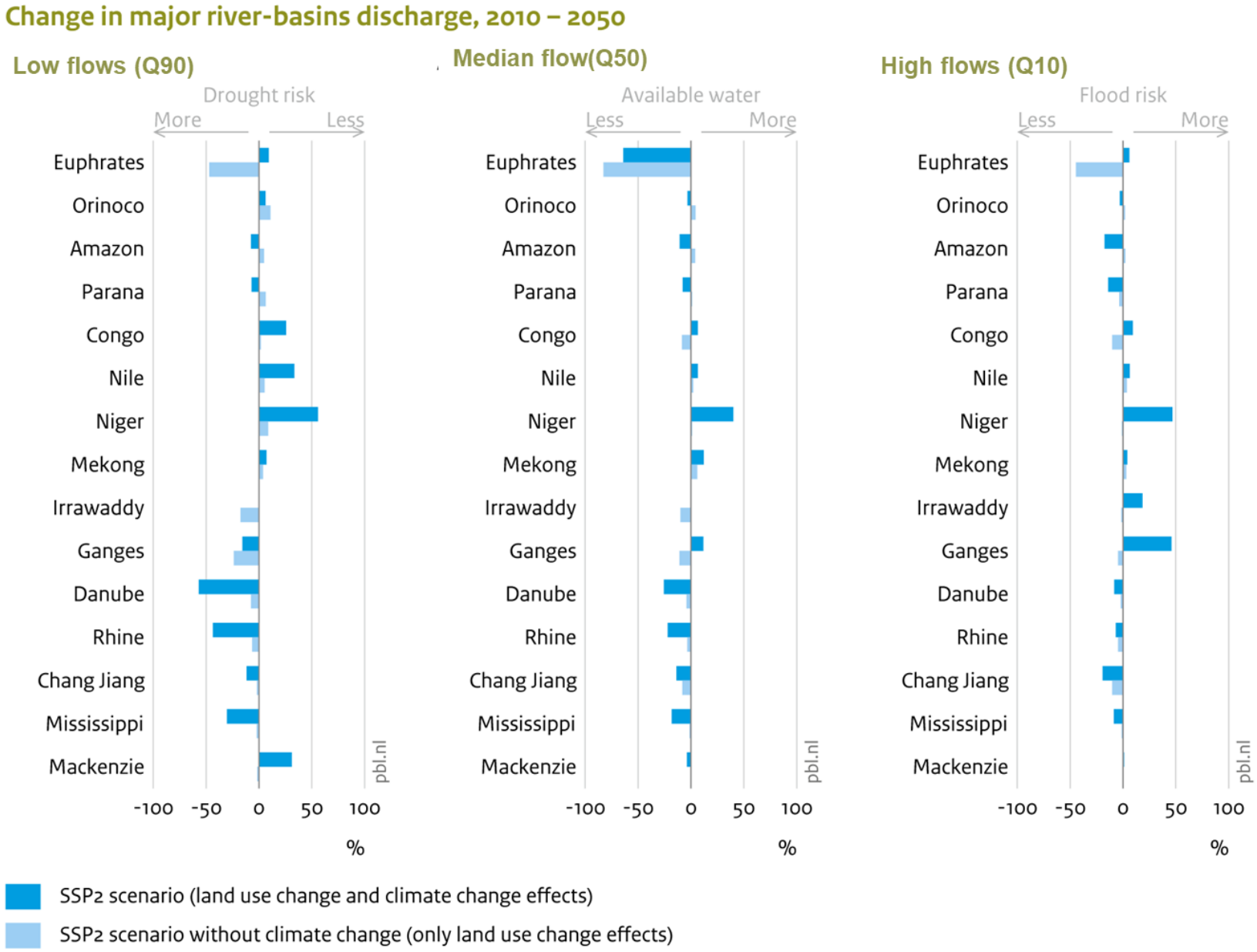
Semi-structured interviews
Scenario-building workshops
Implications of health crisis





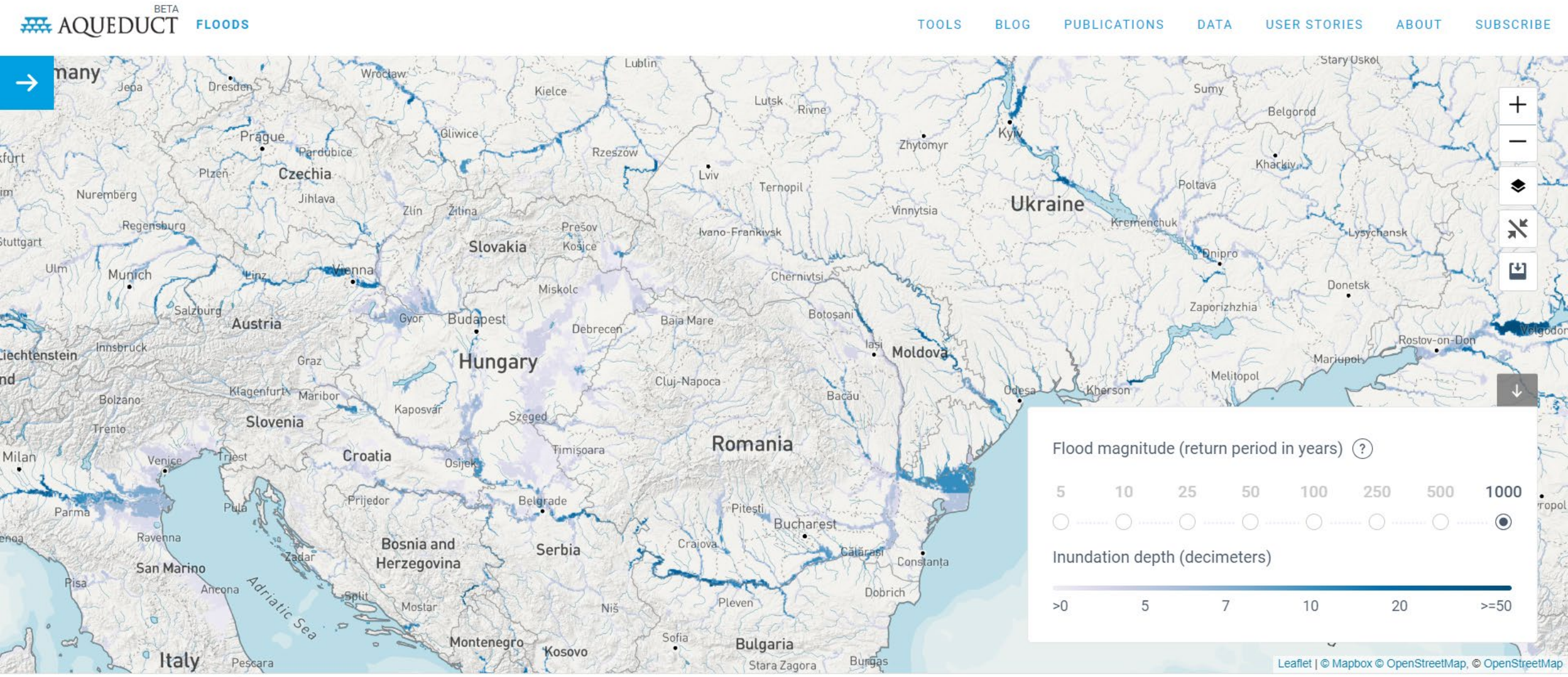
# Model capabilities in relation to the proposed challenges

