Experiences in Mediterranean river basin adaptation to global change

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NET-SCARCE CONFERENCE
RIVERS UNDER WATER SCARCITY:
Threats and Challenges
Barcelona, 15th November 2016

CREAF

MAIN CONTRIBUTIONS TO THIS PRESENTATION

ACCUA www.creaf.uab.cat/accua: CREAF, IRTA, ETC-SIA, UPC (2007-2012)

LIFE+ MEDACC www.medacc-life.eu: OCCC, CREAF, CSIC-IPE, IRTA (2013-2018)

BeWater www.bewaterproject.eu: CREAF, CYI, Ecologic, EFB, EFI, DBC, INRGREF, IzVRS, JRC, Prospex, GWP-MED, Anbessa (2013-2017)

Third Report on Climate Change in Catalonia (7th chapter): Josep Mas-Pla (coord.) and contributors (*in press*) (2015-2016)

LIFE+ MEDACC (2013-2018)

la Muga

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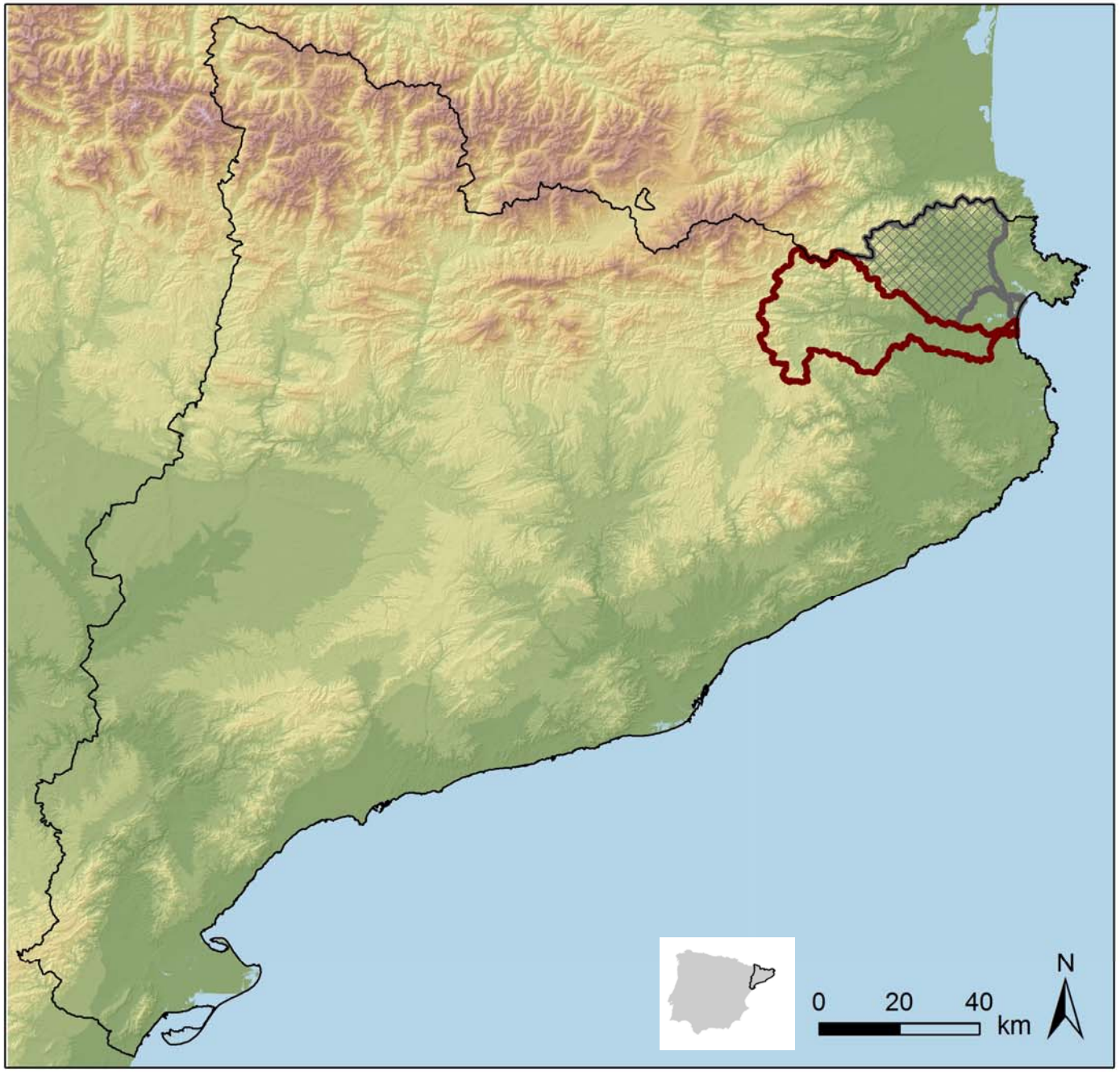

LIFE+ MEDACC (2013-2018)

la Muga

ACCUA (2008-2011)

el Fluvià

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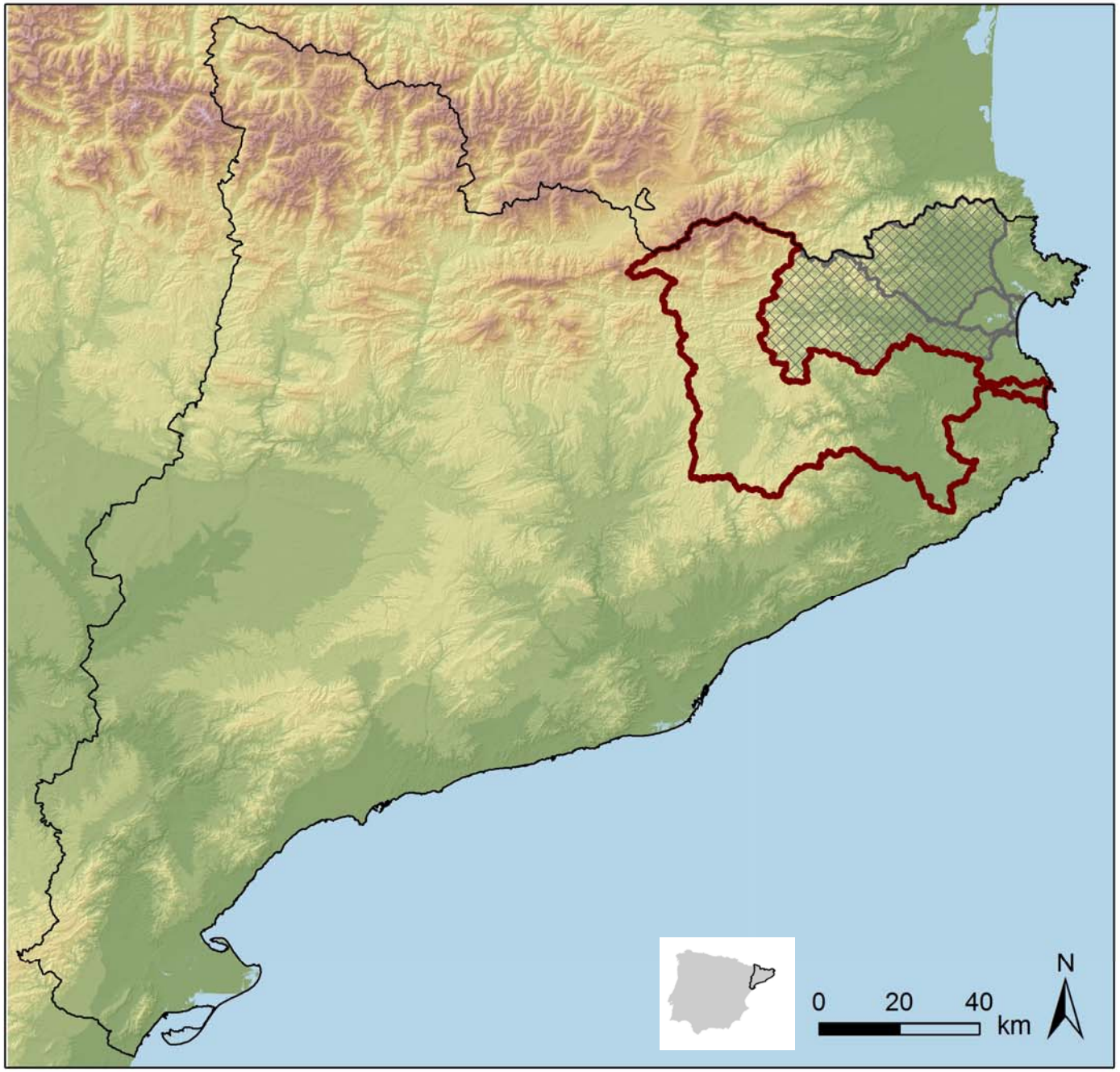

LIFE+ MEDACC (2013-2018)

la Muga

el Ter

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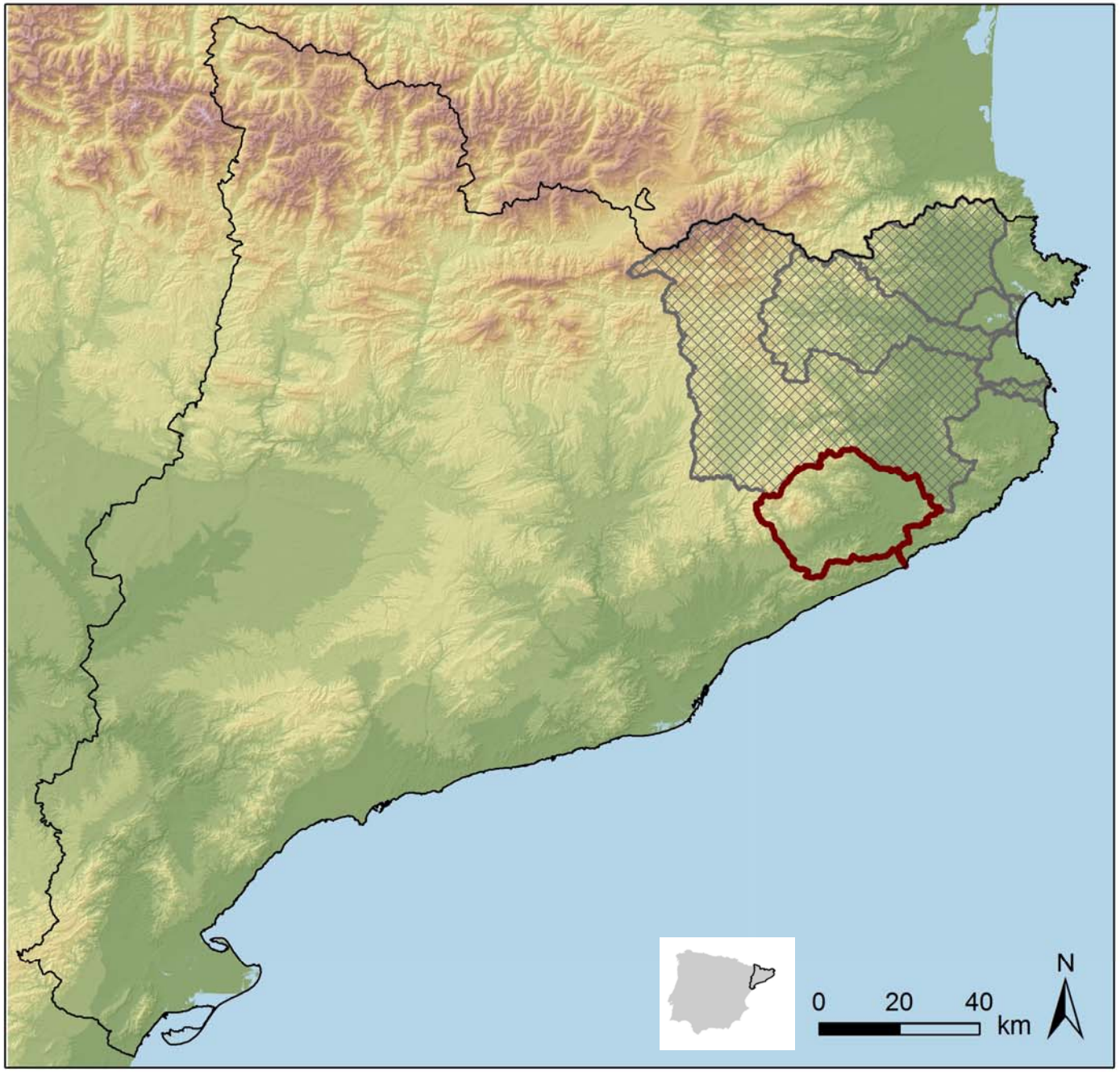

