



EVALUATING THE SUPPLY OF HYDROLOGIC ECOSYSTEM SERVICES TO SUPPORT THE WATER—FOOD—ENERGY NEXUS IN THE ARNO RIVER BASIN (ITALY)

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INTERNATIONAL SOIL AND WATER ASSESSMENT TOOL CONFERENCE 2017

SWAT Soil & Water
Assessment Tool

Evaluating the supply of hydrologic ecosystem services to support the water–food–energy Nexus in the Arno river basin (Italy)

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Technische
Universität
Braunschweig

Warsaw 28 June 2017



Products



Functions and processes



Culture and quality of life





Products

Food	Drinking water
Energy	Timber

Provisioning Ecosystem Services

Functions and processes

Pollution dilution and detoxification	Flood regulation
Climate regulation	Pollination

Regulating Ecosystem Services

Culture and quality of life

Recreation	Health & wellbeing
Amenity	Wildlife habitat

Cultural - Aesthetic Ecosystem services



Research objectives

- How the **ecosystem services (ES)** related to water can be quantified?

Spatial explicit quantification of water provisioning and regulating ES through hydrological modelling

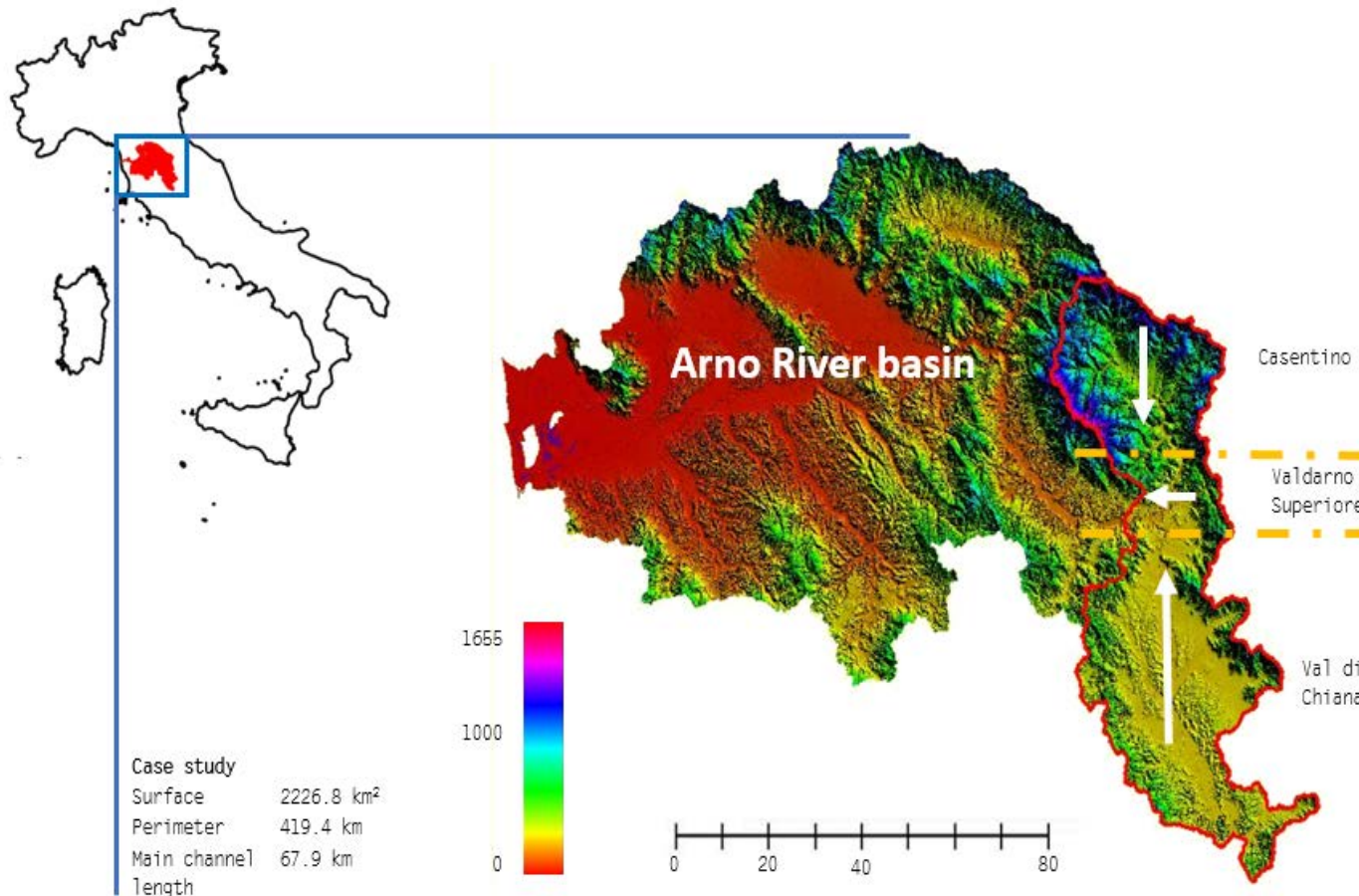
Identification of hydrologic ES hotspots in a case study

- Which management strategies could **increase the provision of ecosystem services?** Which are **the trade-offs between different ecosystem services?**

Integrating the Ecosystem services analysis with existing management frameworks

“Glocal approach”: Arno River basin case study

ES are very **locally dependent**, in particular when water management is the main concern. A **catchment scale methodology** is hereby proposed to evaluate water related ecosystem services



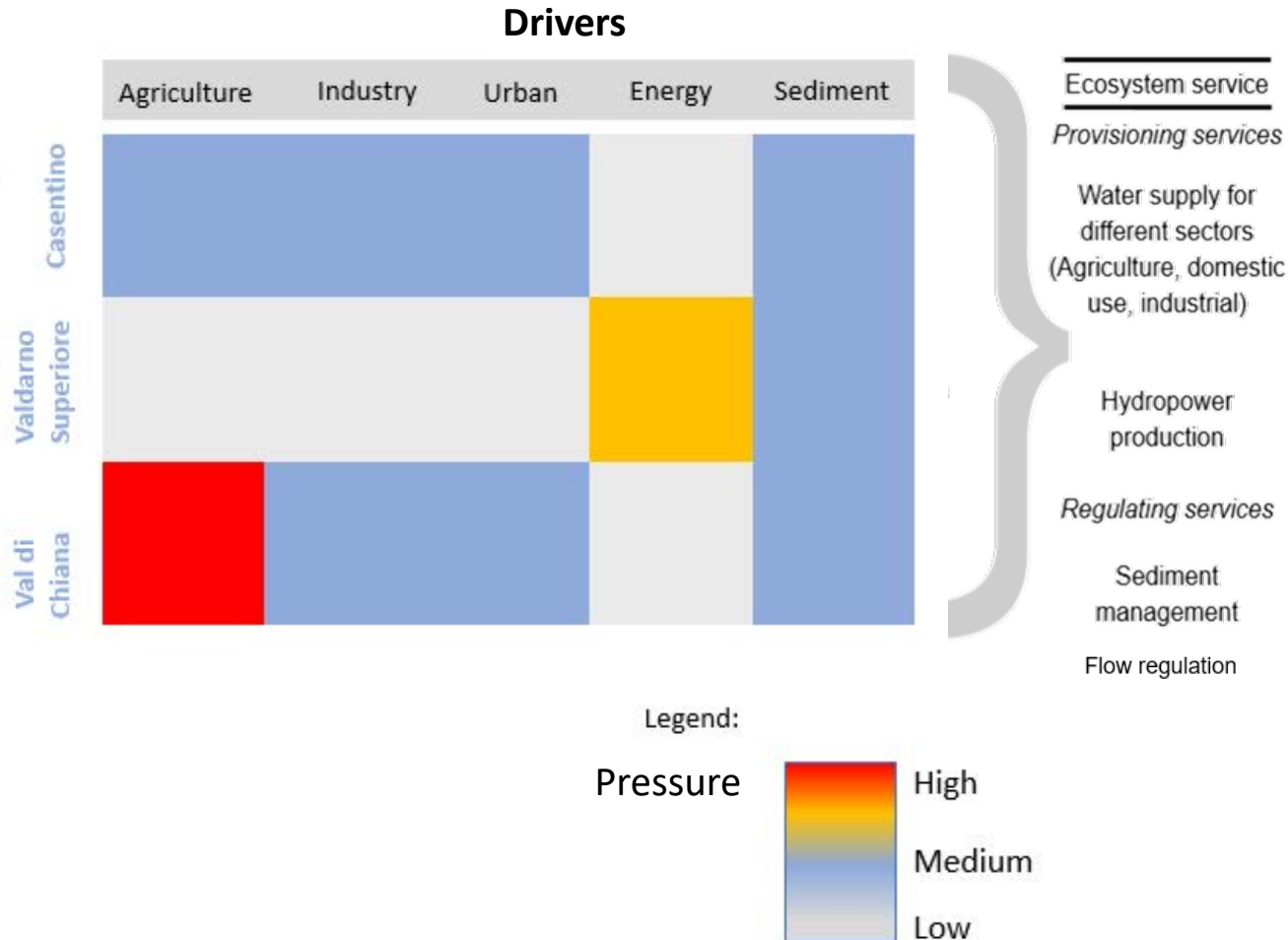
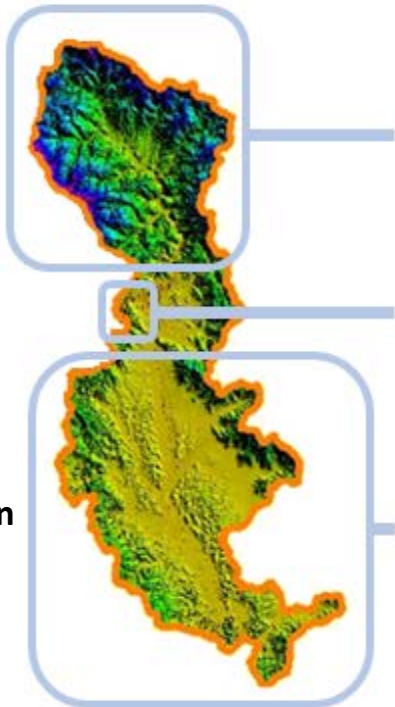