- For the Danube, increased socio-economic pressure reduces the discharge from the river basin.
- Climate change exacerbates this, particularly during low to median flows.
- High flows are the result of extreme weather and are not greatly affected but particular floods may be.
- Climate uncertainty can be assessed (scenario, model).

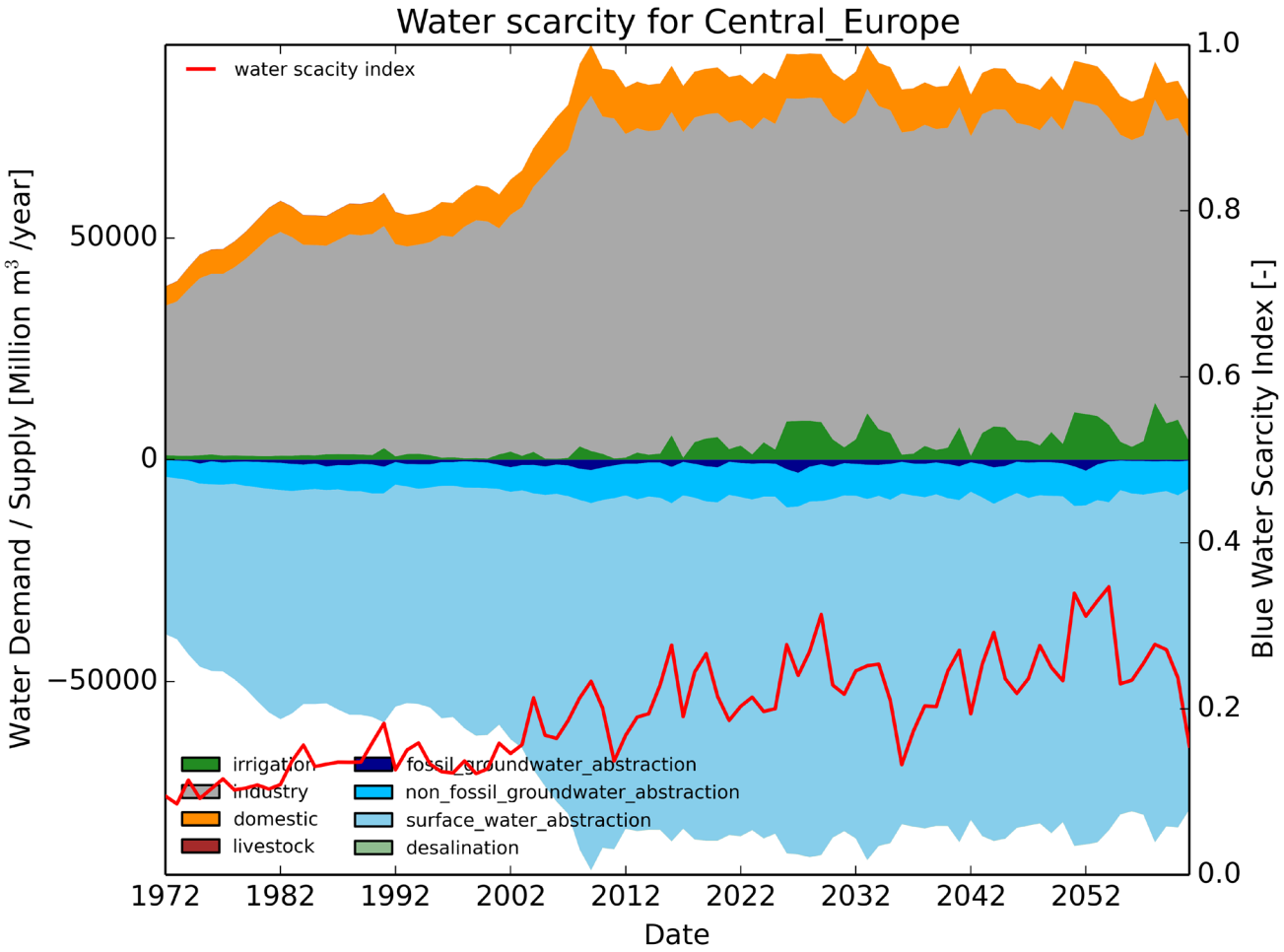



Source: UU; PBL

# Model capabilities in relation to the proposed challenges



# Model capabilities in relation to the proposed challenges

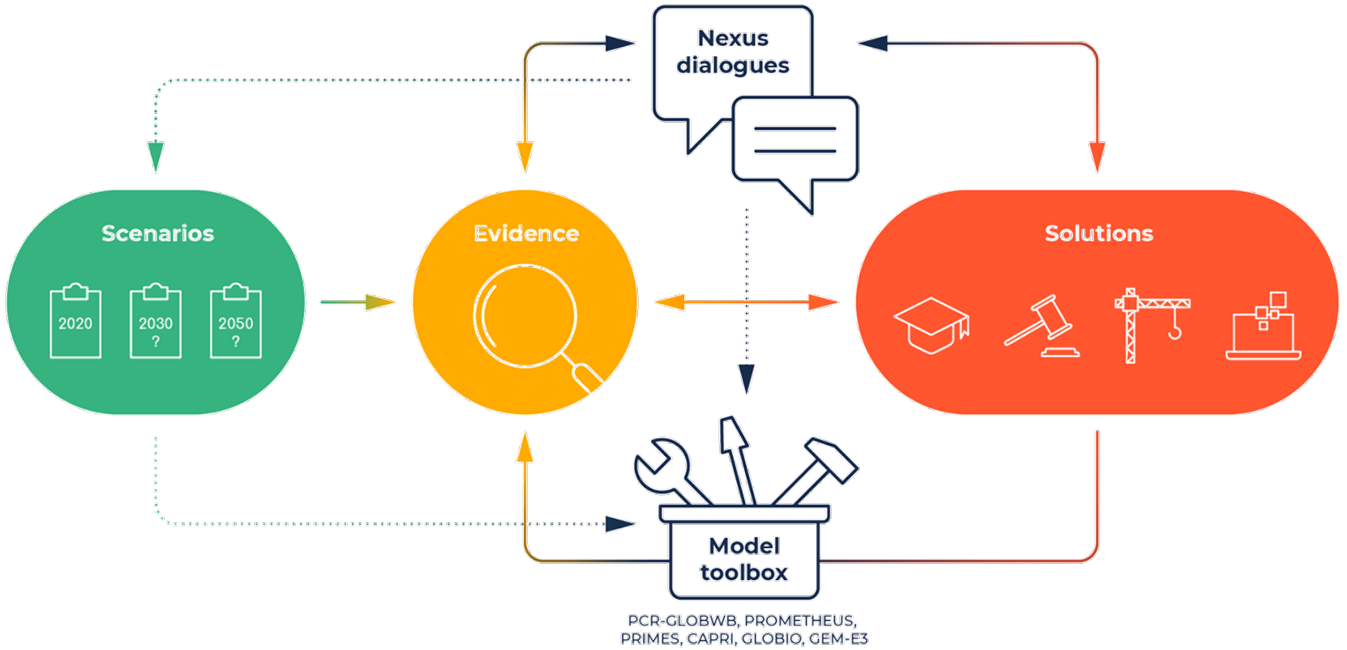



- Composite effect for Central Europe including the Danube River Basin.
- Shown here are the water demand and the mirrored supply from water sources.