LIFE+ MEDACC (2013-2018)

la Muga

el Ter

ACCUA (2008-2011)

el Fluvià

la Tordera

BeWater (2013-2017)

la Tordera

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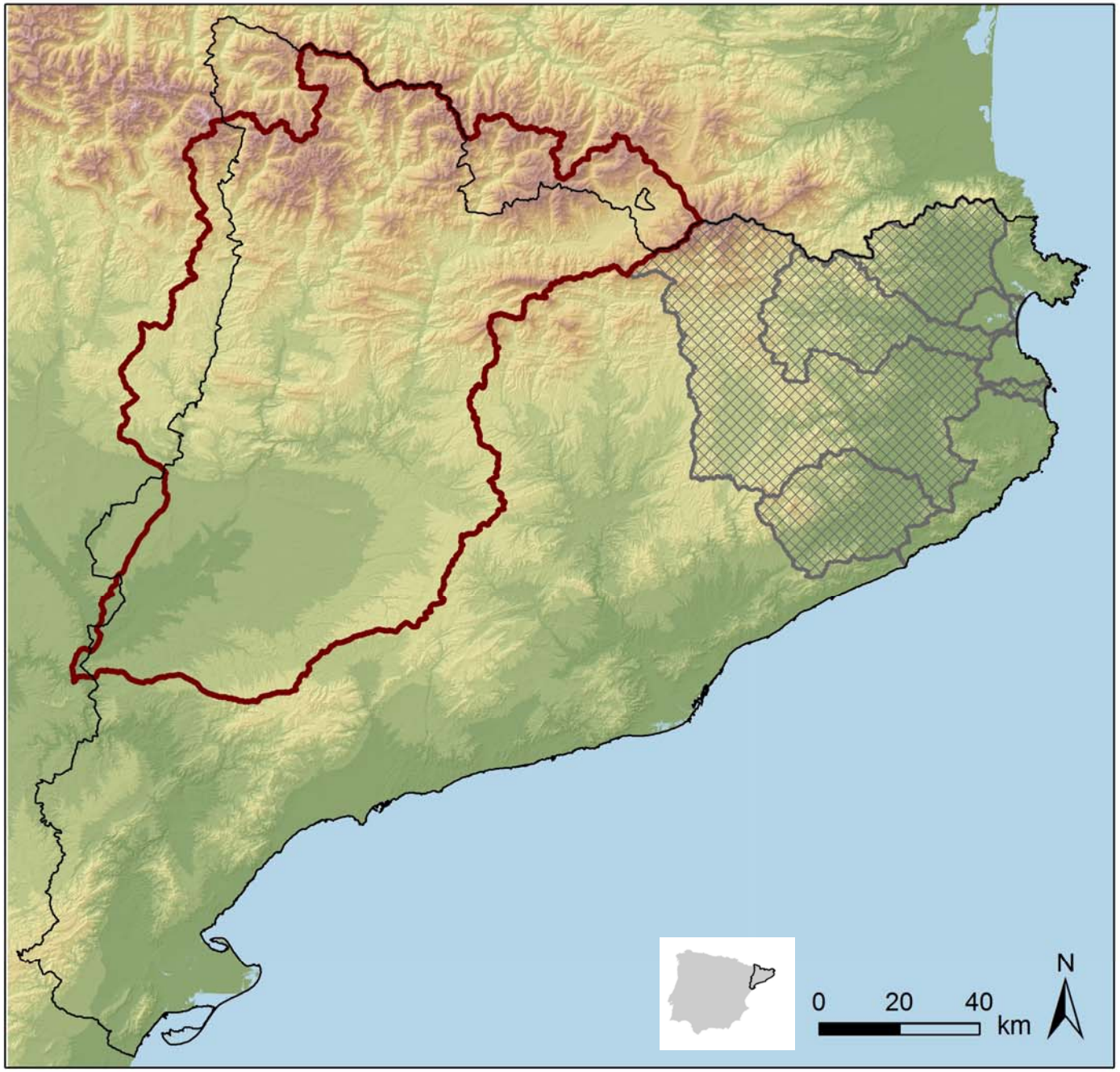

LIFE+ MEDACC (2013-2018)

la Muga

el Ter

el Segre

ACCUA (2008-2011)

el Fluvià

la Tordera

FP7 BeWater (2013-2017)

la Tordera

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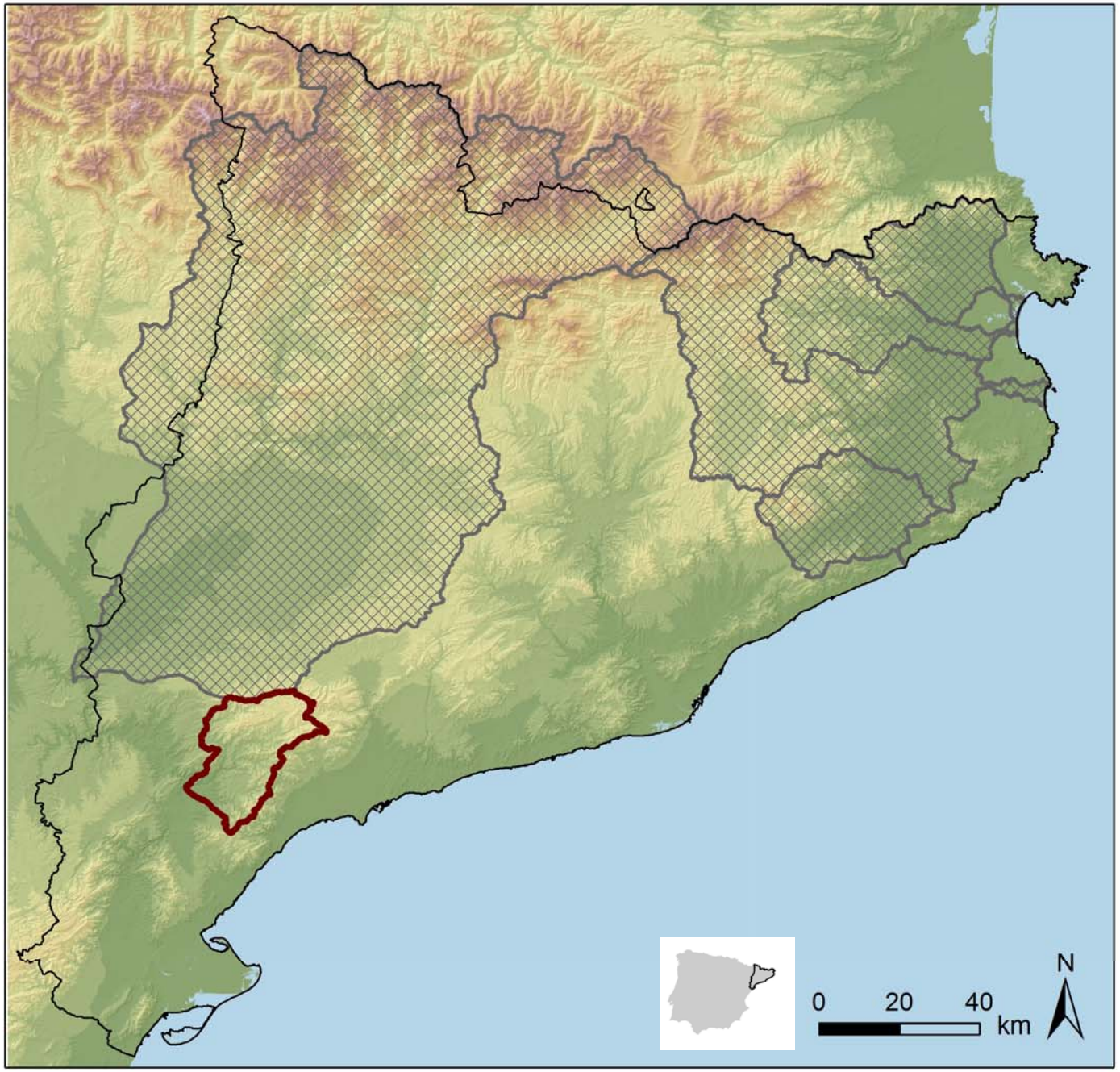

LIFE+ MEDACC (2013-2018)

la Muga

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el Fluvià

la Tordera

el Siurana

FP7 BeWater (2013-2017)

la Tordera

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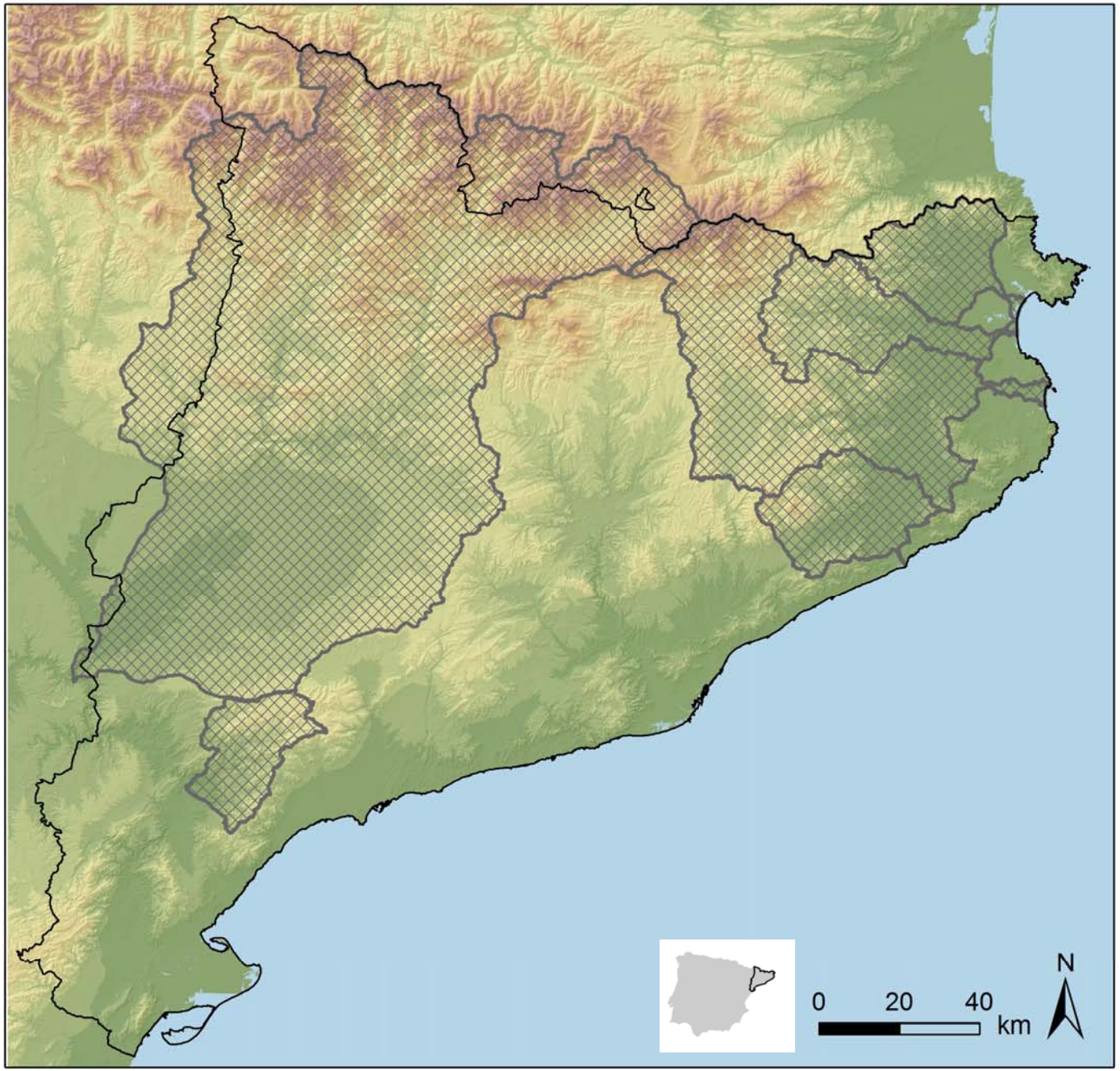


LIFE+ MEDACC (2013-2018)

la Muga

el Ter

el Segre

ACCUA (2008-2011)

el Fluvià

la Tordera

el Siurana

FP7 BeWater (2013-2017)

la Tordera

They cover the 60% of the area of Catalonia!