Methodology

- A** Definition of the major challenges regarding water management in the basin : **ES analysis**
- B** **Water balance**: deep understanding of the processes affecting the water cycle and the quantitative assessment the hydrological variables associated to ES
- C** **Evaluation of water provisioning ES** (water use for different sectors - i.e. agricultural, domestic and industrial) and **water regulating ES** (sediment production). Hotspots and ES flow analysis
- D** **Scenario analysis** where the trade-offs between different management options are highlighted

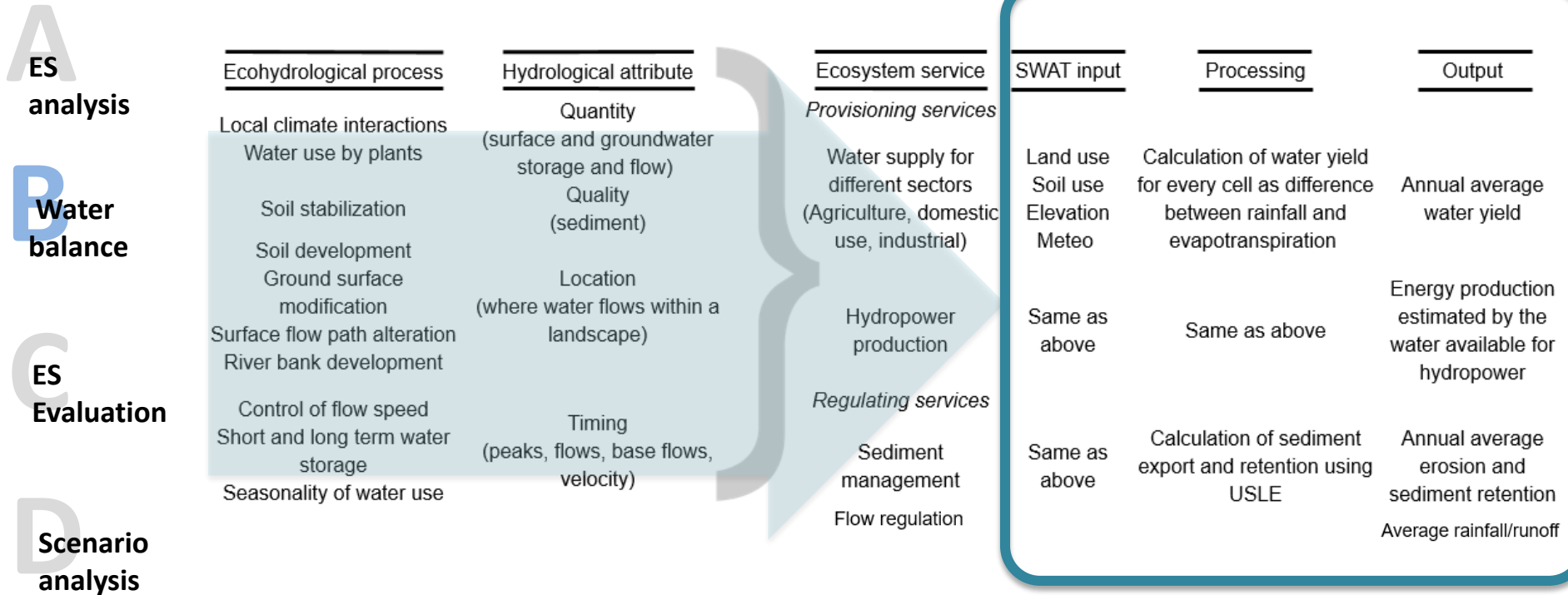
ES analysis

- A** ES analysis
- B** Water balance
- C** ES Evaluation
- D** Scenario analysis