- Water scarcity index is demand over renewable blue water resources (scarcity > 0.2, > 0.4).
- Demands stabilize due to constant population after 2020.
- Demands fluctuate, however, due to increased irrigation water demand.
- Scarcity increases and more non-renewable water is used.

# Danube River Basin modelling

Challenges:

1. Water scarcity and increased flood risk
2. Water scarcity due to growing irrigation demand
3. Vulnerability of riverine and terrestrial ecosystems



# CAPRI

Model type:

- Global agro-economic model

Product/agent coverage:

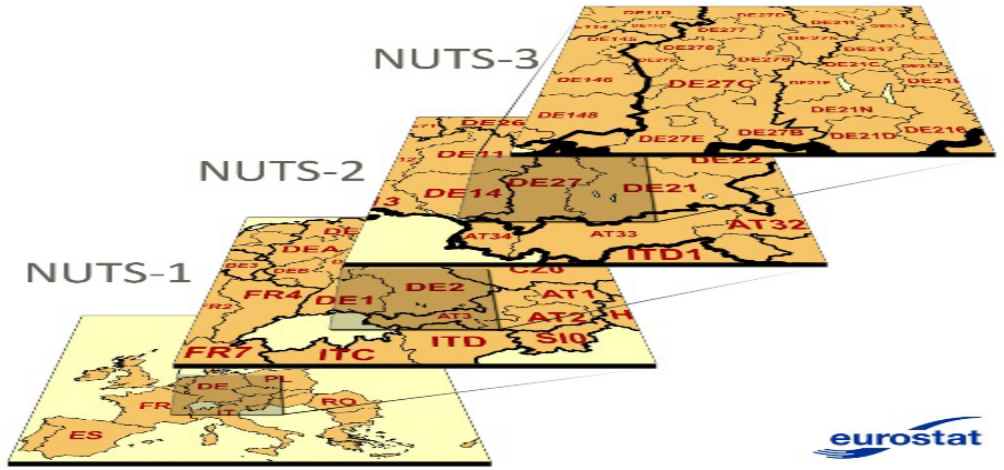
- partial equilibrium / general equilibrium supply / market models