CREAF

WORKING ON GLOBAL CHANGE ADAPTATION…

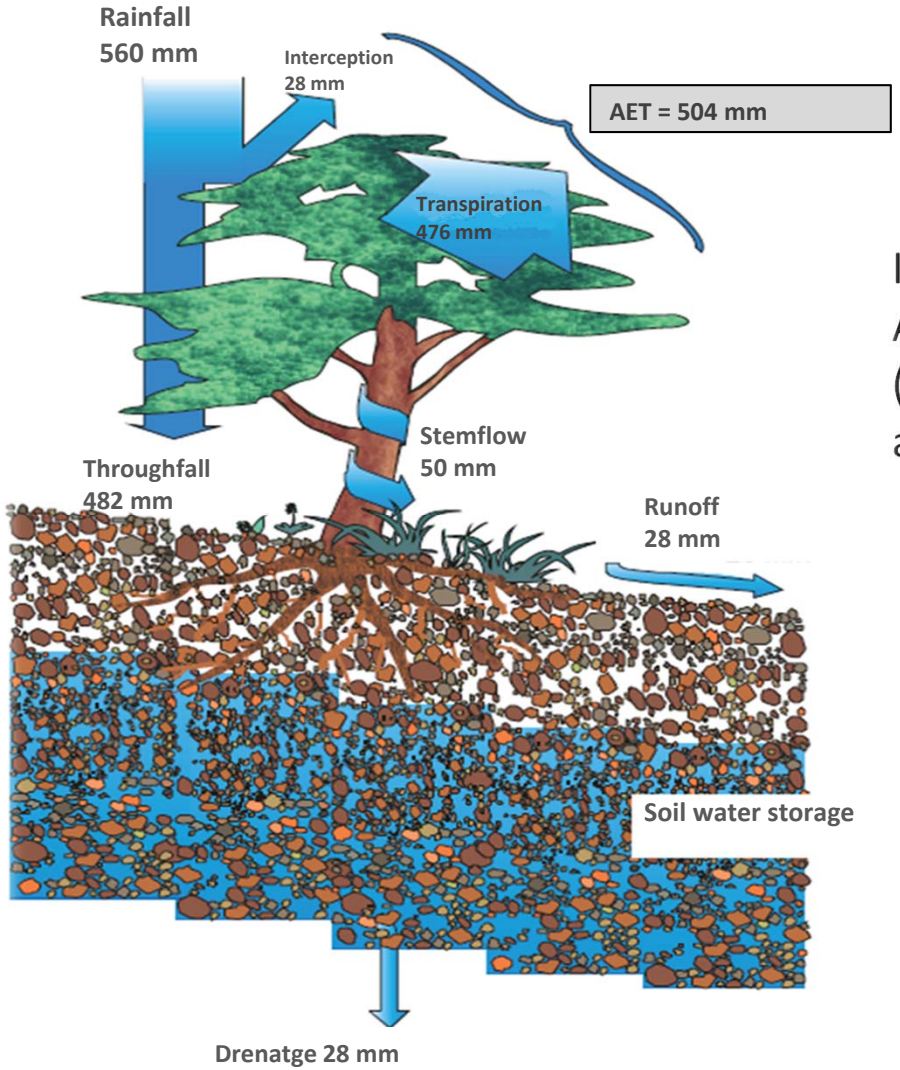
A journey through three interconnected itineraries:

1. From the **forest stand** to the **whole river basin**
2. From the **system impact understanding** to the **integrated management** strategies
3. From the **science** to the **society involvement**

1. From the forest stand to the river basin

Forest water balance

Vulnerabilities of Mediterranean forests

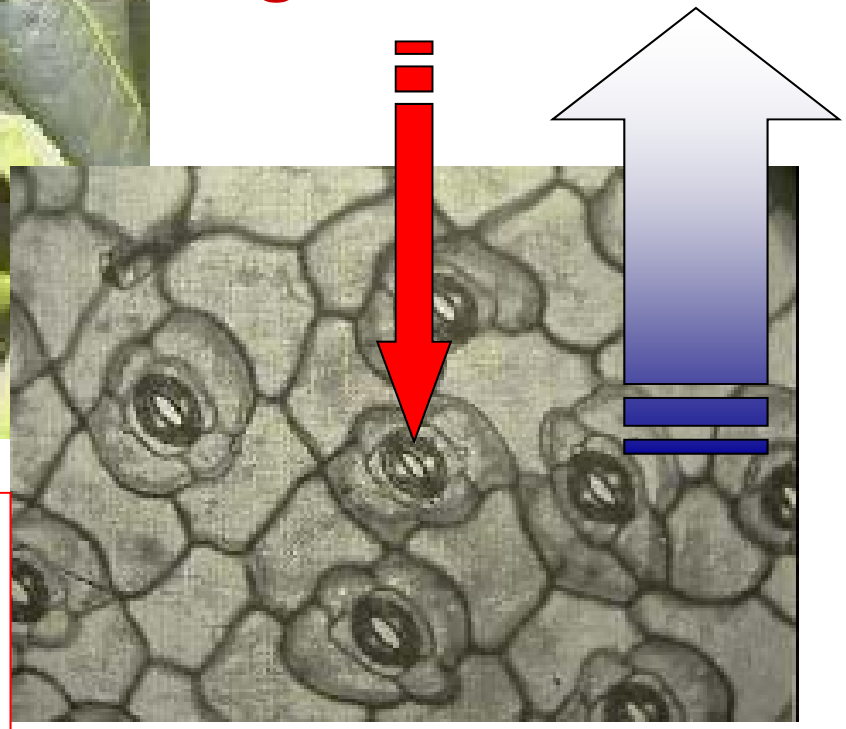


In Mediterranean forests, Actual Evapotranspiration (AET) represents **80-90%** of annual rainfall

Source: Gracia *et al.* 2008

Carbon sequestration

Forest transpires a large amount of water to fix atmospheric carbon



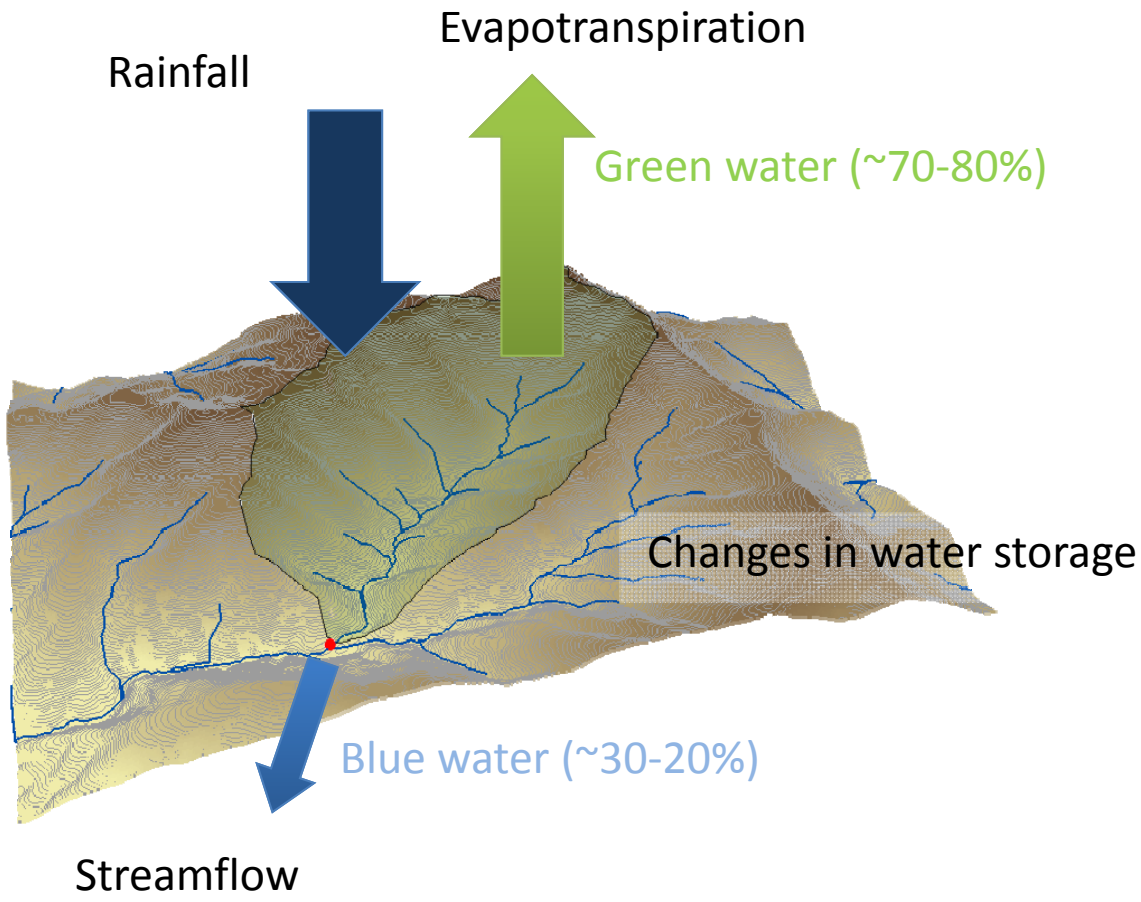
To uptake **1 g of C** the tree must transpire **500 g of water**

In the Mediterranean area, land management without taking into account water fluxes will be unsuccessful!

Source: Gracia *et al.* 2010. 2nd Report of Climate Change in Catalonia

Water balance in a river basin

The river basin as a socio-eco-hydrological unit



80% of water input in a river basin is not directly managed!

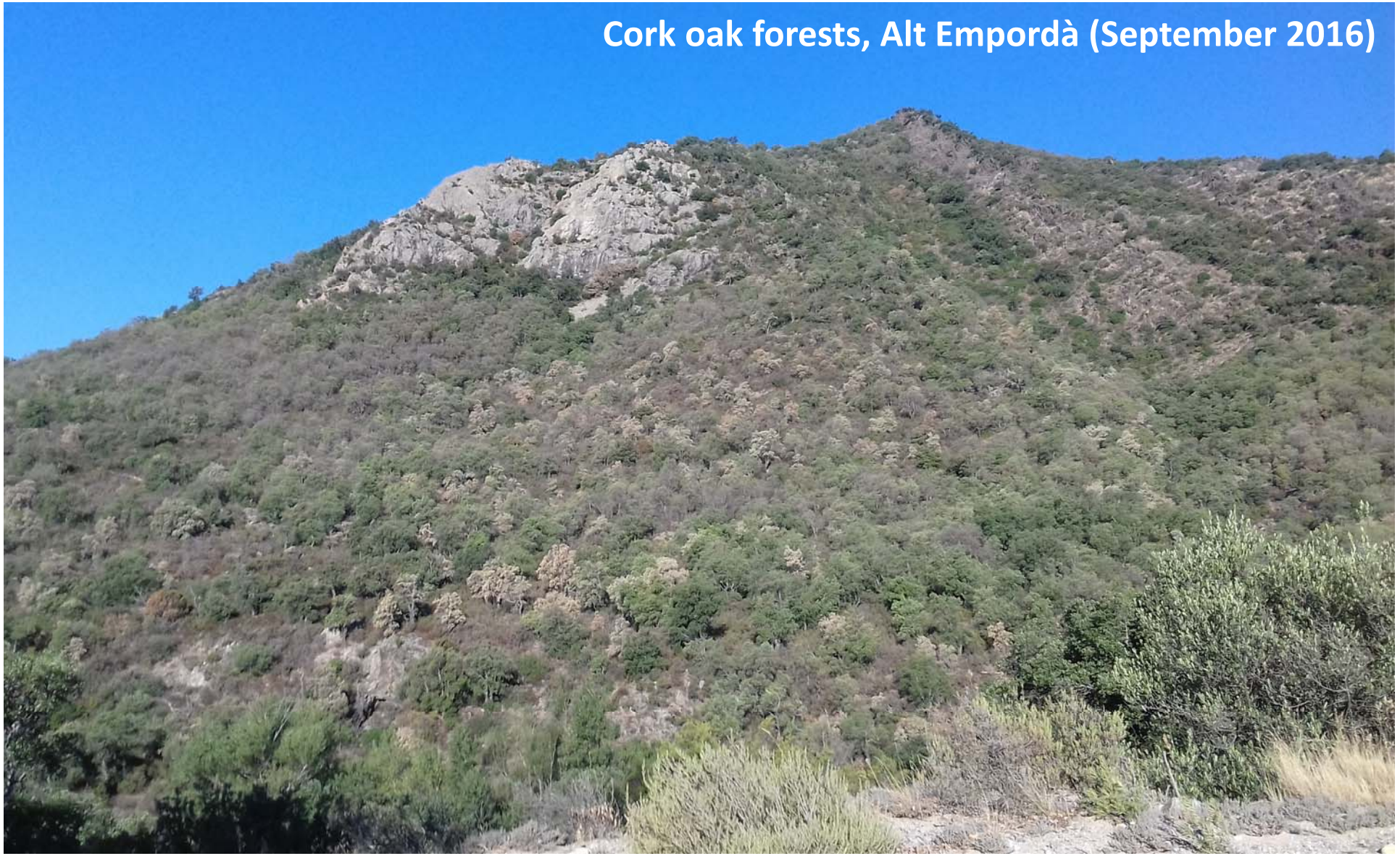
Impacts in Mediterranean forests

Forest decline

Holm oak forests, Alt Empordà (September 2016)