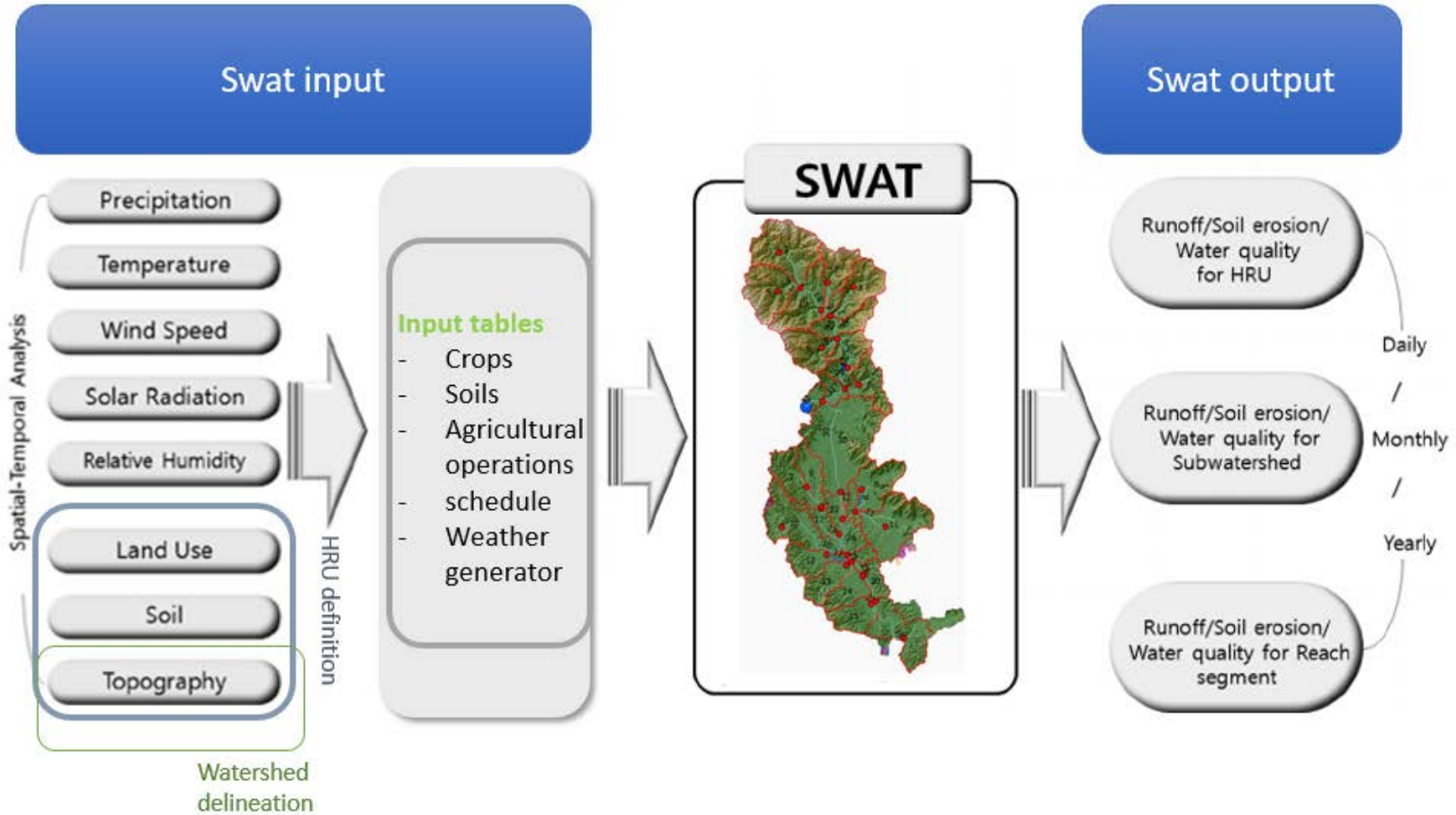


Hydrological modelling: Soil Water Assessment Tool



Hydrological modelling: SWAT

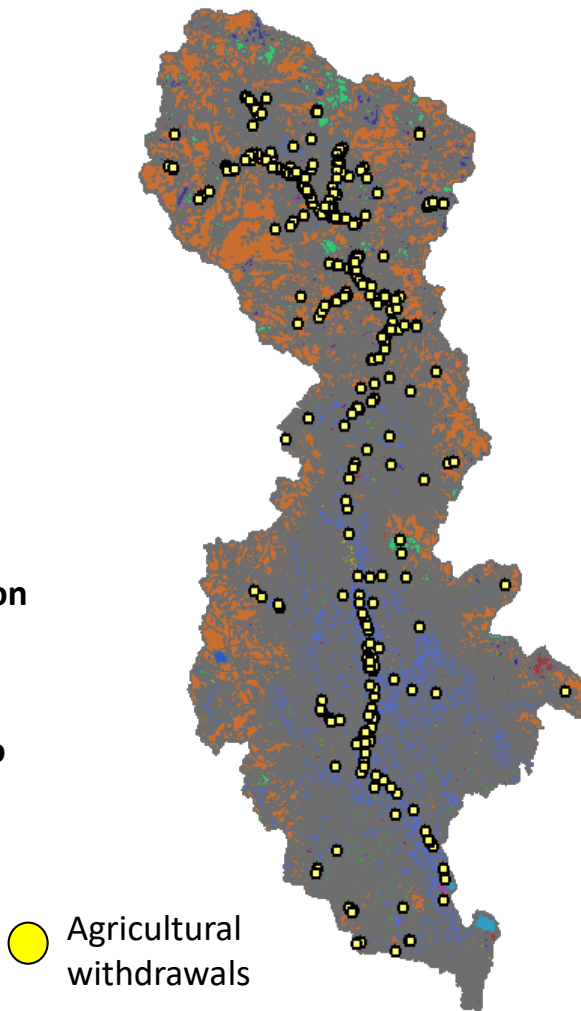
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Focus on agriculture

- A**
ES
analysis
- B**
Water
balance
- C**
ES
Evaluation
- D**
Scenario
analysis



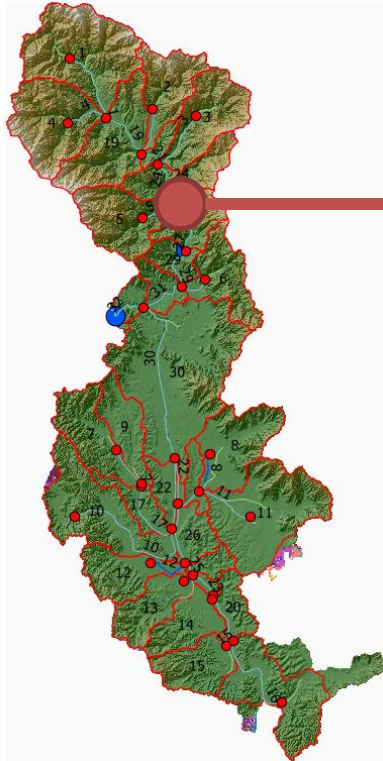
For agricultural water demand it has been calculated the water abstraction for every land use and inserted in swat within the Operation Schedule database

The database contains also the other information regarding the agricultural practices (data based on national statistics institute ISTAT, River Basin Authority and regional agricultural agency Arsia databases):

- 1 Planting/beginning of the growing season
- 2 Irrigation
- 3 Tillage
- 4 Harvest
- 5 Fertilization

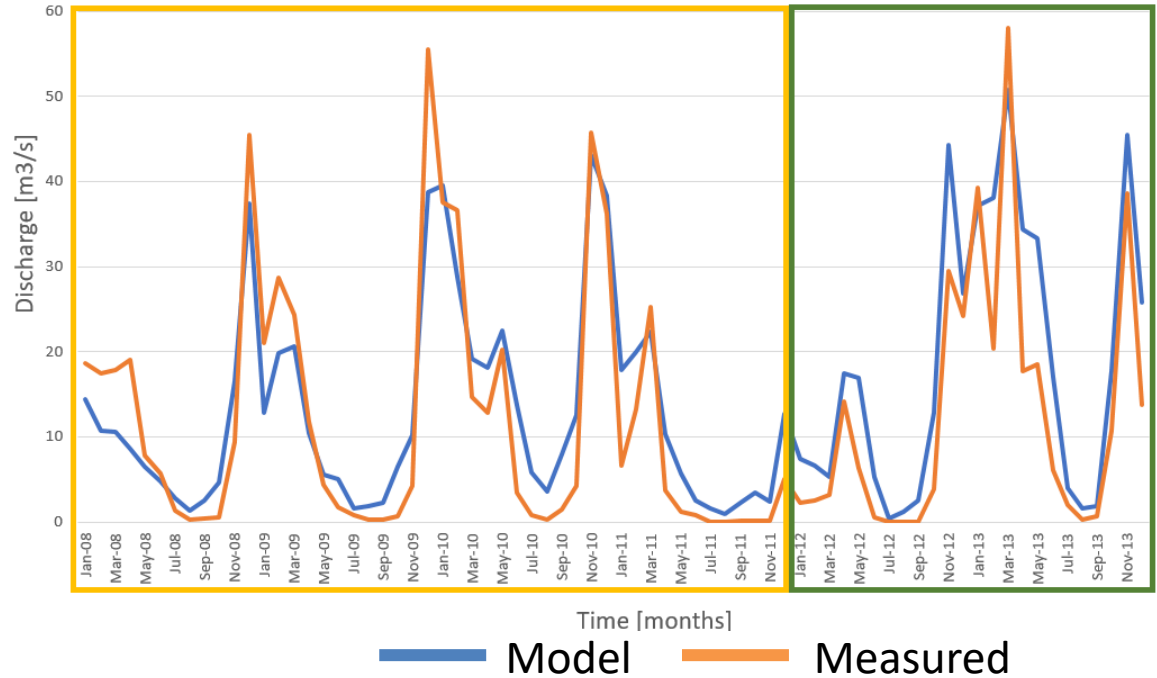
Swat results: surface runoff

- A ES analysis
- B Water balance
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- D Scenario analysis



Calibration

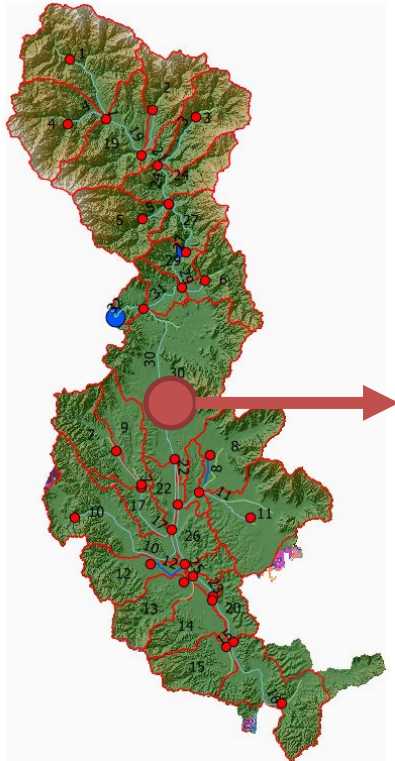
Validation



	Casentino	
	Calibration	Validation
R2	0.92	0.89
NSE	0.89	0.84
RSR	0.32	0.40
PBIAS	-8.2	-23.9

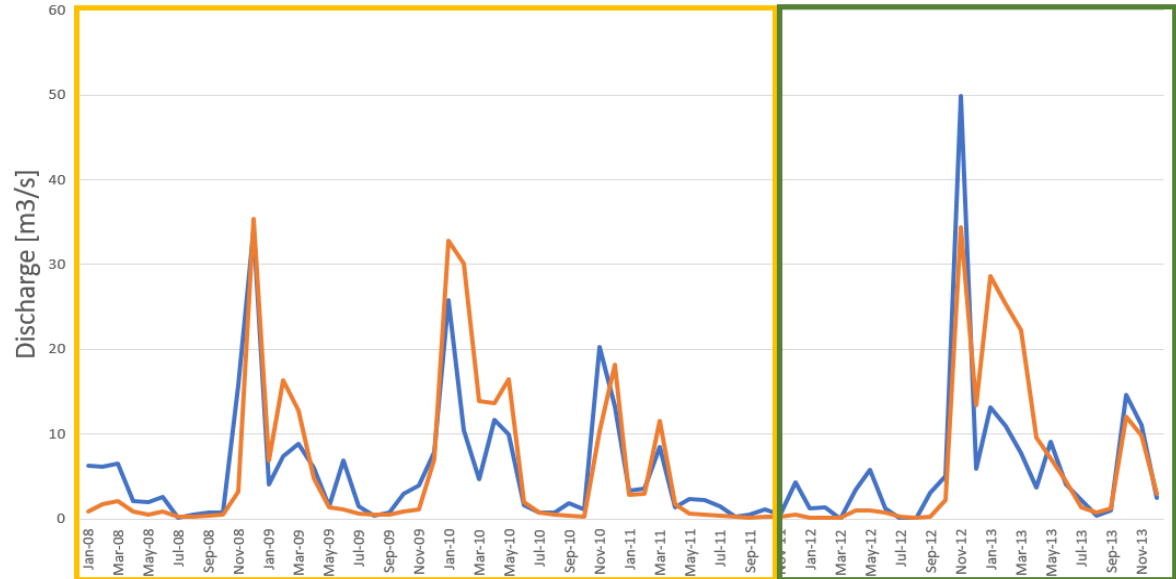
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Calibration