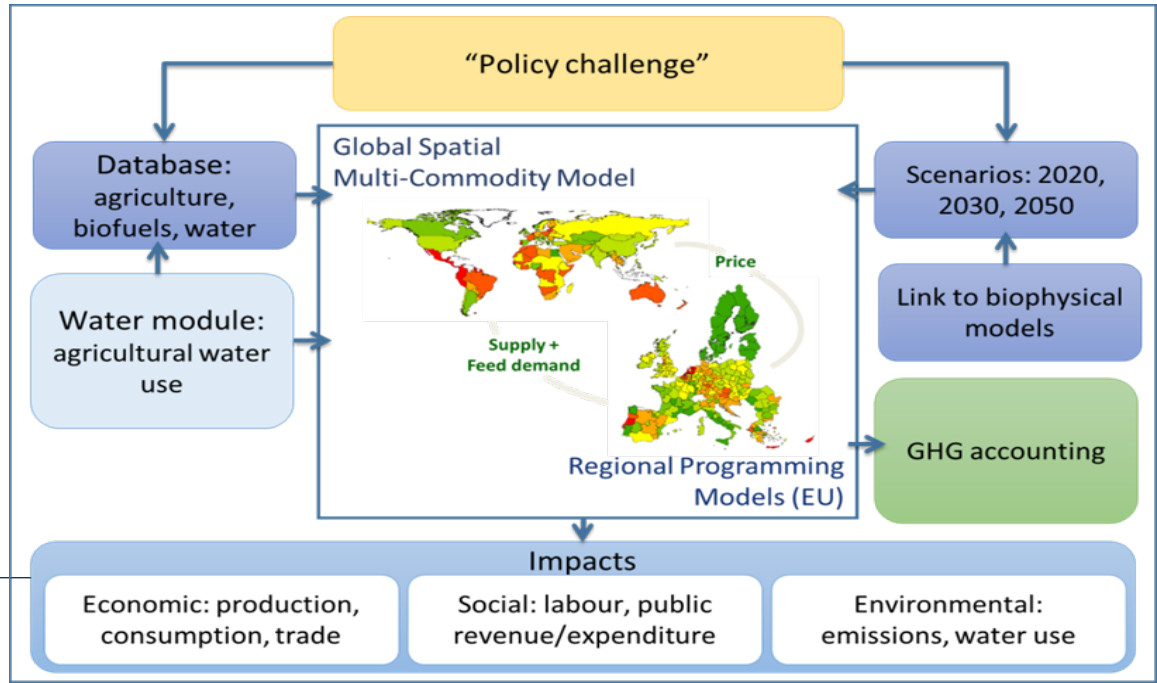
Spatial and temporal coverage:

- Global
- National and regional within the EU
- Until 2050 in flexible time steps

Source of parameters:

- econometric models / synthetic models



# CAPRI

## Outputs of Tier 1

Data on climate socioeconomic scenarios (SSP1-1.9, SSP1-2.6, SSP3-7.0 and SSP5-8.5) has been processed at national level for all global regions and aggregated at the spatial scale in CAPRI for non-EU regions.

## Potential model improvements for Tier 2

Improvement of the water module to cover all global regions (both EU and non-EU regions)

Improvement of interlinkages between agricultural water use and environmental quality

# Modeling solutions and impacts of future change: biomass and energy

**Challenges:**

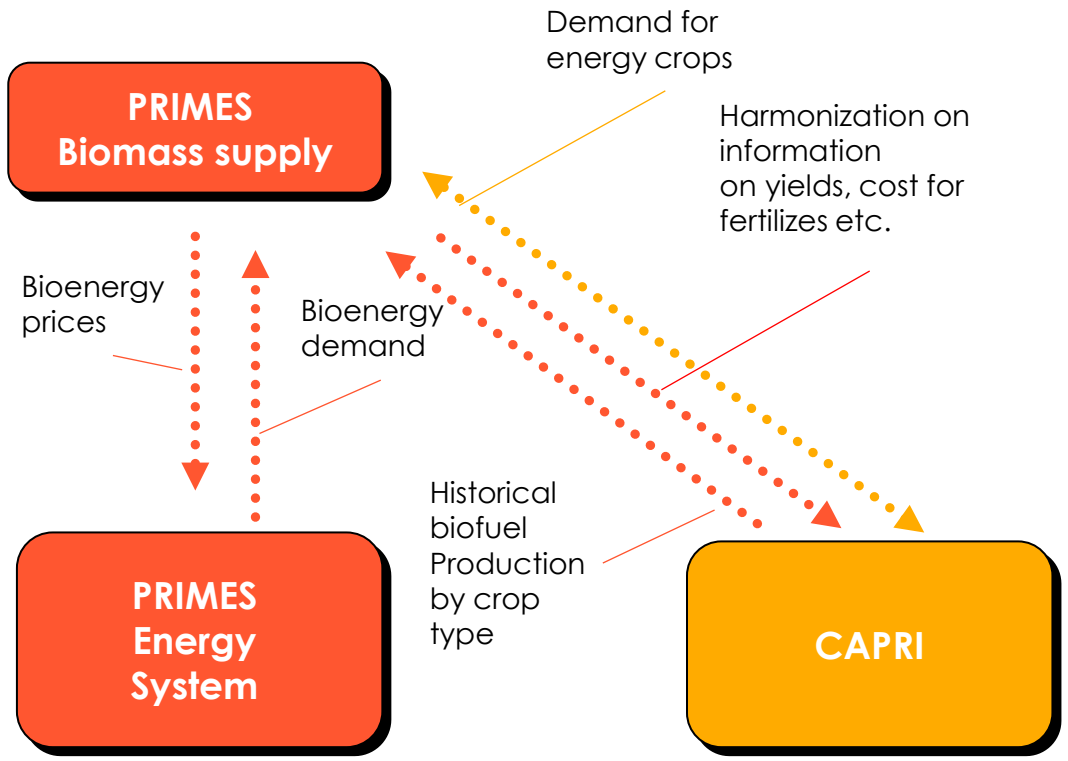
Green energy transition | Water, energy and food security | Policy coherence

**Solutions:**

- Novel water resources
- Increase use of RES

**Water scarcity scenarios that include:**

- Irrigation expansion
- Climate change effect on production of biofuels
- Increase in share of renewable energy scenarios
- Harmonization on information on yields, cost for fertilizes etc.