Impacts in Mediterranean forests

Forest decline

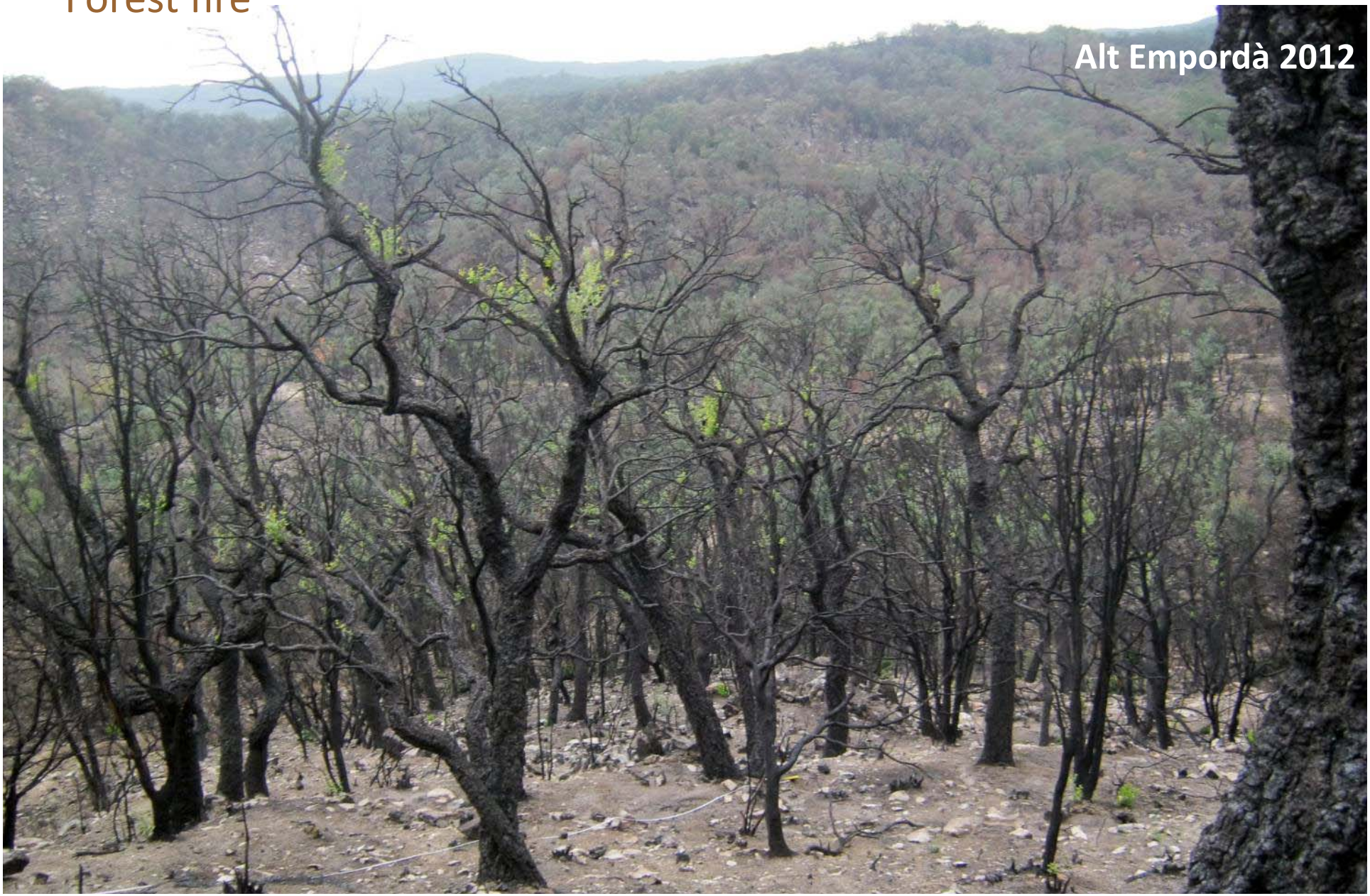


Impacts in Mediterranean forests

Forest decline

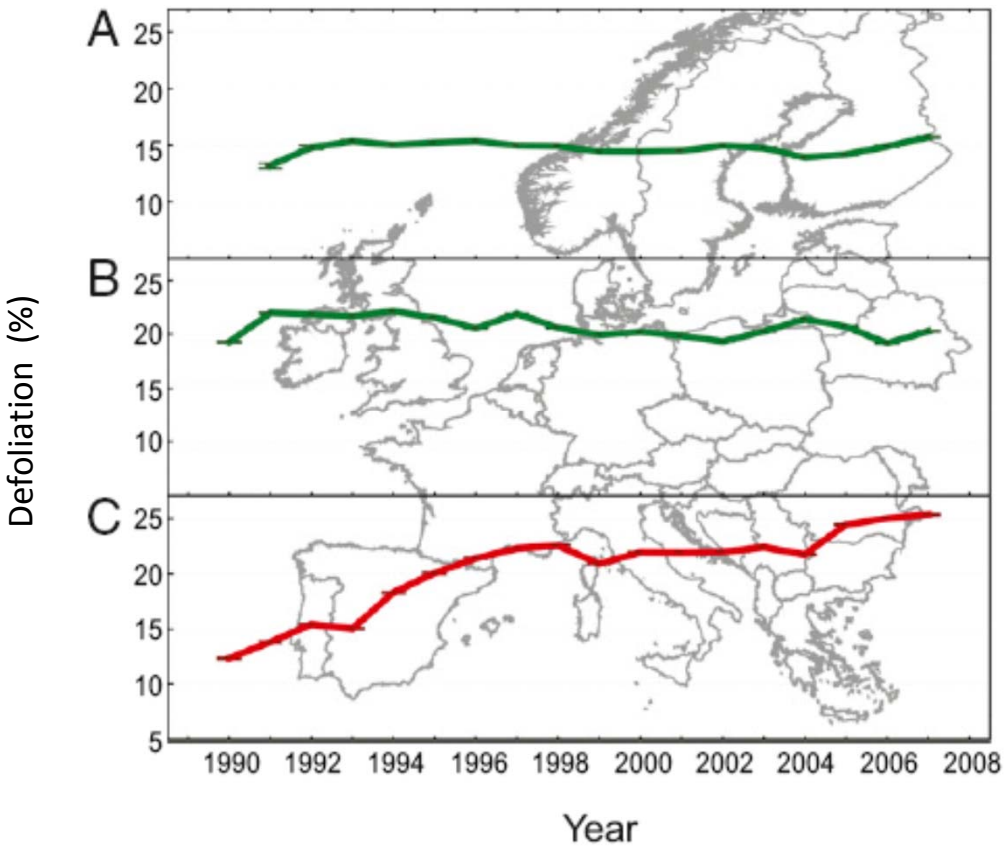
Impacts in Mediterranean forests

Forest fire



Impacts in Mediterranean forests

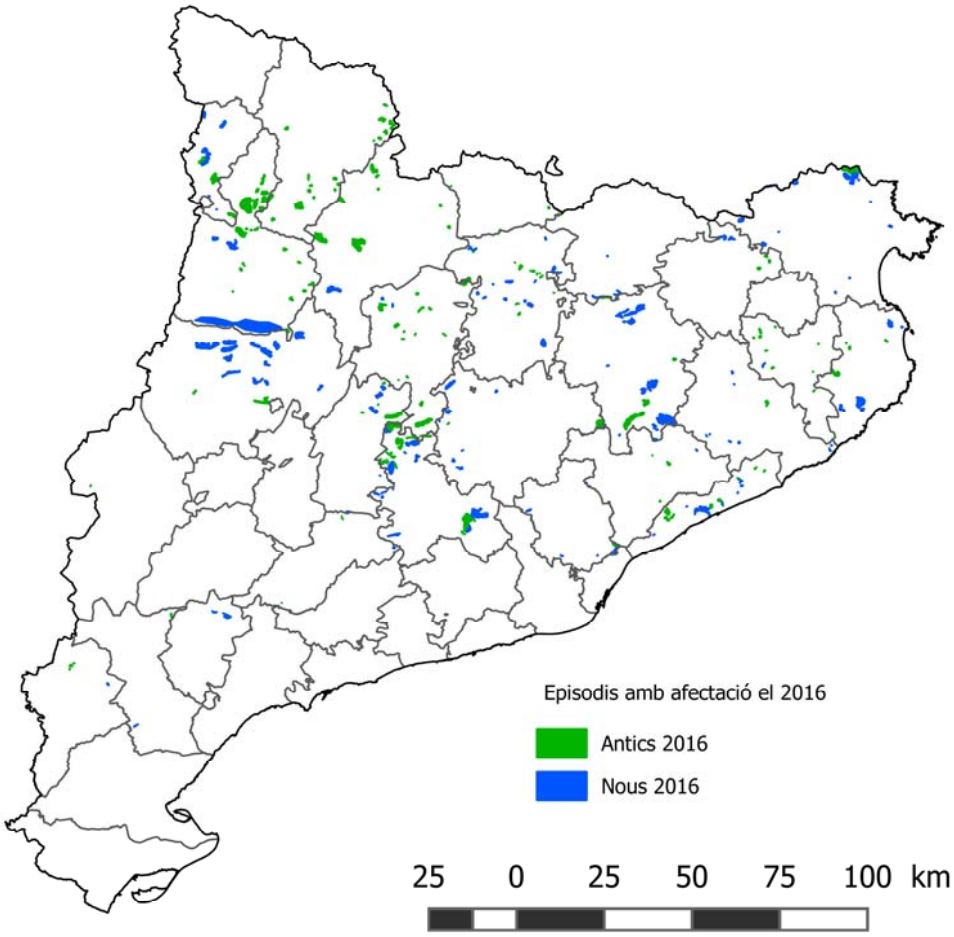
Forest decline



Source: Carnicer *et al.* (2011)

Impacts in Mediterranean forests

Forest decline in Catalonia



Forest decline:
Areas (> 3 ha)

with ≥5% of tree mortality

and/or

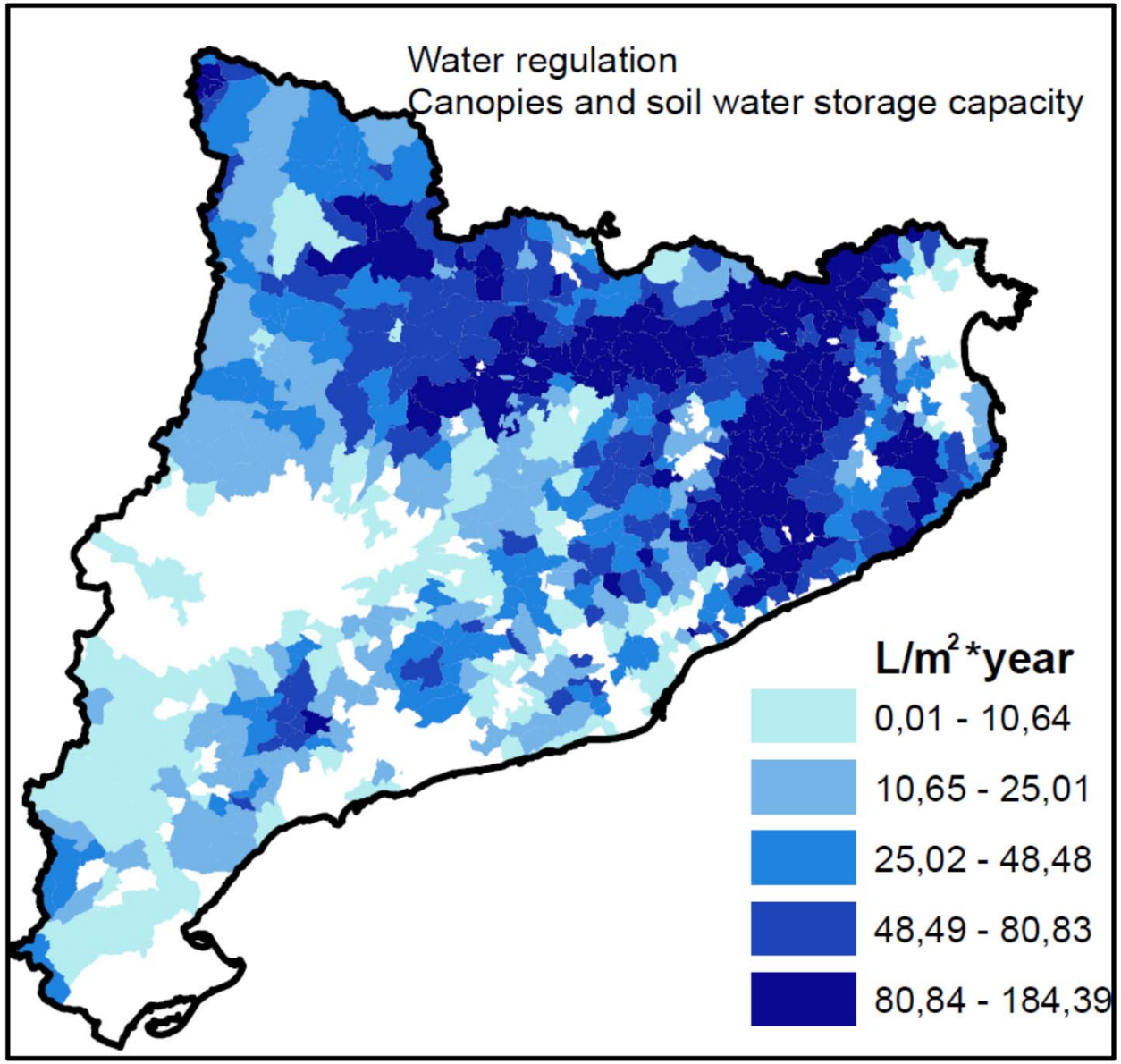
≥ 50% of defoliation/discoloration

2016 episodes affect the **2.2%** of the forest area

Source: DeBosCat Project (2016). Direcció General de Medi Natural. Generalitat de Catalunya