Validation

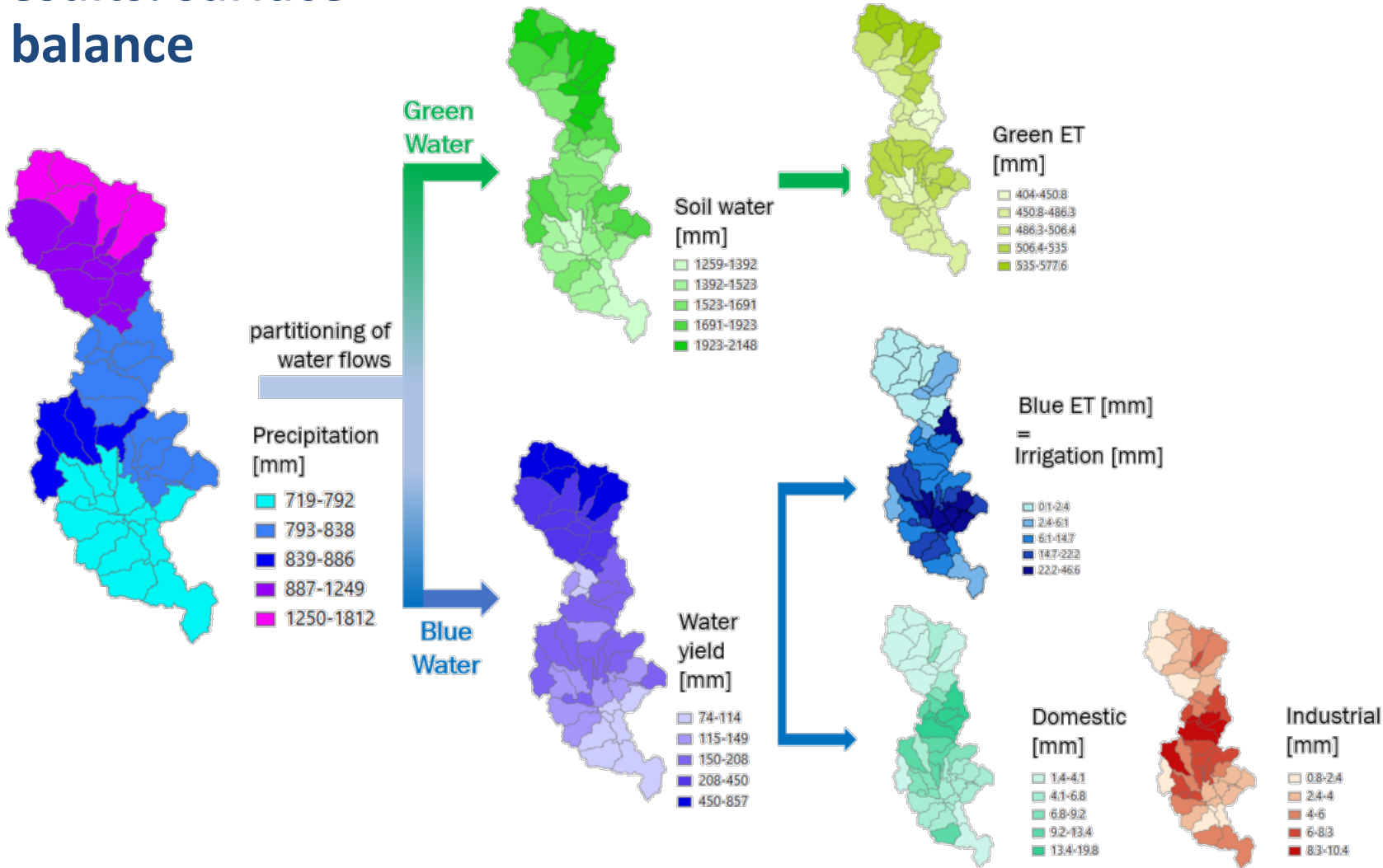


— Model — Measured

	Val di Chiana	
	Calibration	Validation
R2	0.82	0.81
NSE	0.81	0.74
RSR	0.44	0.51
PBIAS	-17.5	25.1

Swat results: surface water balance

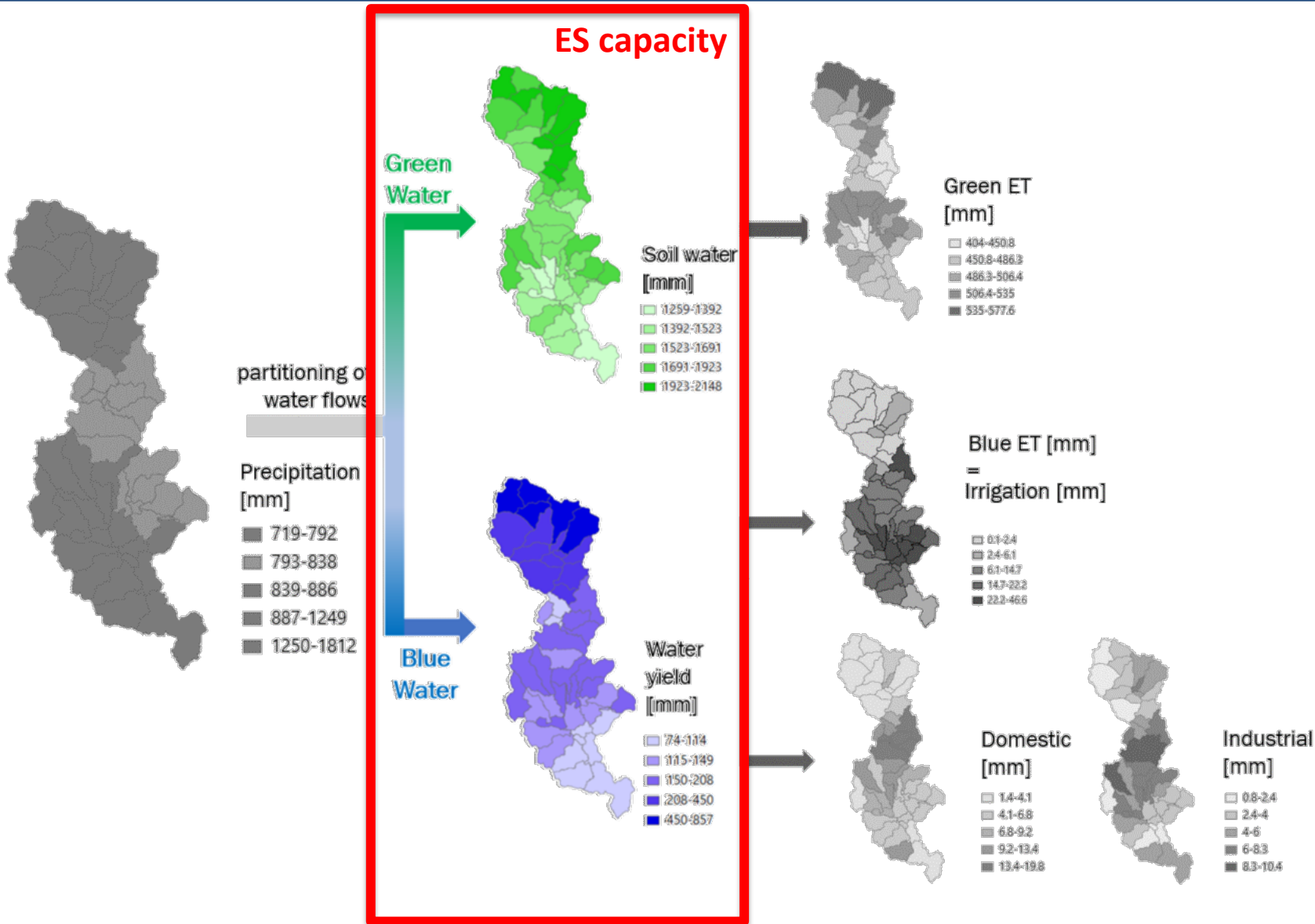
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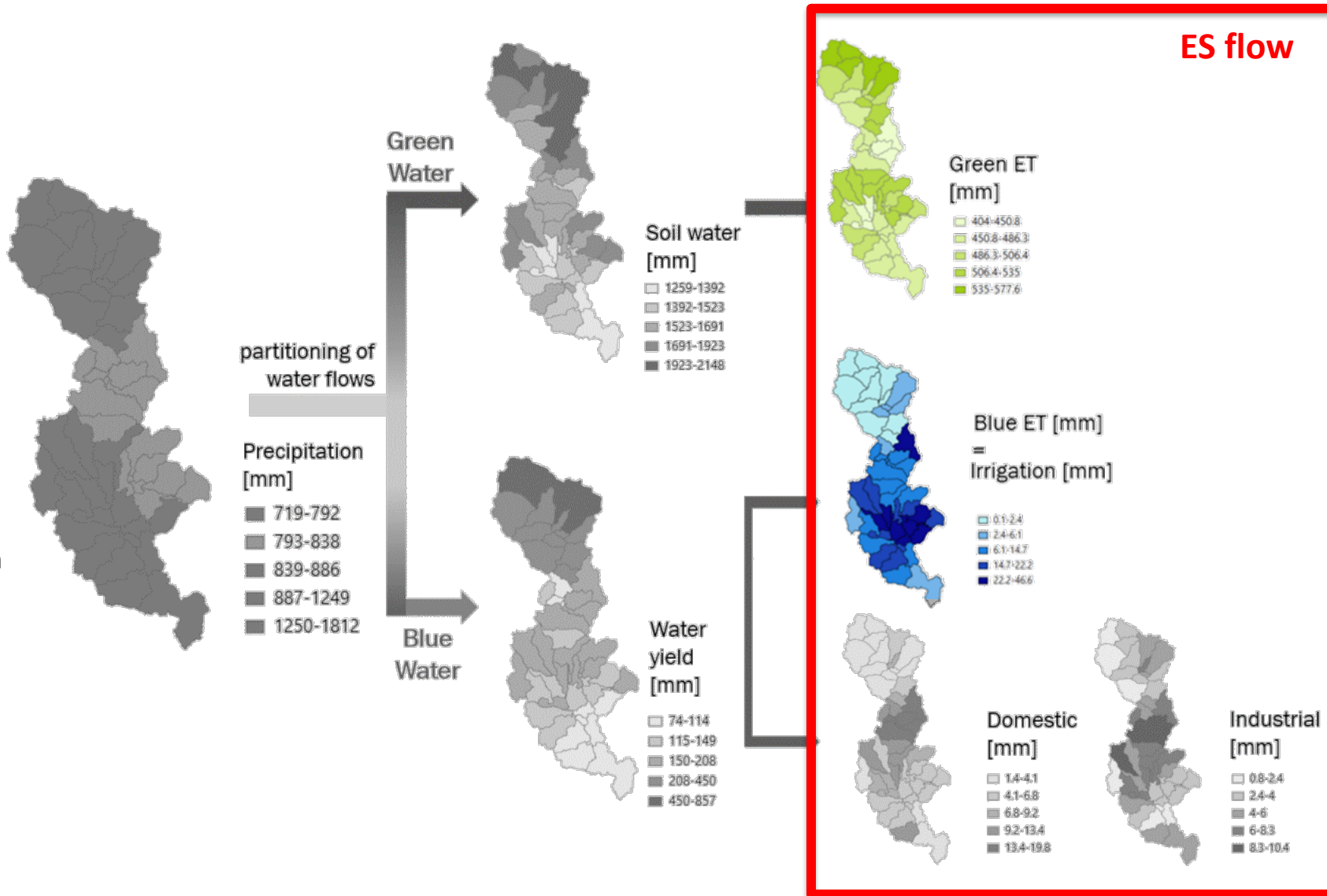
← Water Land and Ecosystem Processes in landscapes →