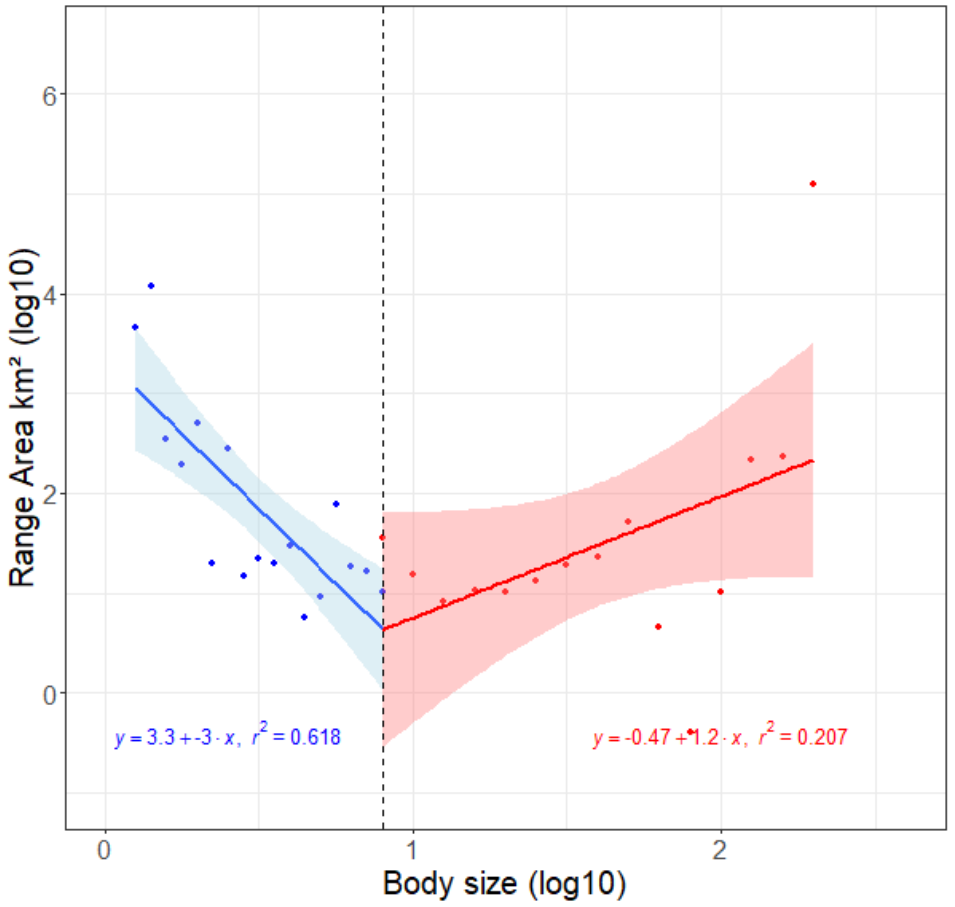
# GLOBIO-Species model (freshwater fishes)

**Impacts on freshwater fishes**

- Dams → Habitat fragmentation (Barbarossa *et al.* 2020)
- Changes in discharge → Habitat loss (Barbarossa *et al.* 2021)
- Changes in water temperature → Habitat loss (Barbarossa *et al.* 2021)

**Integration of impacts (GoNEXUS Tier 1)**

- Identify and remove habitat fragments too small to sustain a viable population
- Based on a novel relationship between fragment area and body mass (see figure; Keijzer *et al.* in prep)



# GLOBIO-Species model (freshwater fishes)

**Outputs of Tier 1**

- Declines in freshwater fish species distribution due to habitat loss (climate change → discharge and water temperature) and fragmentation (dams) in response to Tier 1 scenarios

**Potential model improvements for Tier 2**

- Refining the fish species' thermal tolerance thresholds based on lab data
- Adding dispersal to allow for range shifts in response to climate change

**Possible scenario-based adaptation measures**

- Measures affecting discharge and water temperature (e.g., climate change mitigation measures)
- Dam removal

# Nexus model inter-linkages

PCR-GLOBWB => PROMETHEUS/PRIMES (**Energy**)

- Energy demand by water-using energy technologies
- Desalinization capacity and water use

PCR-GLOBWB + WOFOST => CAPRI (**Food**)

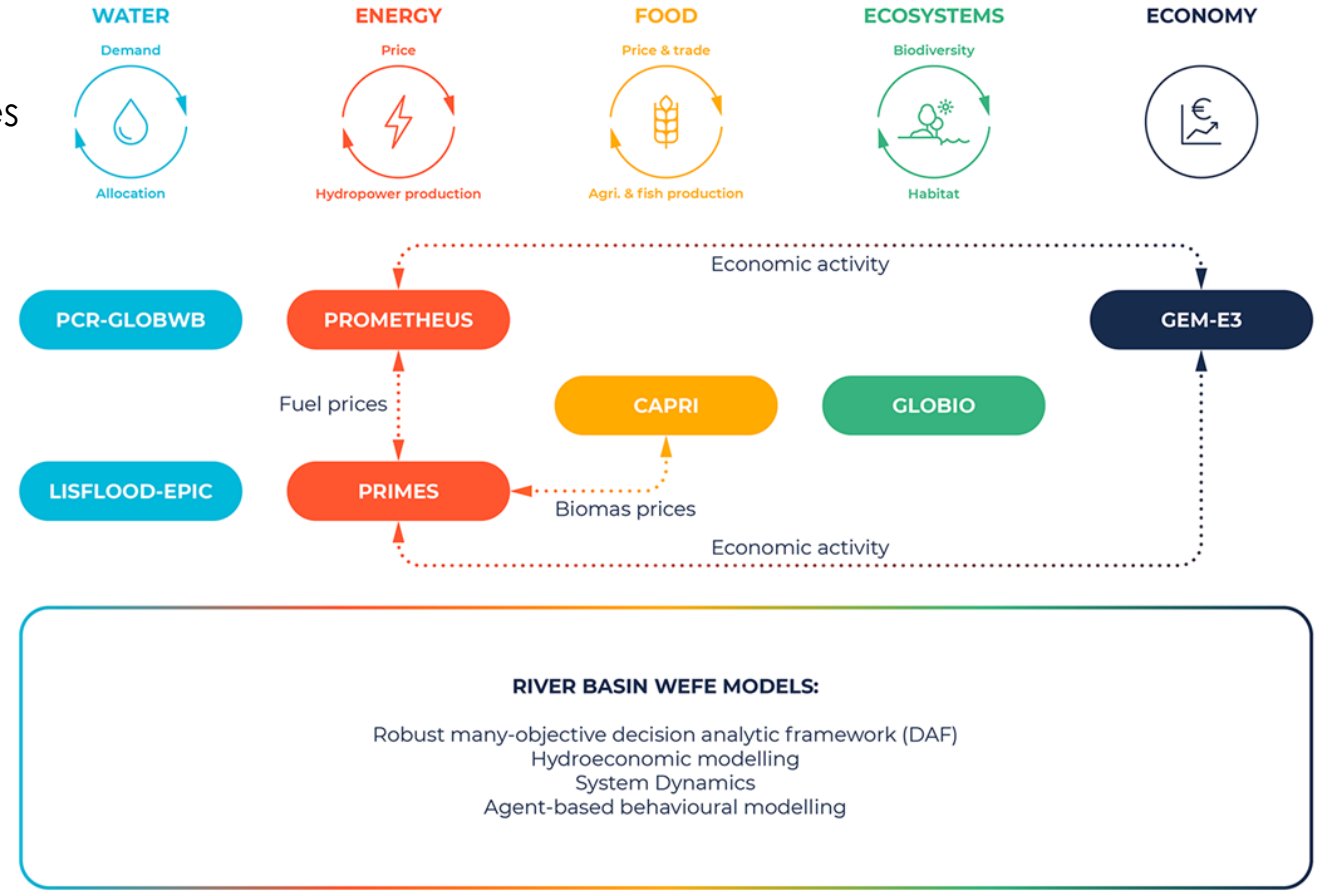
- Soil moisture and actual evaporation
- Crop yield
- Groundwater pumping capacity for irrigation
- Agricultural land use and water demand