Ecosystem services provided by forests

Water regulation

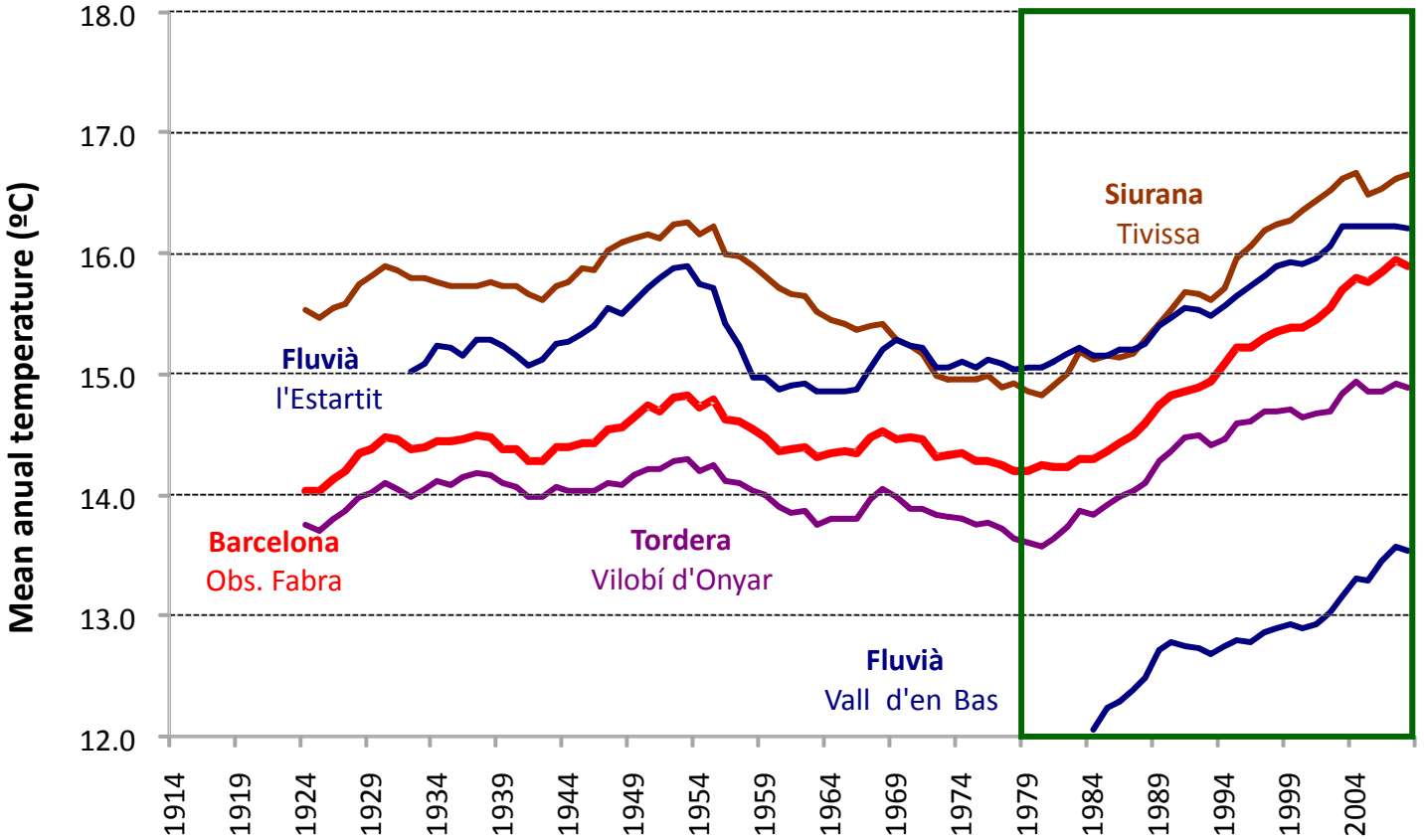


forESmap project

Source: Roces *et al.* (submitted 2016)

Impacts in Mediterranean river basins

Observed temperature trends (1914-2008)

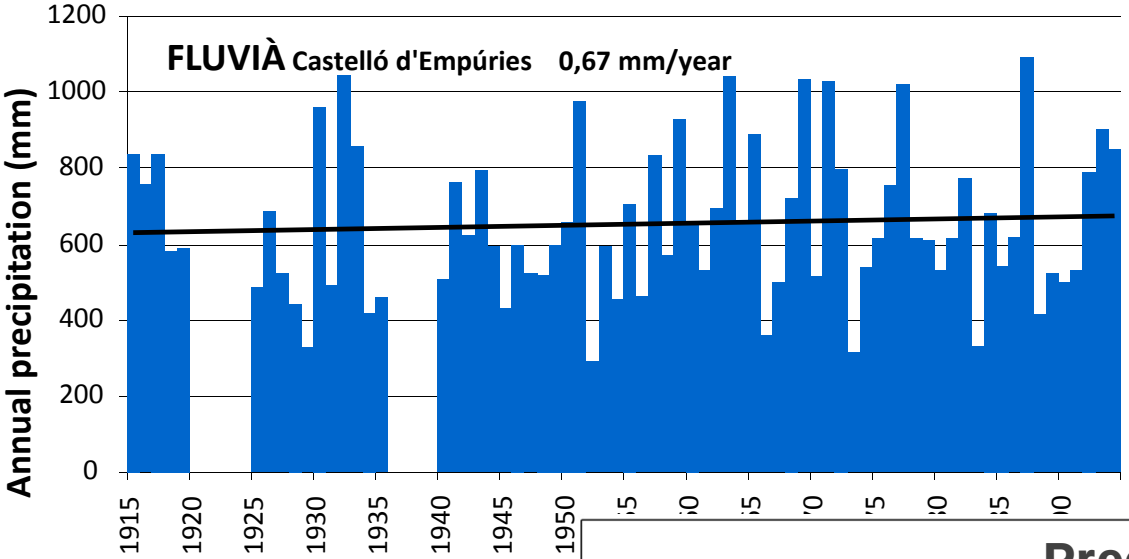


A **1.9 ºC** temperature increase since **1979** has been monitored at three watersheds in Catalonia

Source: ACCUA project. SMC and NESATv2 data base from Climate Change Research Group. Universitat Rovira i Virgili.

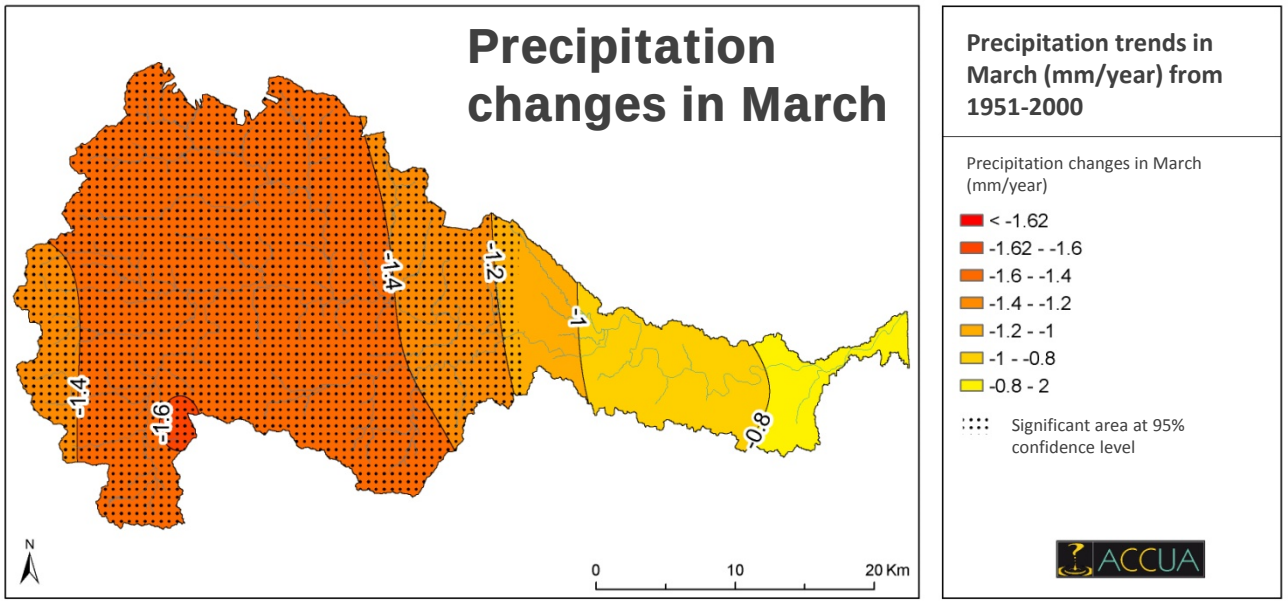
Impacts in Mediterranean river basins

Observed precipitation trends



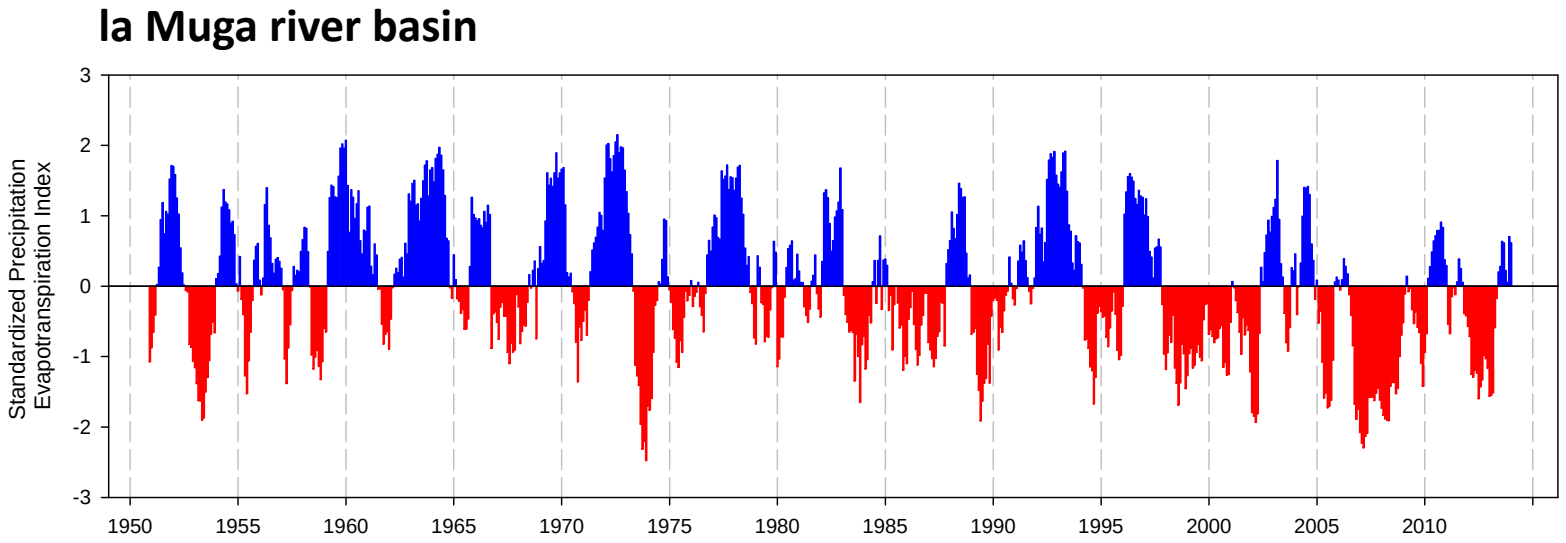
No significant **changes** in annual precipitation...

...but **significant** changes in certain **months**



Impacts in Mediterranean river basins

Observed in drought trends

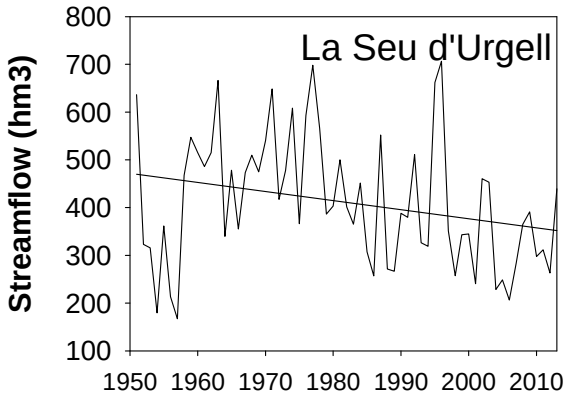


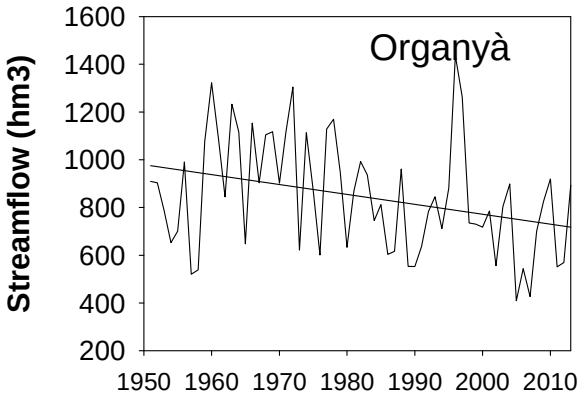
Climatic drought index *Standardized Precipitation Evapotranspiration Index, SPEI* (Vicente-Serrano *et al.* 2010). Boadella station

Impacts Mediterranean river basins

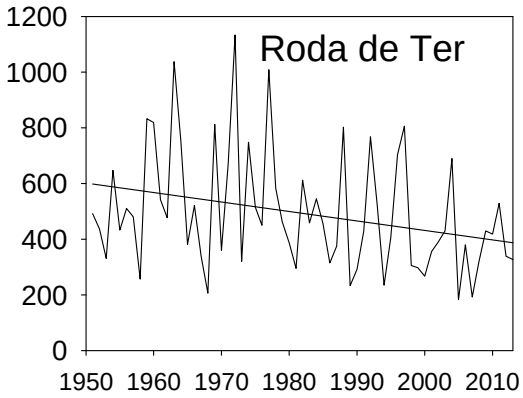
Observed streamflow trends in headwaters