← Provision of Ecosystem Services →

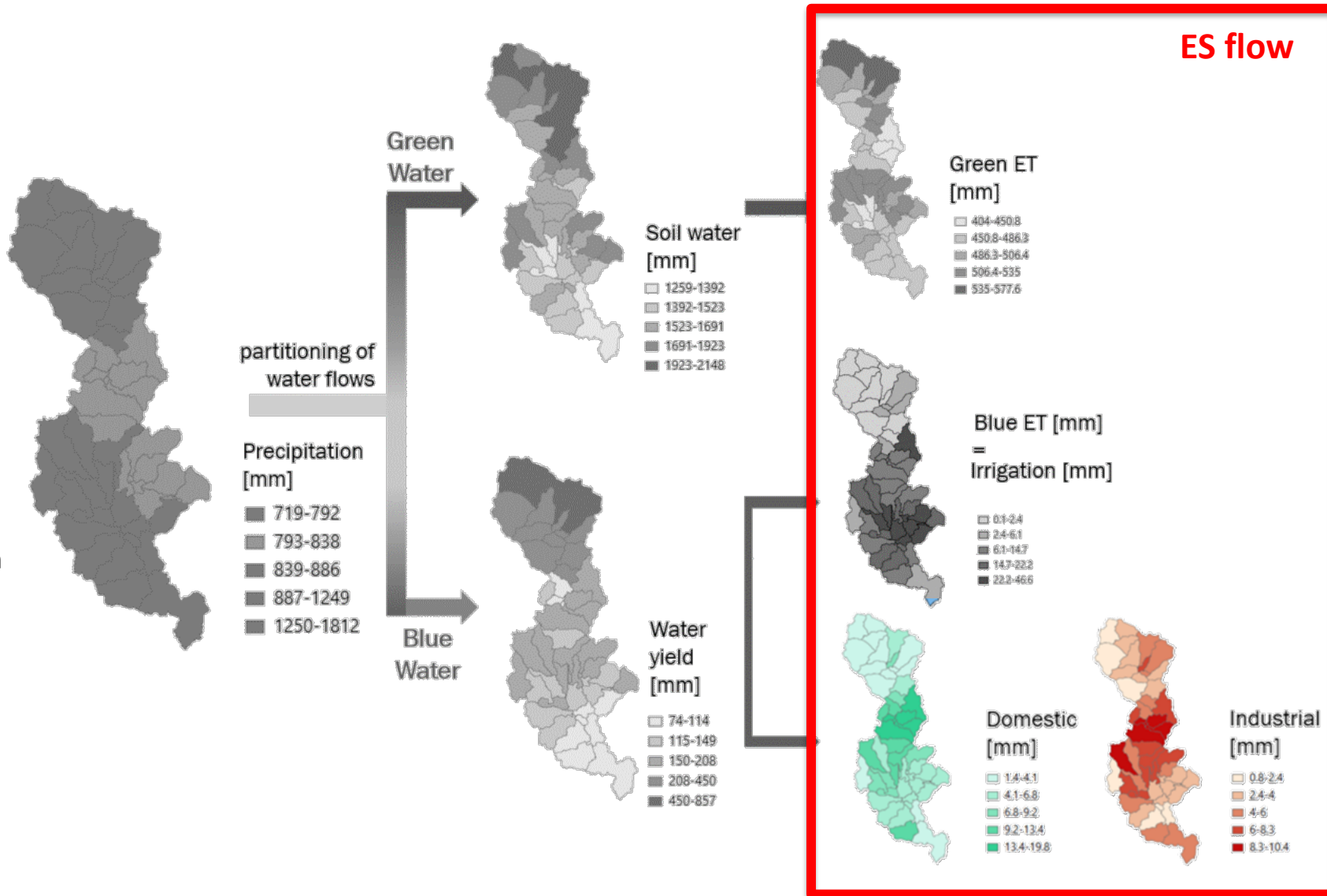
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ES indicators

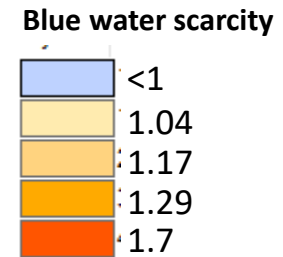
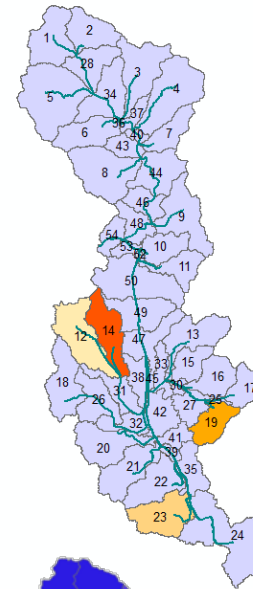
	ES	Capacity -> Flow	Indicator
A ES analysis			
B Water balance	Water supply for different sectors	Blue water availability -> Water use (i.e. runoff)	Water use/Run off, Water use/WYield
C ES Evaluation	Erosion control	Sediment yield	SYLD
D Scenario analysis	Flow regulation	Blue/green water partitioning -> discharge regulation	SURQ/PCP, SW

Hotspots analysis: water supply

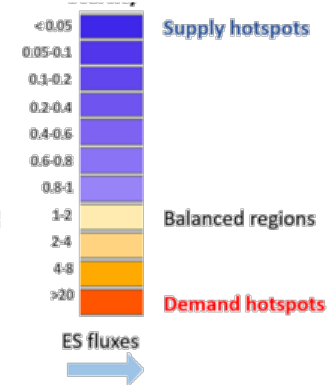
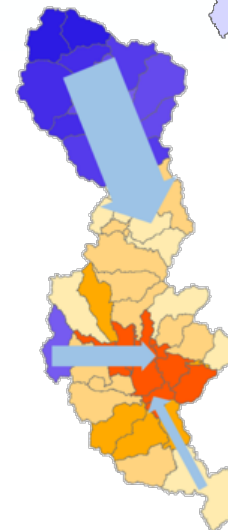
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Water
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Hydrological
perspective:
Blue water scarcity
analysis