PCR-GLOBWB => GLOBIO (**Ecosystems**)

- Dam operations
- Discharge
- Surface water temperature

CAPRI ->GEM-E3 (**Economy**)

- Agricultural commodity trade flows




Solutions and possible trade-offs can be evaluated via the model toolbox and the dialogues

# Challenges and Solutions

**Challenges:**

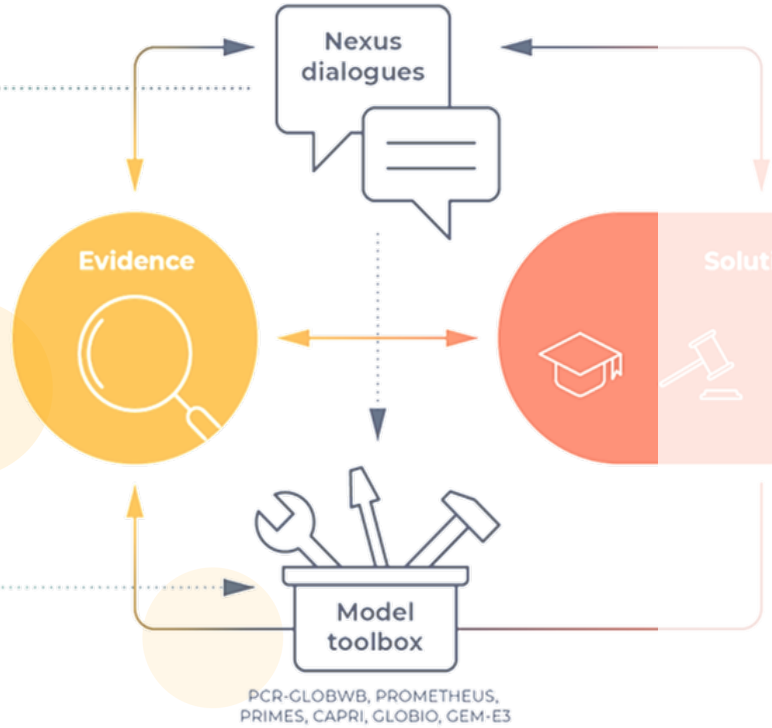
Growing water scarcity | Green energy transition | Water, energy and food security | Ecosystems conservation | Policy coherence | **…(DIALOGUES)**

**Socio-economic scenarios:**

- GDP
- Land-use change
- demographics

**Global warming scenarios:**

- **RCP1.9** (< 1.5°C)
- **RCP2.6** (2.0°C)
- **RCP7.0** (3.5°C)
- **RCP8.5** (>4°C)




**Solutions:**

- Water use efficiency investments
- Novel water resources
- Higher energy efficiency targets
- Increase use of RES
- Promote nature-based solutions for improving, conservation of water bodies, water ecosystems, flood control, and meeting water management objectives
- … (**DIALOGUES**)

# Modeling solutions and impacts of future change: water, energy, food

**Challenges:**

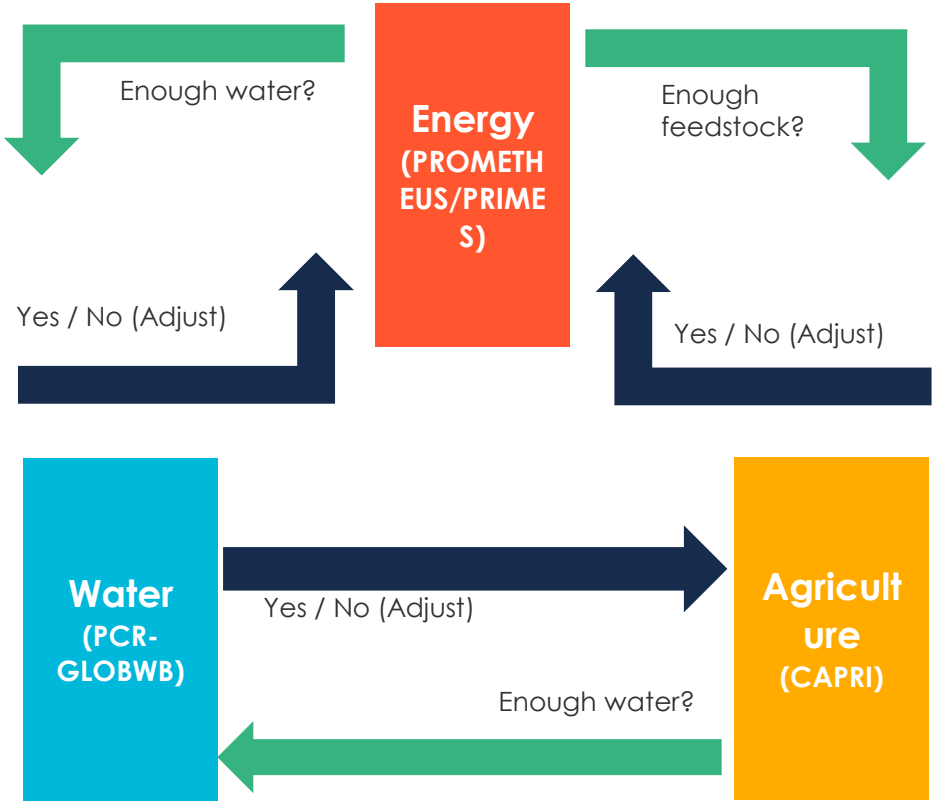
Green energy transition | Water, energy and food security | Policy coherence