SEGRE

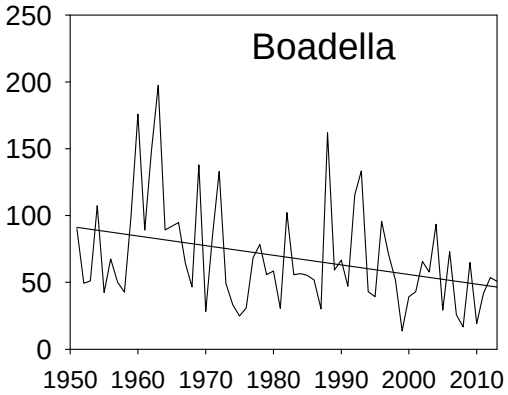




TER



MUGA



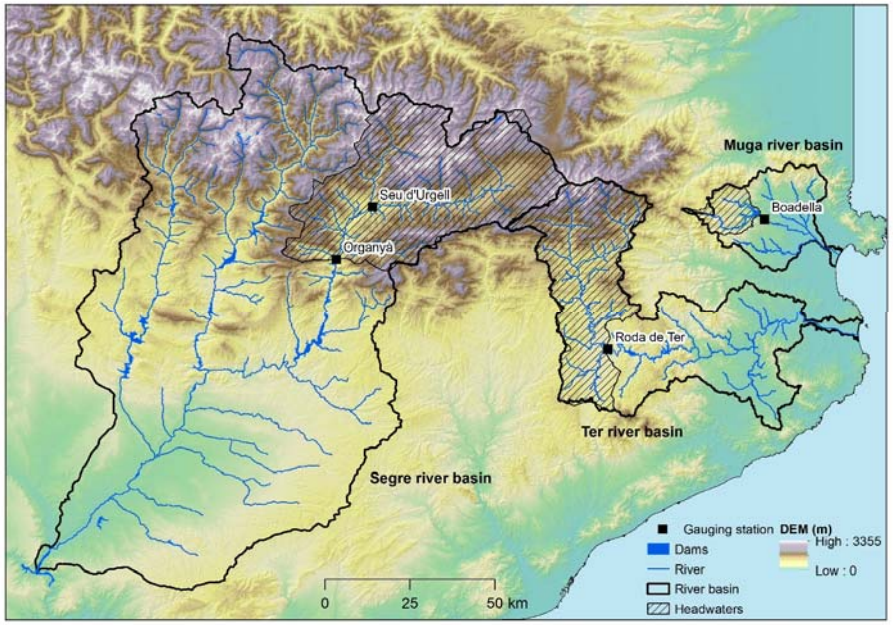
-25% to -50% decrease in 60 years!

Source: LIFE+ MEDACC project
Pla *et al.* (2016)

2. From impact understanding to the integrated management

Impacts in Mediterranean river basins

Streamflow reduction in headwaters

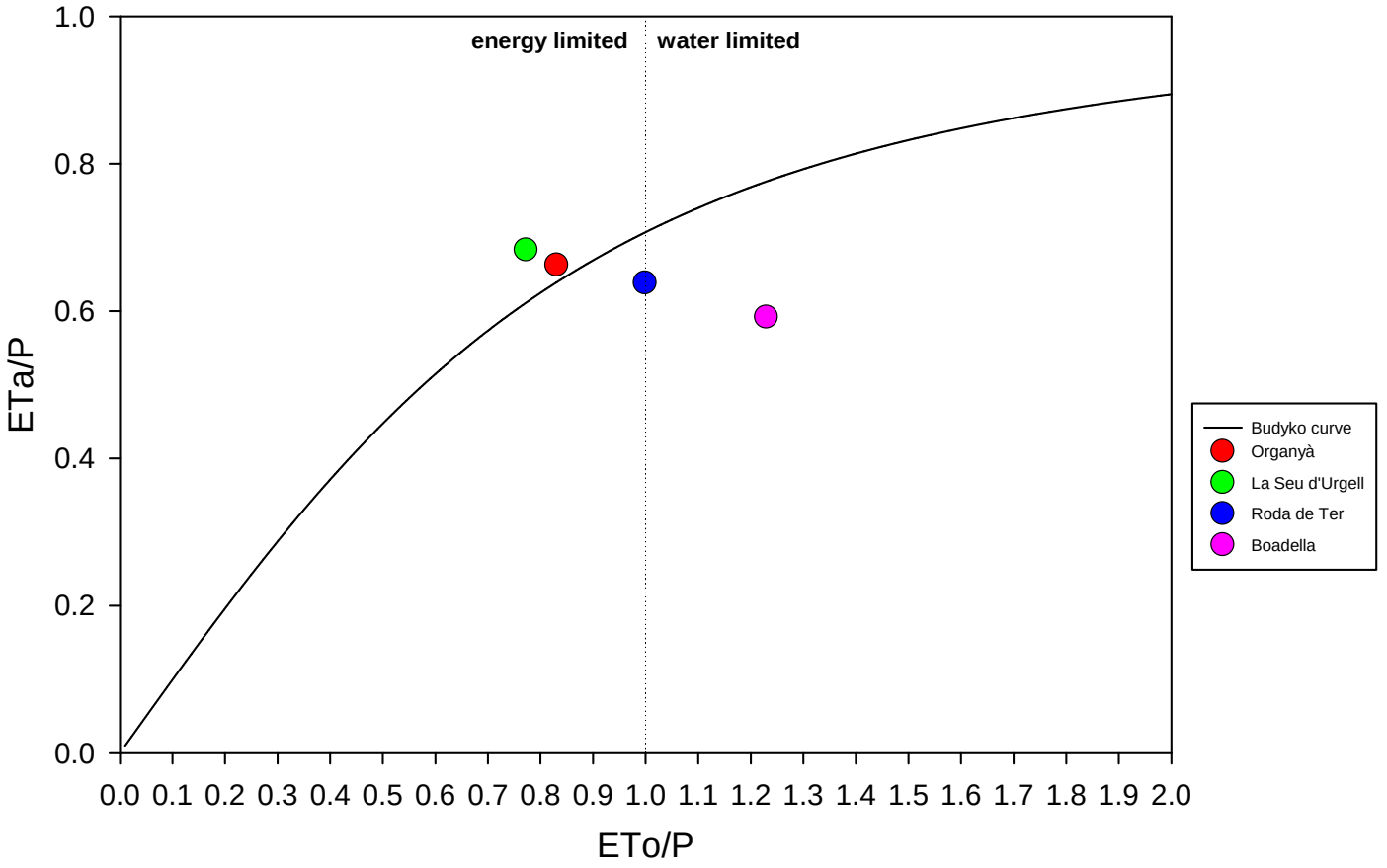


	% change in observed streamflow	% change in streamflow expected by climate evolution	% change in runoff coefficient (Q/P)
Segre headwaters			
Organyà	-26.4	-28.0	-3.9
La Seu d'Urgell	-25.1	-28.1	-2.7
Ter headwaters			
Roda de Ter	-35.3	-38.8	-17.2
Muga headwaters			
Boadella	-49.0	-30.7	-41.3

Source: LIFE+ MEDACC project
Pla *et al.* (2016)

Impacts in Mediterranean river basins

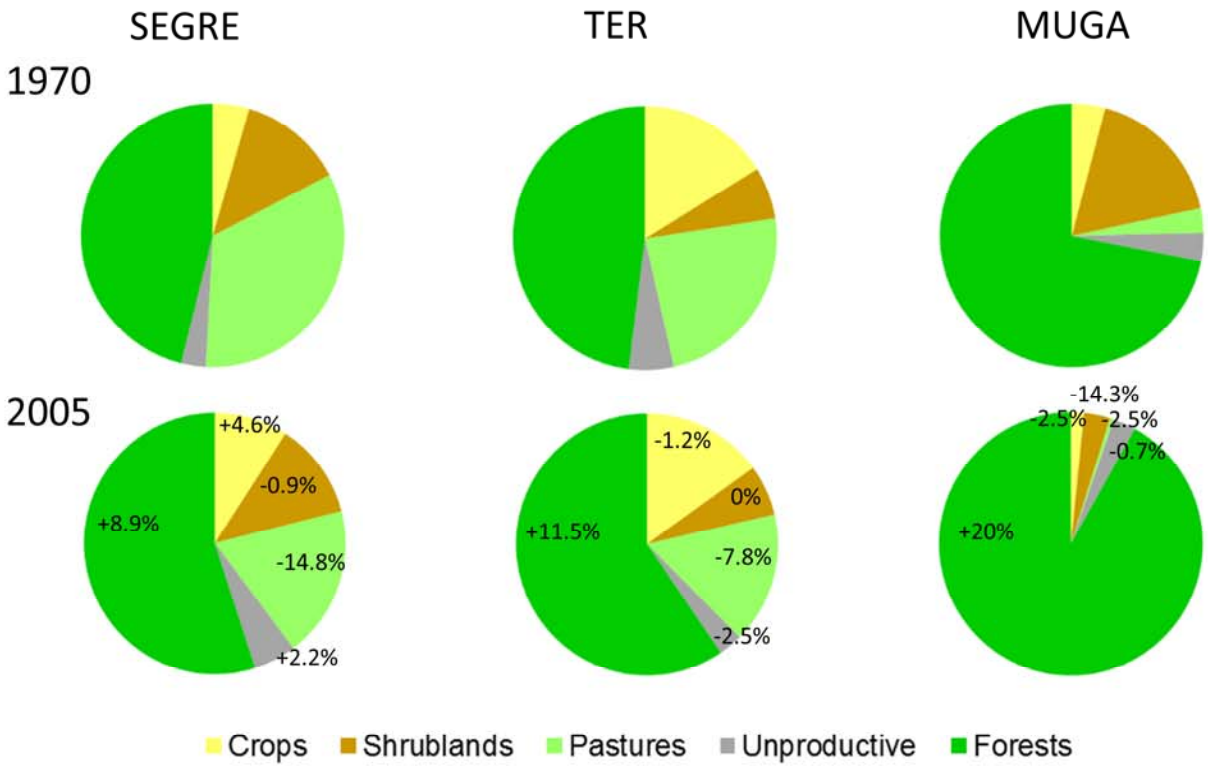
Mediterranean influence in the water balance



Source: LIFE+ MEDACC project
Pla *et al.* (2016)

Impacts in Mediterranean river basins

Land use structure and land use change in headwaters



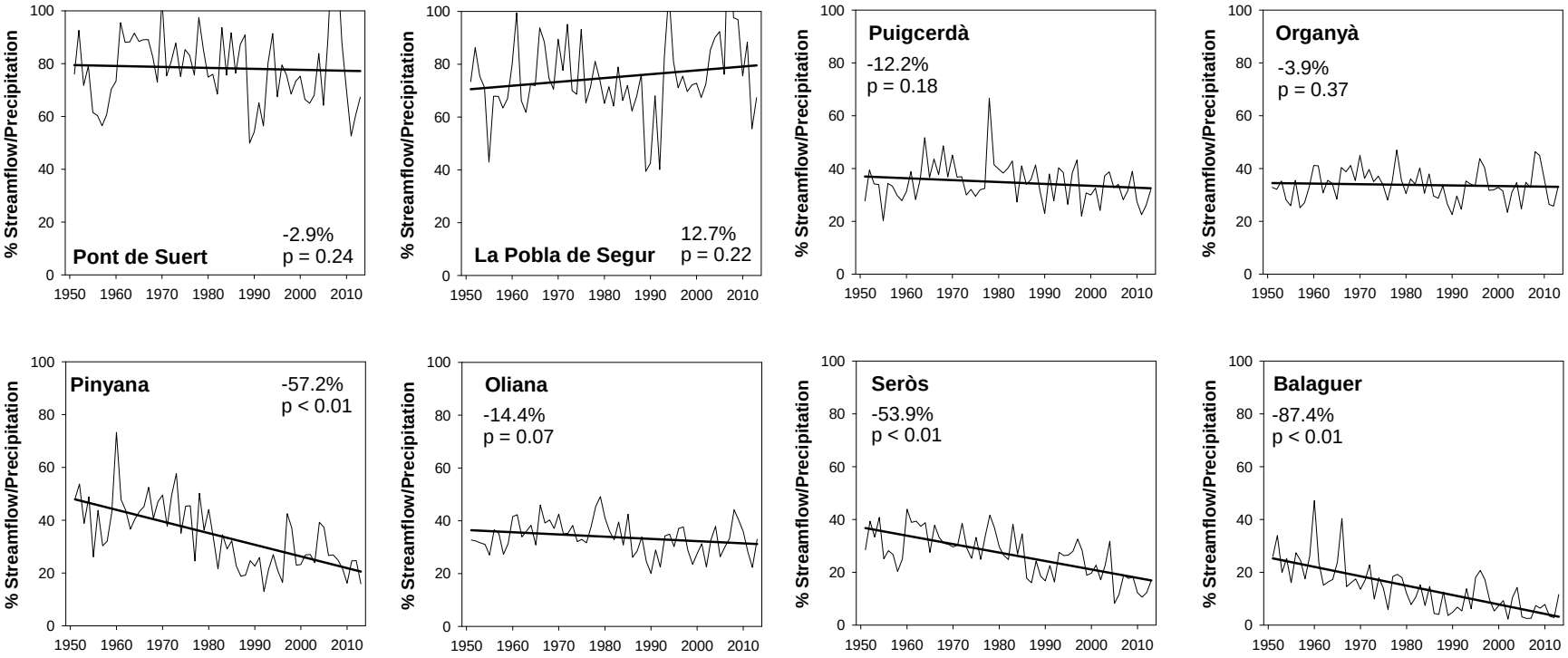
The effects of land use changes could be synergically amplified in highly water-limited systems!