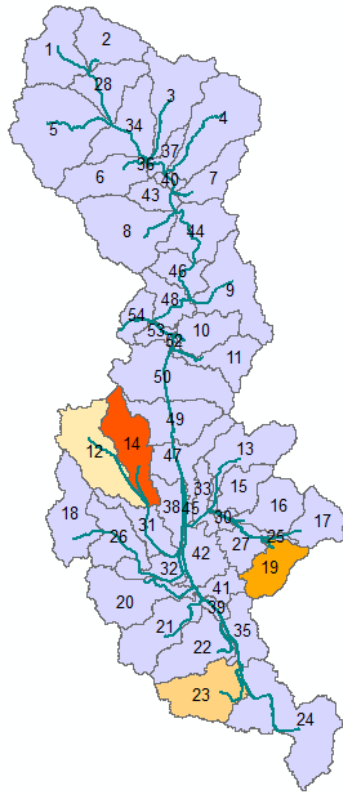


ES perspective:
Es supply/demand
hotspots analysis

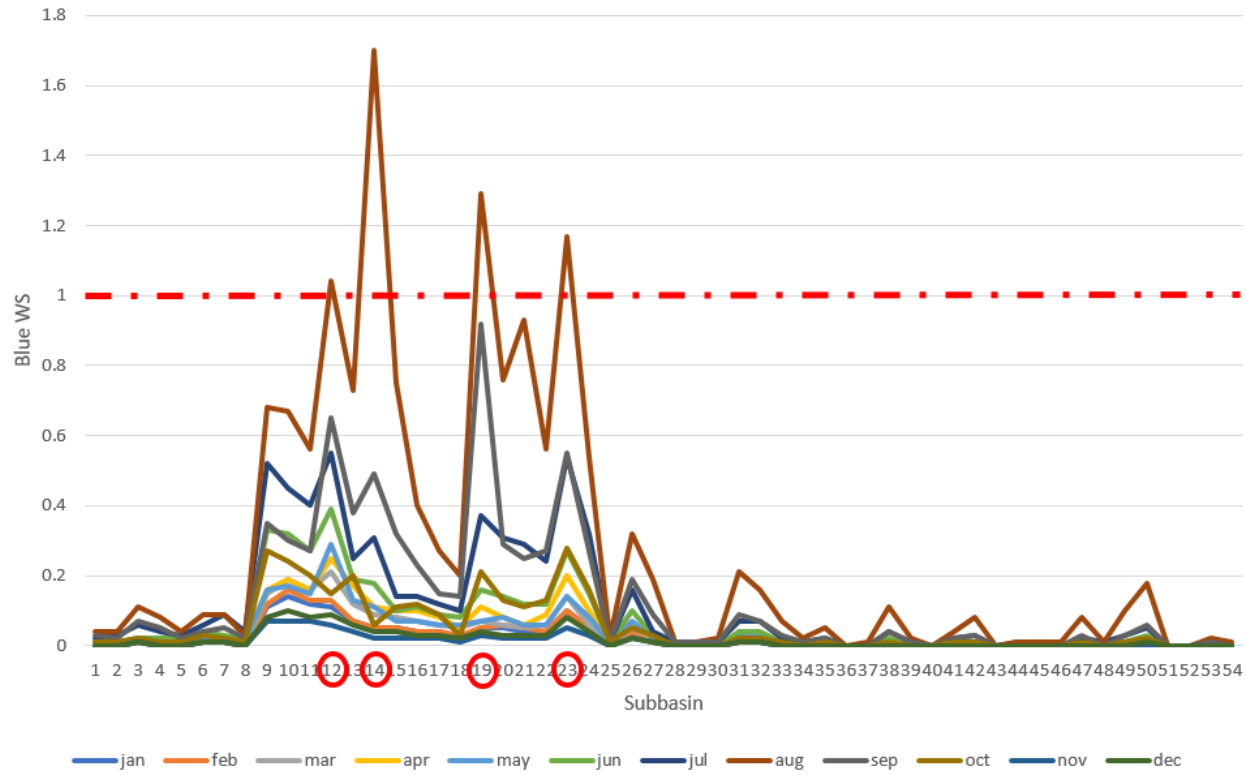


Blue water scarcity

- A** ES analysis
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August blue water scarcity

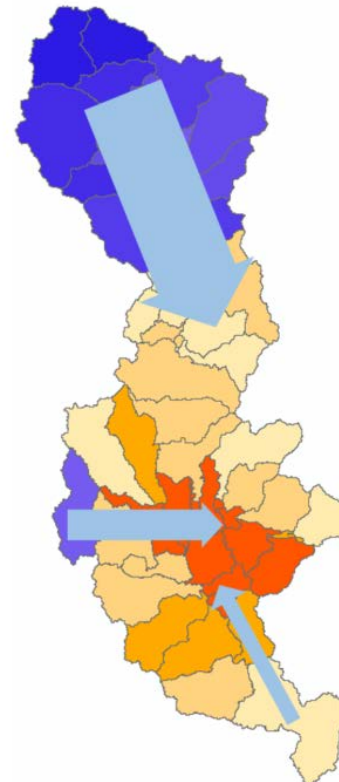
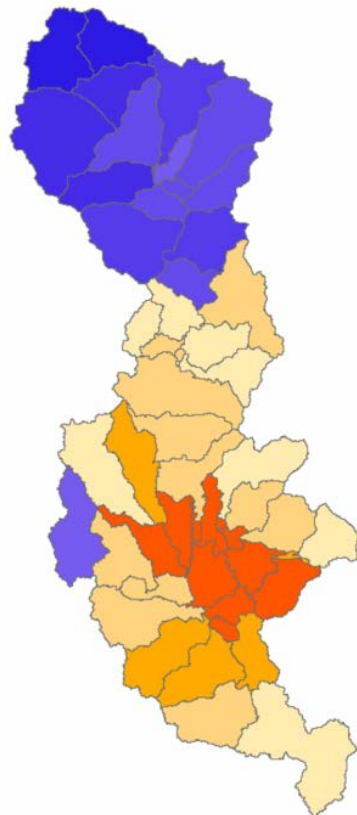