**Solutions:**

- Improved efficiency of fertilizer usage
- Water use efficiency investments (irrigation)
- Reuse of wastewater and desalinated water
- Higher energy efficiency targets
- Increase use of RES

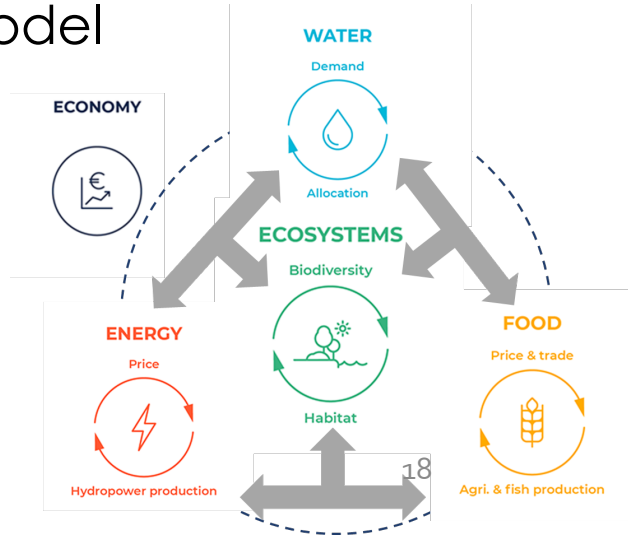
**Water scarcity scenarios that include:**

- Irrigation expansion
- Climate change effect on production of biofuels and agricultural water demand
- Effects of water scarcity for cooling of thermal powerplants, reduced electricity generation capacity



# Model capabilities in relation to the proposed challenges

- Model linkages to consider the complete WEFE nexus
- Enhanced spatial resolution (30 arc seconds, ~ 1km)
  - Good performance for the Danube River Basin
- Land use allocation and management
- Crop yield and production of rainfed and irrigated agriculture and trade-offs with the market
- Responsible energy solutions and biofuels
- Full modelling of water resources, including a 2D groundwater model
- Claims for environmental flow requirement in terms of streamflow
- Water temperature and thermal pollution
- Dams for hydropower generation and habitat fragmentation
- Cost-benefit analysis via the eventual toolbox



# Scenario design in dialogue

Opportunities:

- Quantitative indicators of impacts of future change (Sustainability Assessment Framework)
- Directly linked to challenges and evaluation of feedbacks within the hydrological system and through the WEFE nexus.
- Tailored intervention scenarios that can reflect global projections and policies

Considerations:

- Limited future narratives (SSPs + RCPs) and land use allocation at high resolution
- Climate uncertainty shall be included but is computationally expensive
- High-resolution modelling (1 km) is feasible but at the expense of model complexity (coupled 2D groundwater, surface water temperatures, WOFOST; 10 km is standard)
- Limited interventions can be explored (land use, water use efficiency, …)
- "Deep dives" for selected subbasins can be a solution.

GoNEXUS
Integrated solutions for water, energy, food and ecosystems

# Integrated solutions for water, energy, food and ecosystems

Identified nexus challenges on the Danube River Basin.

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GoNEXUS has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement number 101003722.

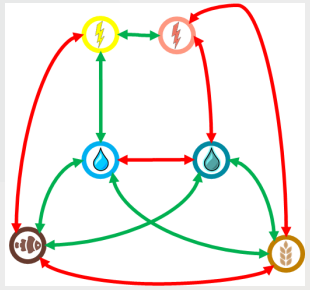
www.gonexus.eu

# Goals of the presentation

1. Briefly present the way of the identification of challenges.
2. Introduction of the identified challenges:
    - to co-design the challenges, scenarios, indicators and solutions for the Danube River Basin Case Study.

# Identification of challenges on the DRB

## Conceptual Model
### WEFE NEXUS SYSTEM



H. Macian-Sorribes

## Project proposal
### ISSUES

1. increased flood risk and frequency of water scarcity and droughts and the need for water quantity management;
2. water pollution;
3. increasing hydropower development and increased share of renewable energy;
4. potential agricultural growth.