Source: LIFE+ MEDACC project
Pla *et al.* (2016)

Impacts in Mediterranean river basins

Water demands in the whole river basins

In Segre river, the increase of streamflow regulation for irrigation has a strong impact on the streamflow in the lower part of the basin



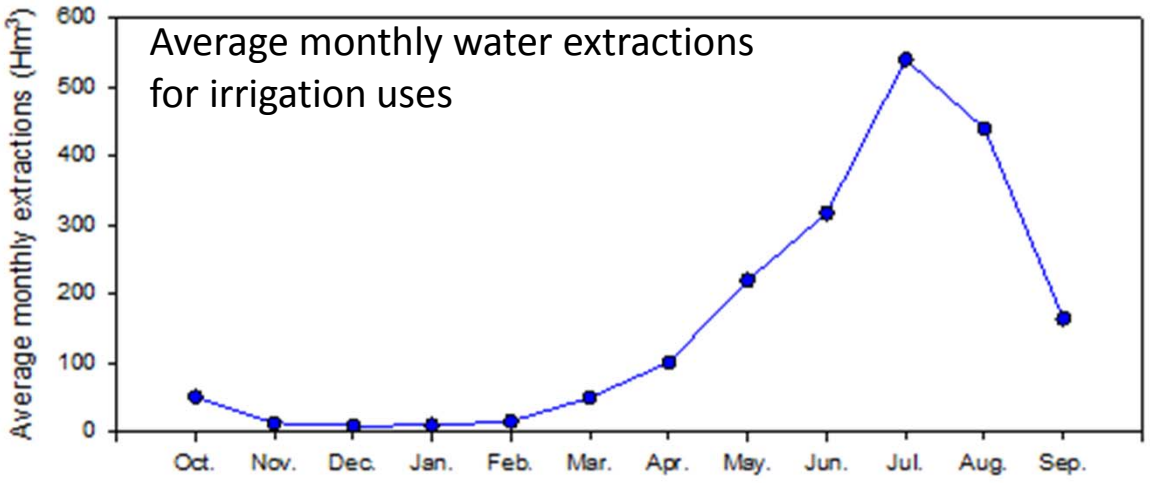
The progressive increment of reservoir capacity increased the dissociation between climate and runoff!

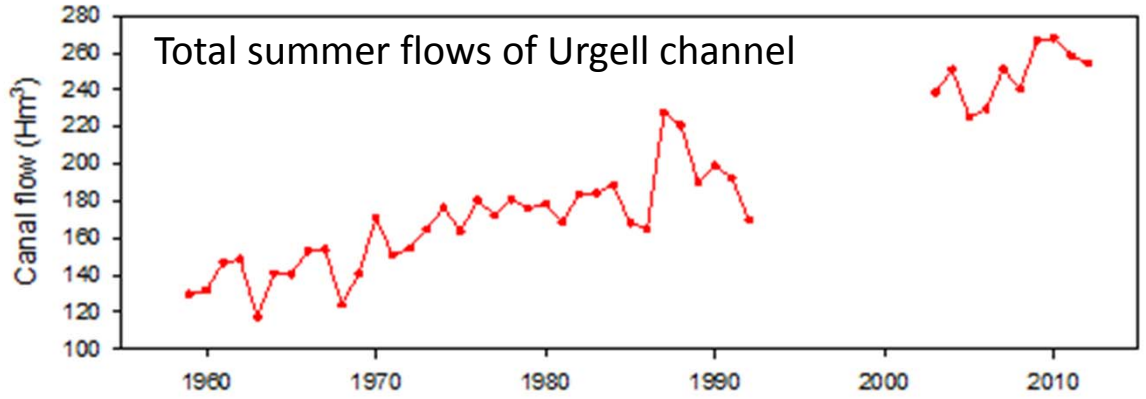
Source: Vicente-Serrano *et al* 2016
MEDACC project www.medacc-life.eu

Impacts in Mediterranean river basins

Water demands in the whole river basins

Irrigation in Segre river basin



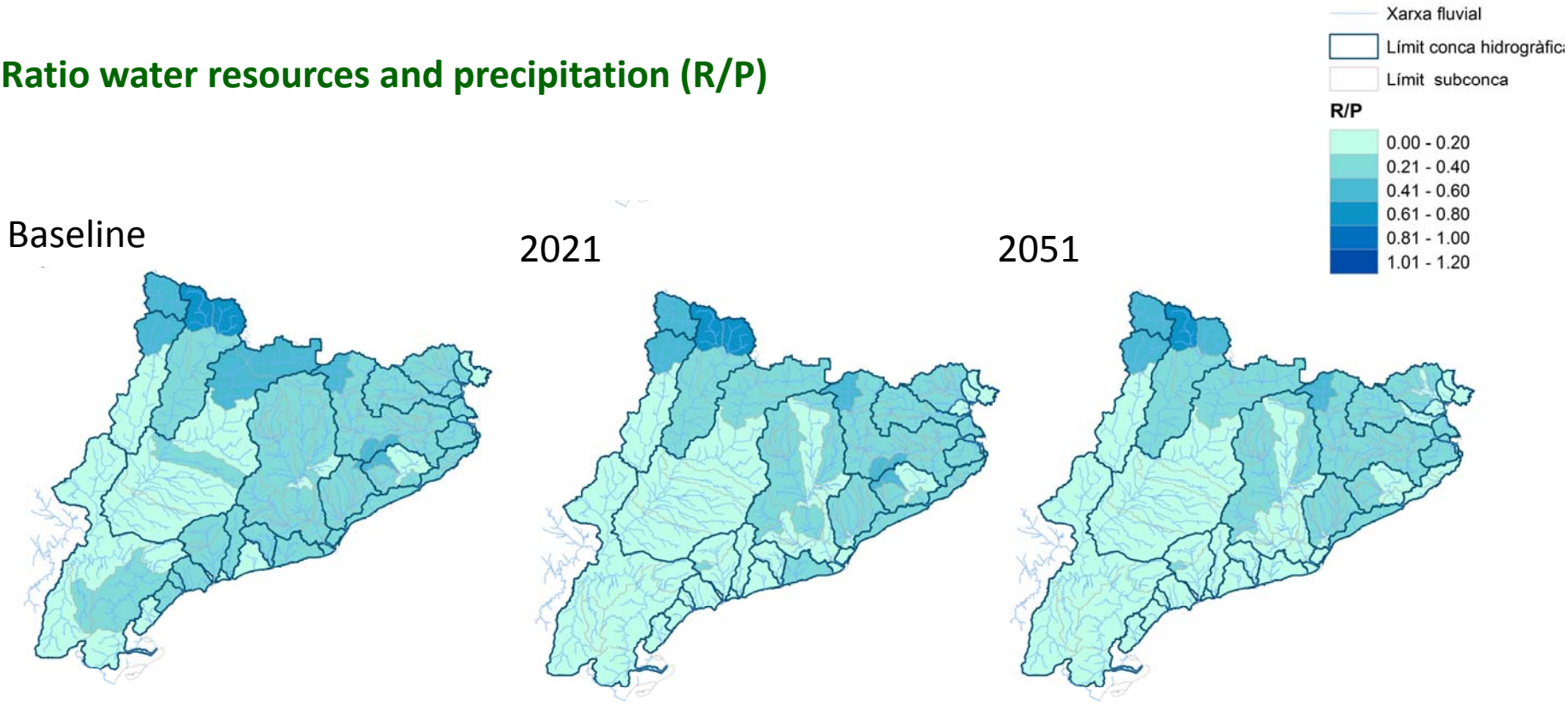


Source: Vicente-Serrano *et al* 2016
MEDACC project www.medacc-life.eu

Impacts in Mediterranean river basins

Blue water projections

Ratio water resources and precipitation (R/P)

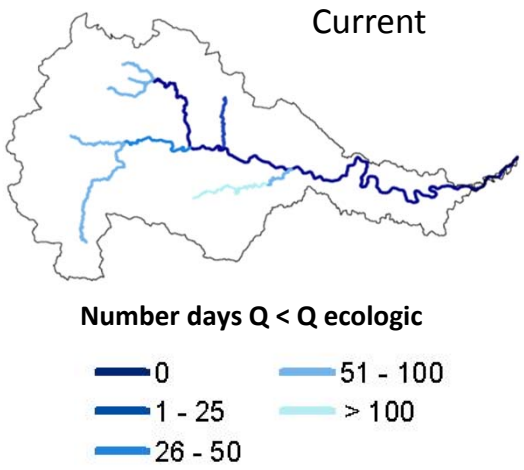


Average reductions of 10% in Pyrenean basins and 22% in the coastal basins!

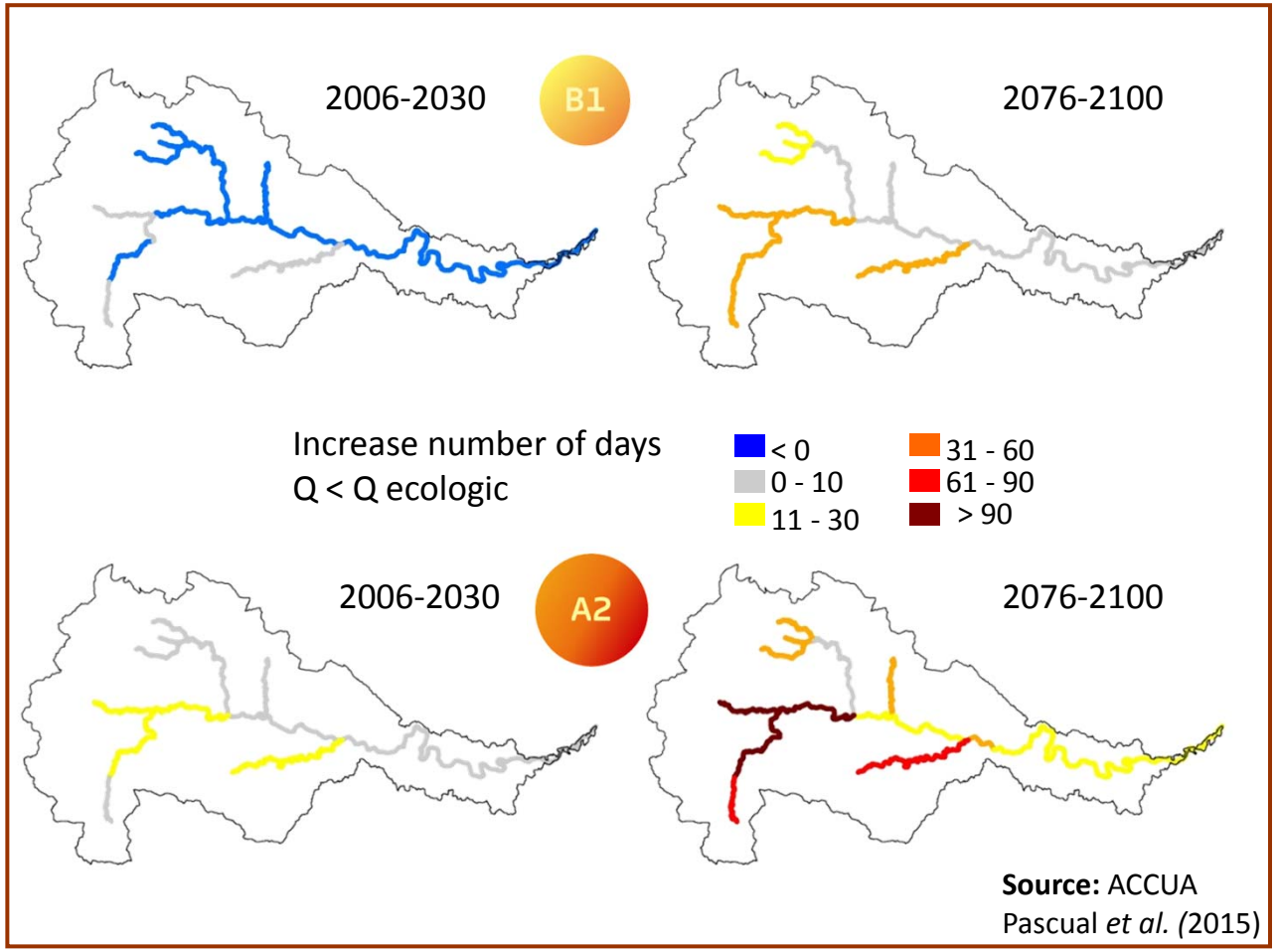
Source: Mas-Pla *et al* 2016. 3rd Report on Climate Change in Catalonia. *In press*

Impacts on freshwater ecosystems

Ecological streamflow projections



el Fluvià river



At the end of the Century, the number of days per year with streamflow lower than ecological flow will increase (more than 90 days in A2 scenario)

Adaptive management options

Adaptation in the Mediterranean river basins

Management options in LIFE+ MEDACC project

1. **Compilation** and assessment of previous measures/solutions which contribute to river basin adaptation
2. **Implementation** of adaptive options designed within the project framework in the fields of forestry, agriculture and water management and effectiveness **monitoring**
3. Design of **new management options** for these sectors which should be implemented to improve the resilience of the studied river basins

Adaptation in the Mediterranean river basins

Management options in LIFE+ MEDACC project

Implementation of forest management experiment to increase holm oak forest resilience to drought and fire