Hotspots analysis Ecosystem services flows

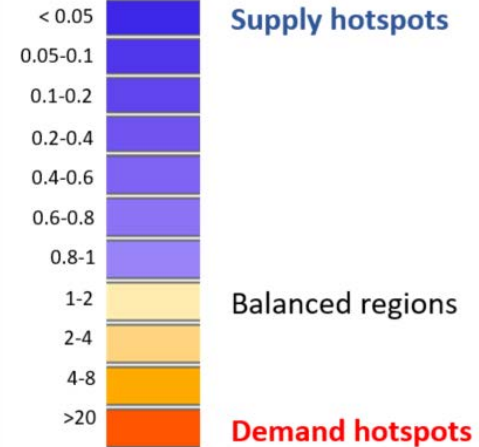
W use/ W yield



ES flows map



ES hotspots

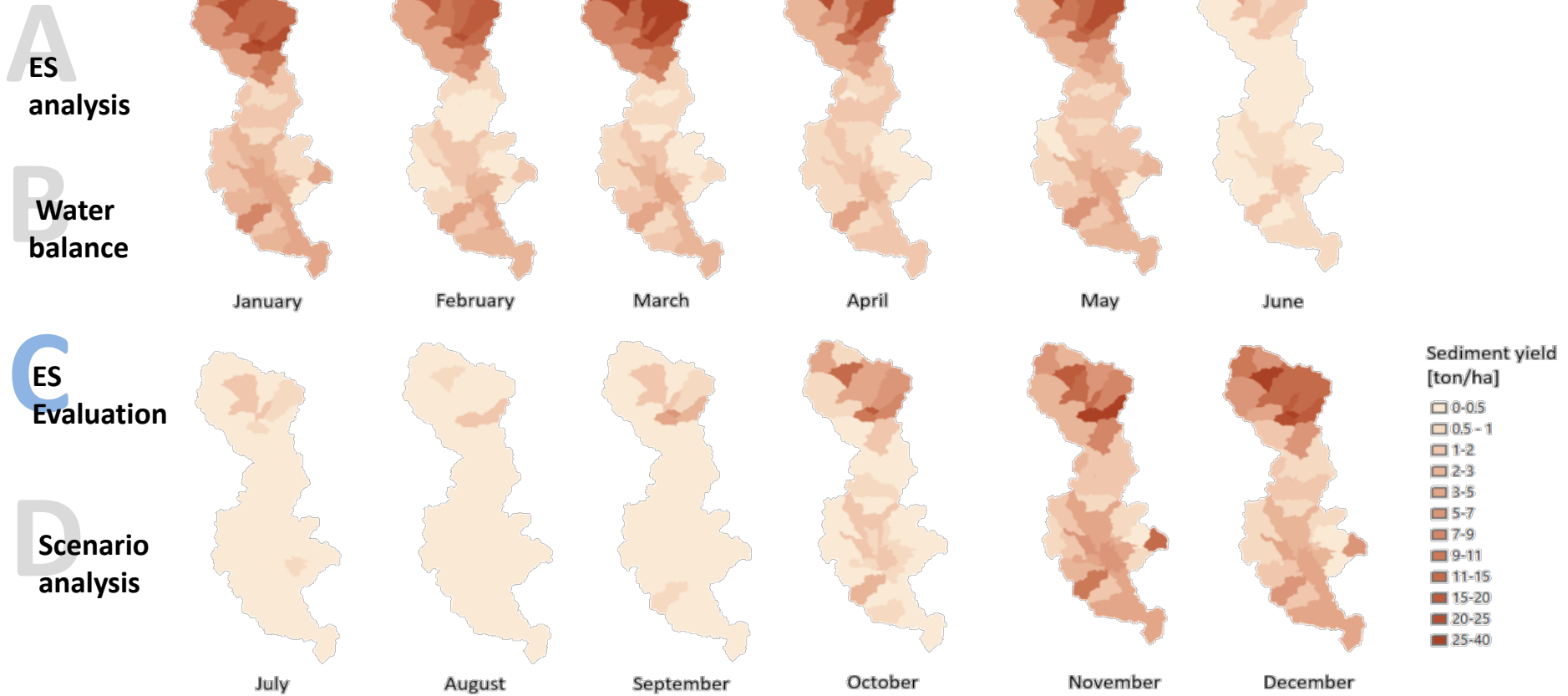


ES fluxes



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Hotspots analysis: Sediment retention service





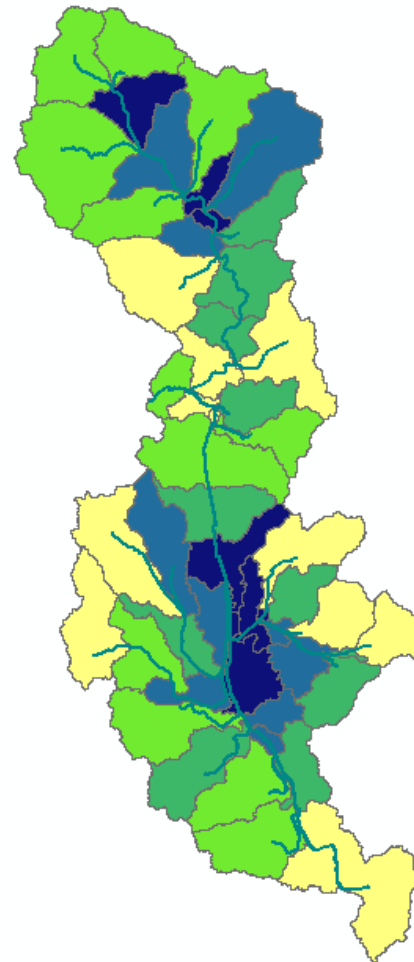
Hotspots analysis: Flow regulation

A
ES
analysis

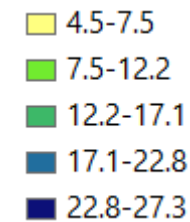
B
Water
balance

C
ES
Evaluation

D
Scenario
analysis



SurQ/PCP



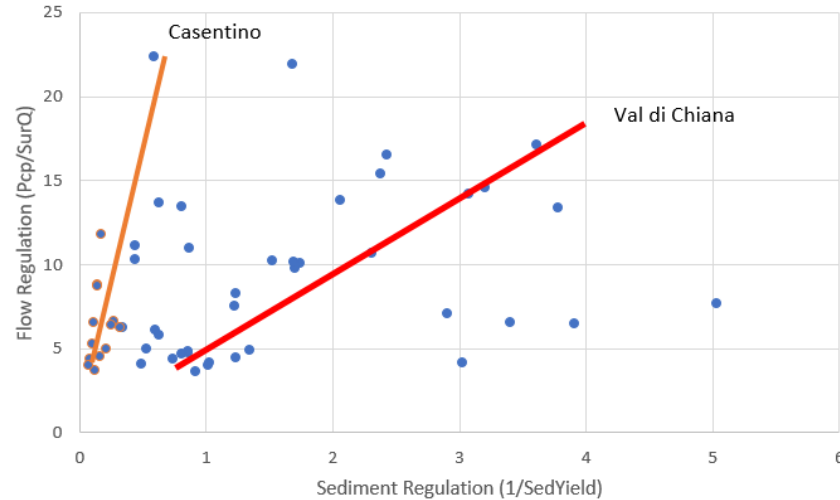
ES synergies and trade offs analysis

A
ES
analysis

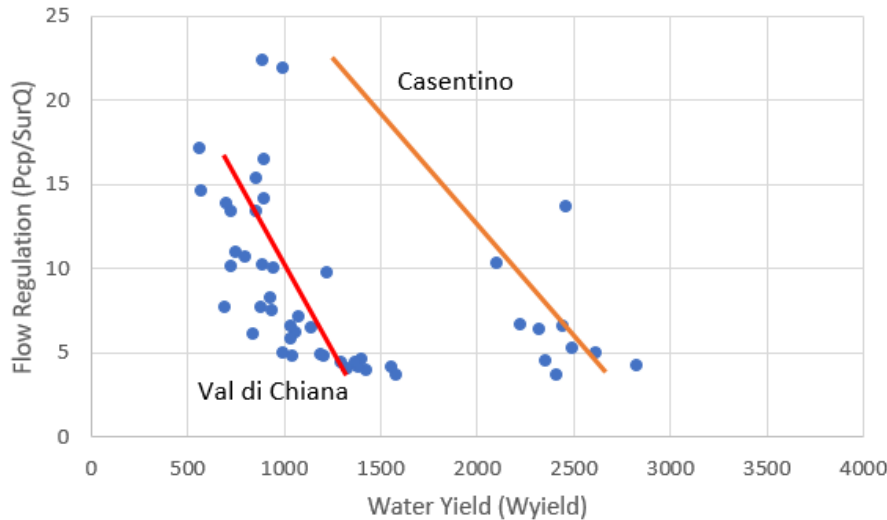
B
Water
balance

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ES
Evaluation

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Scenario
analysis



Synergy



Trade offs

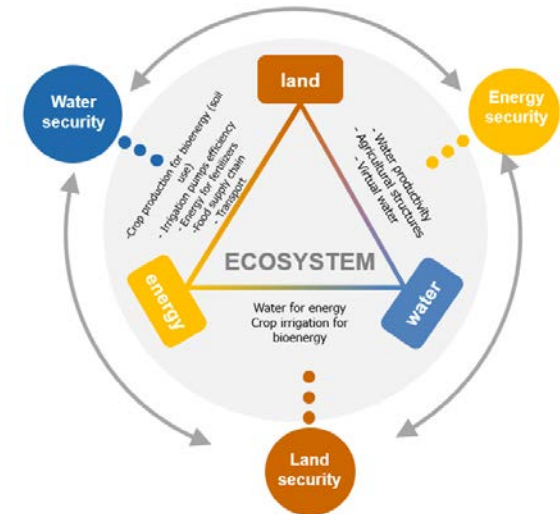


Next steps: from theory to policy

The concept of ecosystem services in water policy implementation is still in an **explorative stage** (Grizzetti, 2016).