## Finished/ongoing projects
### GAPS/TOPICS COVERED

Former projects, ICPDR documents, and research studies, publications dealing with water/energy/food/ecosystem issues and/or interrelations on the whole Danube River Basin were scanned (2018)

**Phase 1 - Preliminary assessment: long list of research questions and 8 challenges**

## Sectoral policies, strategies
### RELEVANCE

WFD
CAP
European Green Deal (Farm to Fork)
Paris Agreement
EU Biodiversity Strategy, Natura2000
Sustainable Development Goals

## Modelling capability
### LIMITATION

Current knowledge
Set up of the GoNexus MODEL TOOLBOX
(possible links between the models)
Spatial scales
Data availability
Number of scenarios

## Added value
### SIGNIFICANCE

compared to relevant pervious projects, studies, research results (2022)

(no basin wide nexus research on this field)

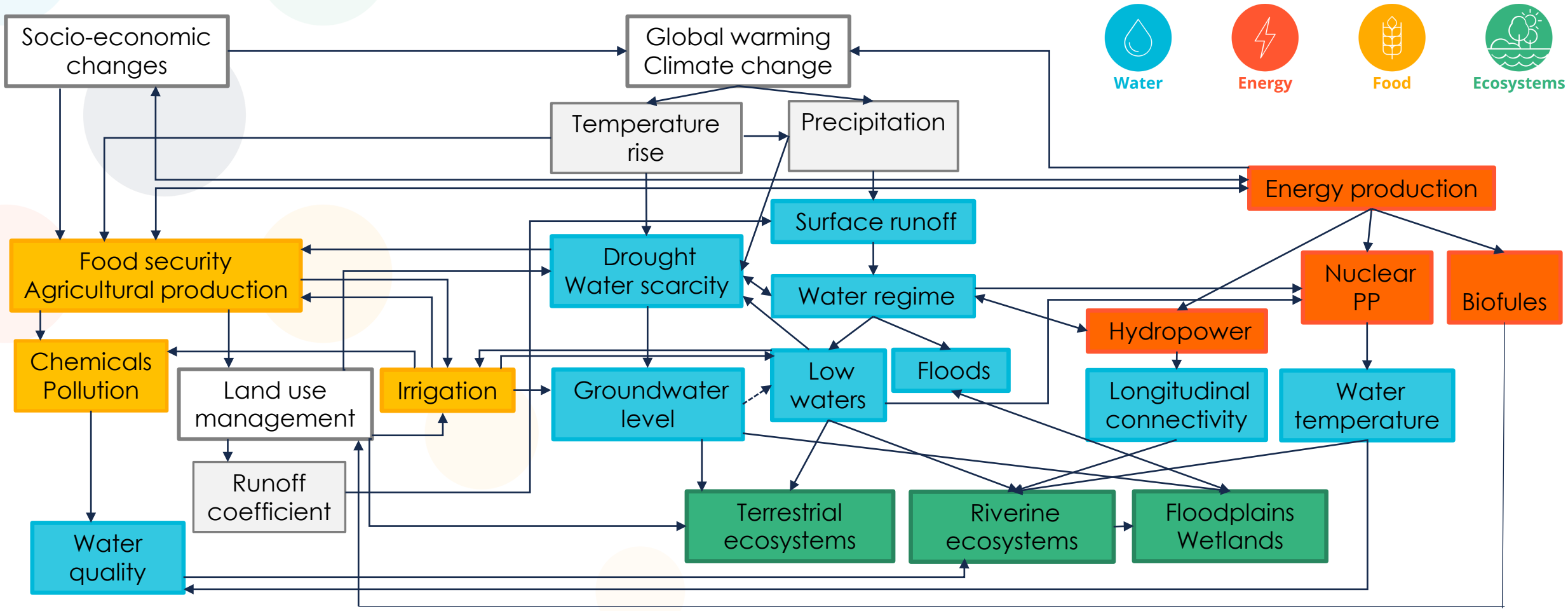
**Phase 2 - Integrated assessment: 3 proposed challenges**

# Challenges identified for the Danube River Basin

1. **Water scarcity and increased flood risk** due to climate change, which may require changes in land management
2. **Water scarcity due to growing irrigation demand** as a consequence of a warmer and drier climate
3. **Vulnerability of riverine and terrestrial ecosystems (biodiversity)** due to water scarcity and land use changes driven by agriculture and energy

**Phase 3 – Dialogue: feedback on the 3 challenges, suggestions, new ideas**

# WEFE NEXUS in the DRB



# Challenge 1

**Water scarcity and increased flood risk** due to climate change, which may require changes in land management

*As a consequence of climate change and dramatic changes in land management there are quite significant changes in surface runoff, water retention and storage, hence floods and water scarcity. These changes are going to influence the recent land management practices.*

GOAL: Estimating the risks related to extreme events on the Danube River Basin under climate and land management (inc. policy) scenarios.

# Challenge 2

**Water scarcity due to growing irrigation demand** as a consequence of a warmer and drier climate

*Agriculture is the major water user in the basin; in addition to climate change, other drivers that influence the water nexus are demographic changes, changes in agriculture (CAP, Farm To Fork).*

*Pressure is increasing on water-intensive energy and food producers to look for alternative approaches due to the growing demand, particularly in water-scarce areas with large inter-sectoral competition for water.*

GOAL: Estimating the growing water demands by agriculture (and the impacts of it) under climate scenarios

# Challenge 3

**Vulnerability of riverine and terrestrial ecosystems (biodiversity)** due to water scarcity and land use changes driven by agriculture and energy

*Agriculture and increasing energy demand transforme(d) the natural habitats and might need even more area and water for secure production, which can have direct and indirect impacts on rivers and land ecosystems.*

*Water scarcity has direct and indirect impact of floodplains/wetlands, especially along freshwater bodies used for irrigation; development of hydropowers have negative impact on the longitudinal connectivity of the water bodies, hence the ecosystems.*

GOAL: Assessing vulnerability of riverine ecosystems under different climate, socio-economic, and land management scenarios.

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# Thank you for your attention!

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# What GoNEXUS is aiming for with the dialogues?

- Achieve a better and ideally shared understanding of challenges
- Prioritise challenges for our further work

- Discussion
  1. What are your expectations?
  2. Do you have any concerns about the challenges as they have been presented?
  3. Do you have any contributions/thoughts about making the challenges more relevant to your work/interest, e.g. the use of specific models or indicators to be used?
  4. Are we missing other relevant stakeholders/questions?
  5. Do you have any preliminary suggestions for solutions to be tested?

# Thank you for your participation!

**A piece of good advice:**

**Cognition is one of the deepest human joys**