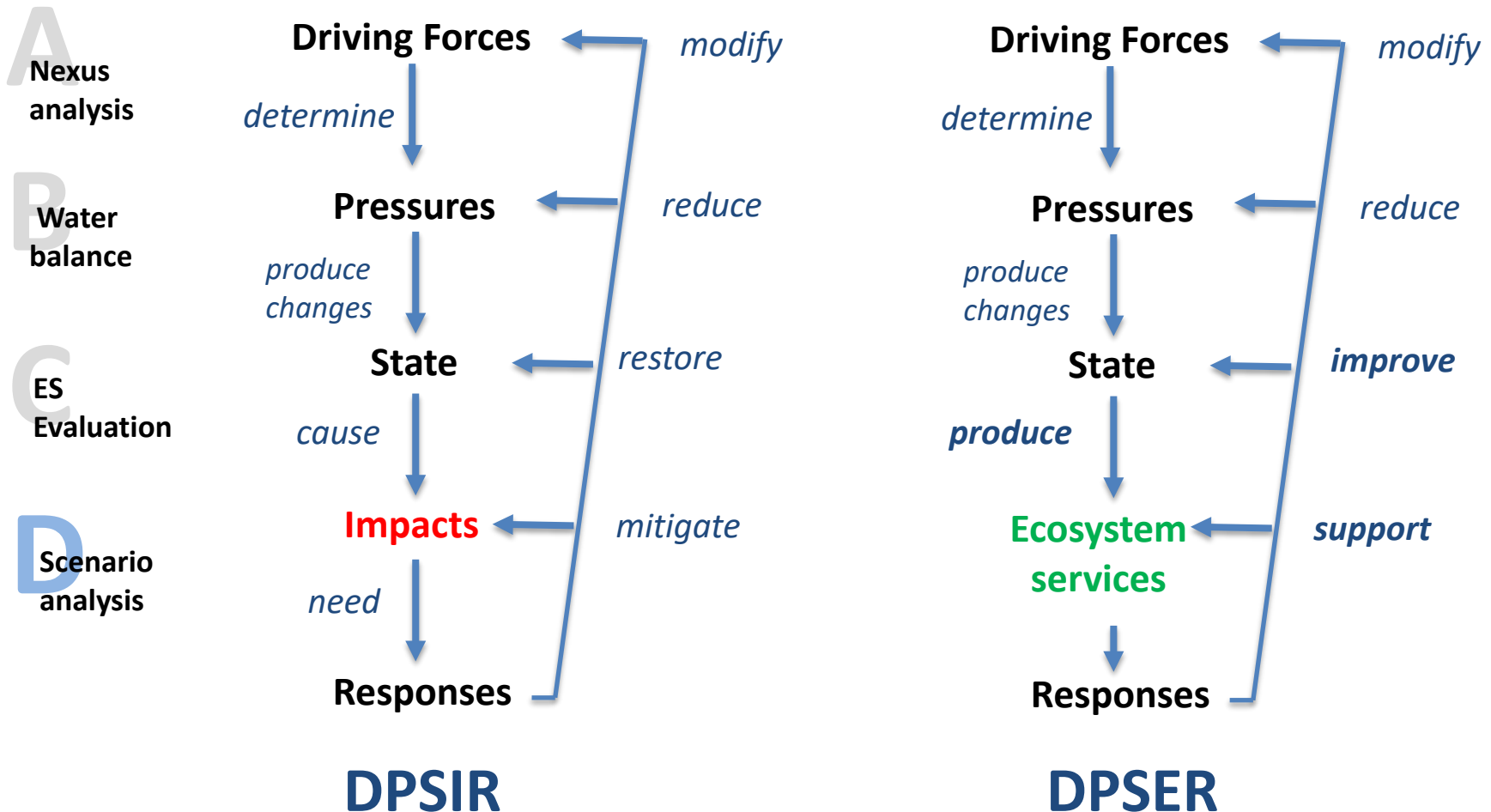
Biodiversity Strategy (European Commission, 2011)
Climate Adaptation (EC, 2009)
Blueprint to safeguard Europe's water resources (EC, 2012), which explicitly refer to ecosystem services.

Methods and tools for assessing ecosystem services are needed to foster the adoption of ecosystem services approach.



Integrate different policies objectives, invest in **multi-functional measures**, improve the **cost-benefit analysis**, and find **synergies and trade-offs** to achieve better solutions for water management.

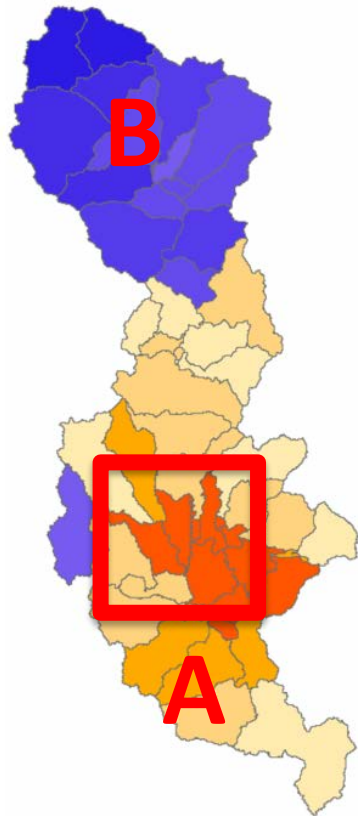
Next steps: from theory to policy



Next steps: Scenario development

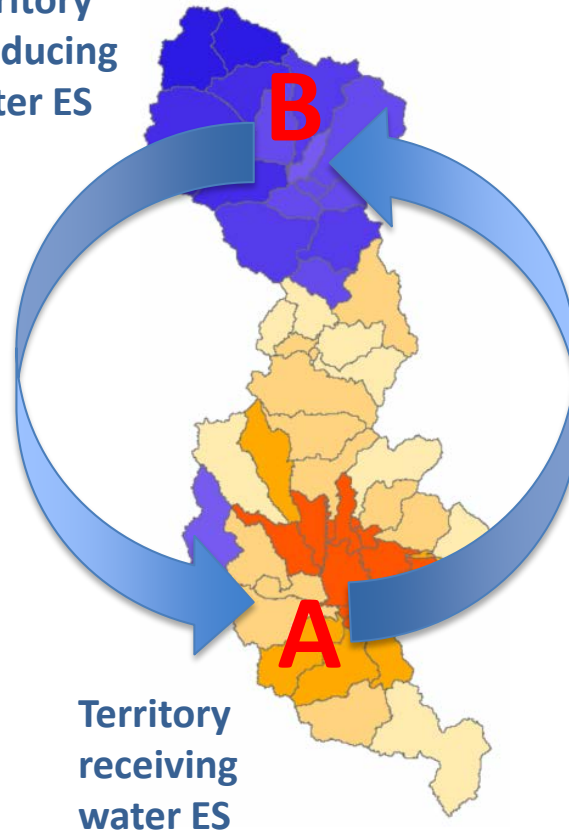
Payment for ES

- A** Nexus analysis
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DPSIR

Territory producing water ES



Payment for ecosystem services (A pays for the conservation of B)

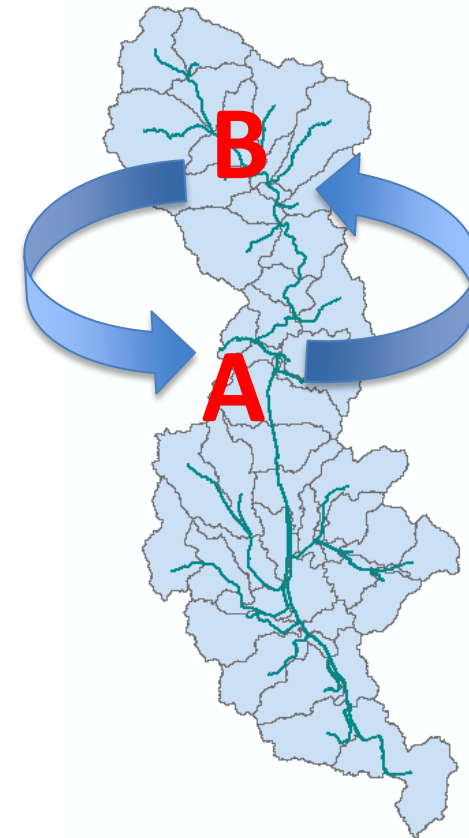
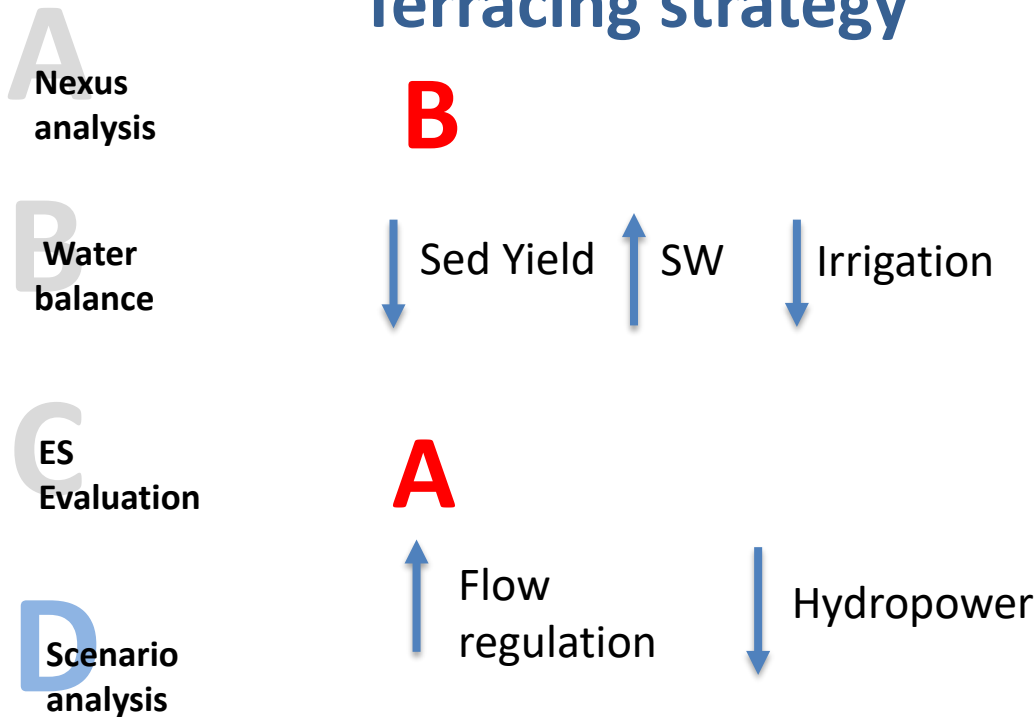
Territory receiving water ES

DPSEIR

Reduce water use in agriculture

Next steps: Scenario development

Terracing strategy





Thank you for your attention

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