Requesens, Muga river basin

T1
Selection

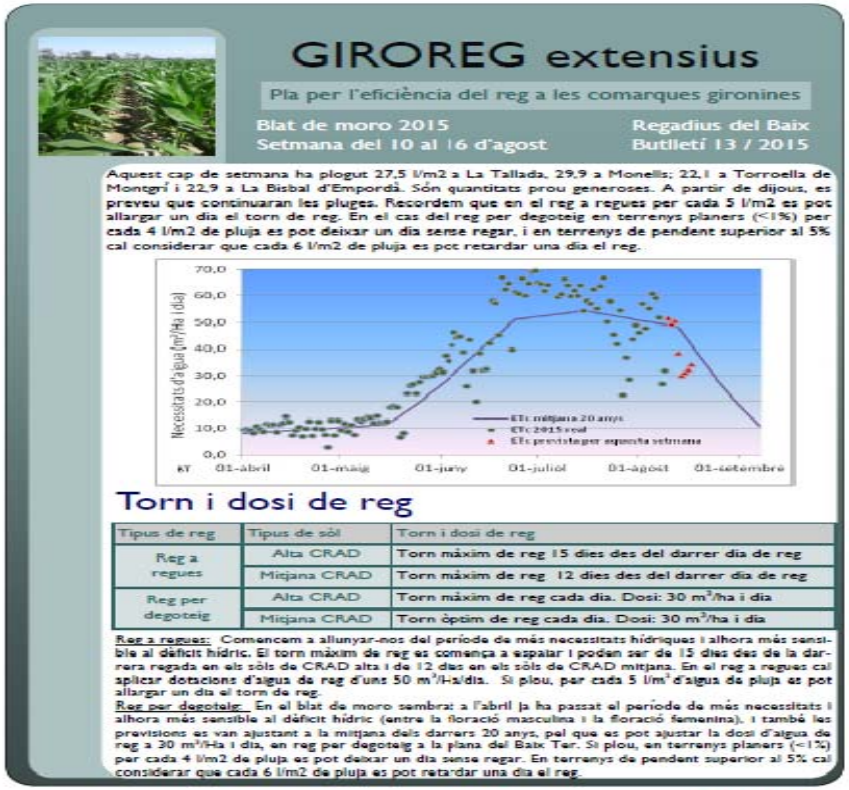
T2
Low thinning

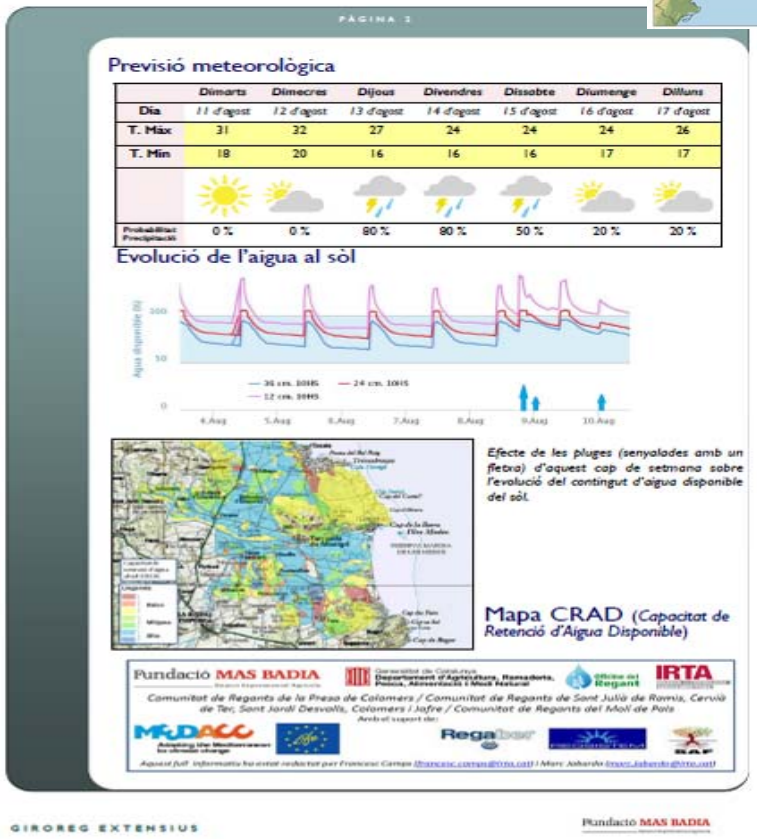
Adaptation in the Mediterranean river basins

Management options in LIFE+ MEDACC project

Implementation of an online advisory system for irrigation improvement and water saving

Lower Ter and Lower Muga





IRTA
RECERCA I TECNOLOGIA AGROALIMENTÀRIES

Adaptation in the Mediterranean river basins

Management options in LIFE+ MEDACC project

New management options

Muga river basin

Well overflow use in lower Muga

Retention ponds in Muga headwaters

Oficina Catalana del Canvi Climàtic

Adaptation in the Mediterranean river basins

Management options in LIFE+ MEDACC project

Constitution of a water user's community

Lower Muga

Oficina Catalana del Canvi Climàtic

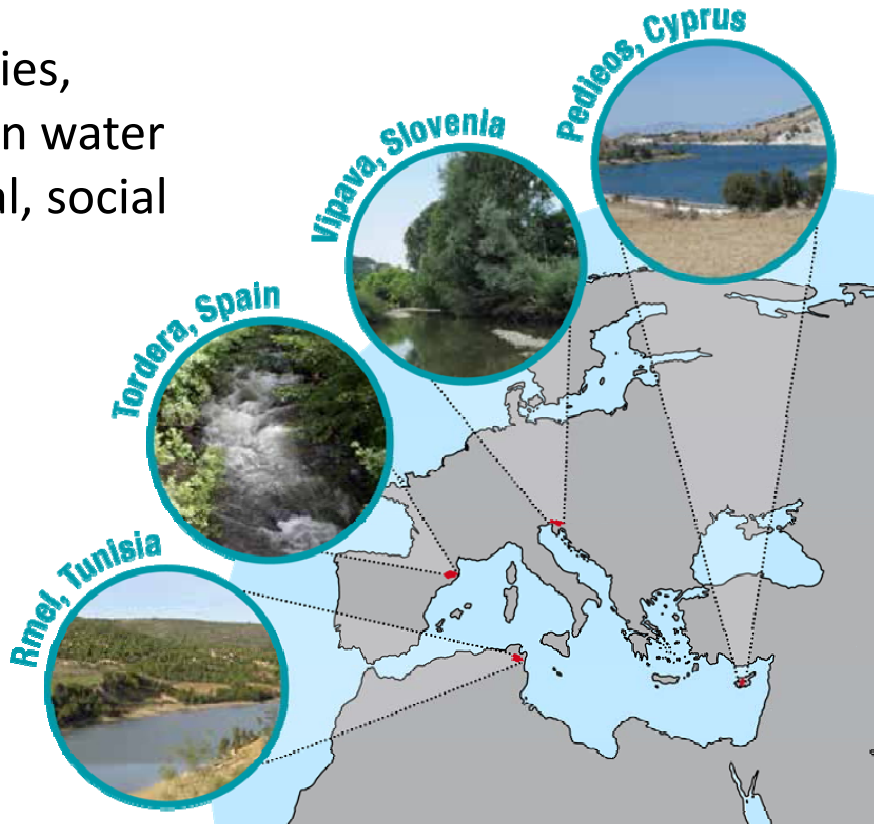
3. From science to the society involvement

Adaptation in the Mediterranean river basins

The BeWater project (FP7 Science in Society)

The **BeWater** project promotes dialogue and collaboration between science and society for sustainable water management and adaptation to the impacts of global change in 4 case study river basins in the Mediterranean.

By actively engaging with local communities, **BeWater** involves society in discussions on water challenges, integrating physical, ecological, social and management processes.



The main outcome is to draw up locally-relevant **Adaptation Plans**, which may be scaled up to develop guidelines of national and international relevance.

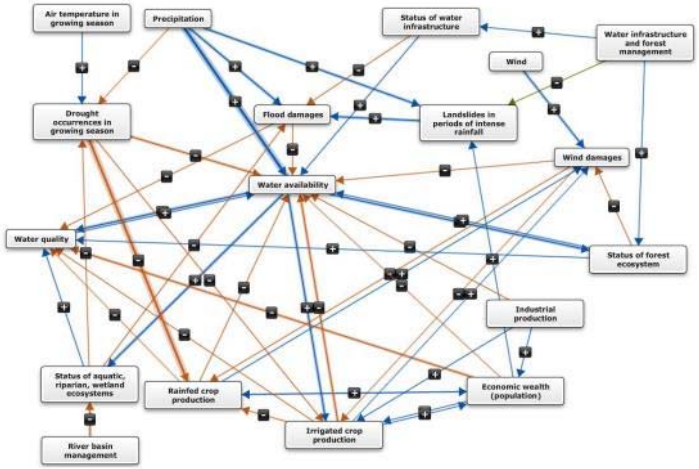
Adaptation in the Mediterranean river basins

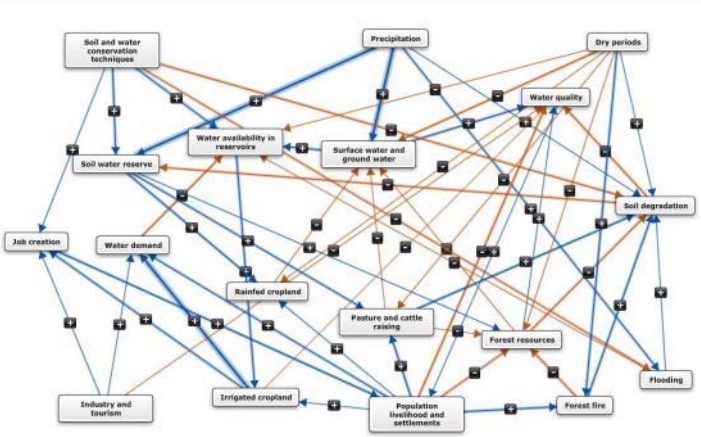
BeWater project: stakeholder workshops

Adaptation in the Mediterranean river basins

BeWater project: fuzzy cognitive maps

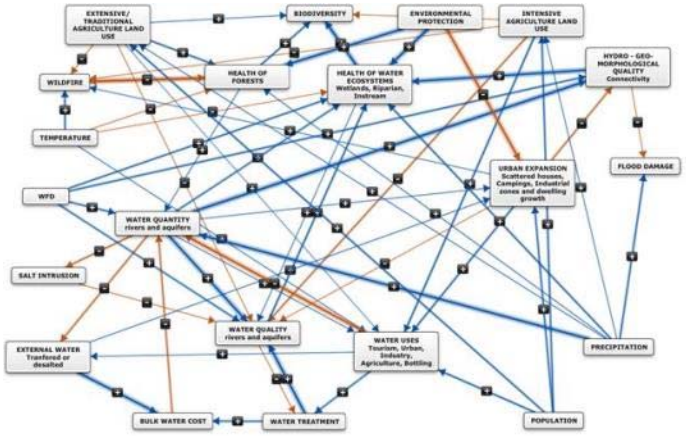
Vipava

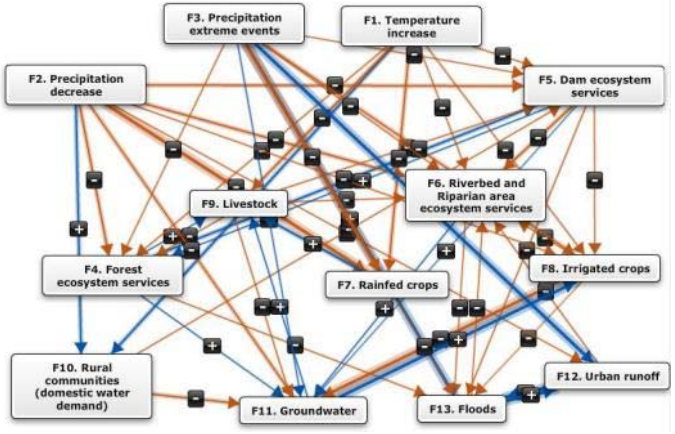




Rmel

Tordera





Pedieos

Adaptation in the Mediterranean river basins

BeWater project: river basin challenges

Vipava:

- Water availability during droughts in growing season
- Flood risk reduction
- Appropriate water quality

Tordera:

- Water quantity
- Water quality
- Health of forests & ecosystems
- Integrated Water Management

Rmel:

- Water quantity
- Water quality
- Agriculture
- Forest & biodiversity management
- Awareness of civil society
- Human resource and employment

Pedieos:

- Quantitative and qualitative status of groundwater
- Quantitative and qualitative status of surface water
- Flooding from the river

Adaptation in the Mediterranean river basins

BeWater project: water management options

Vipava:

- Reconstruction of existing water reservoir and construction of new ones, and irrigation systems.
- Construction of dry reservoirs.
- Awareness campaigns for experts, farmers and local public together with inter-municipal working group.

Tordera:

- Environmental flows and recovering groundwater levels.
- Information access and availability, and citizens engagement.
- Adaptive forest management agreements.

Rmel:

- Promote new water and soil conservation techniques
- Use of water irrigation technologies
- Reduction of society pressure on forests
- Involving stakeholders in all steps of the study and decision making

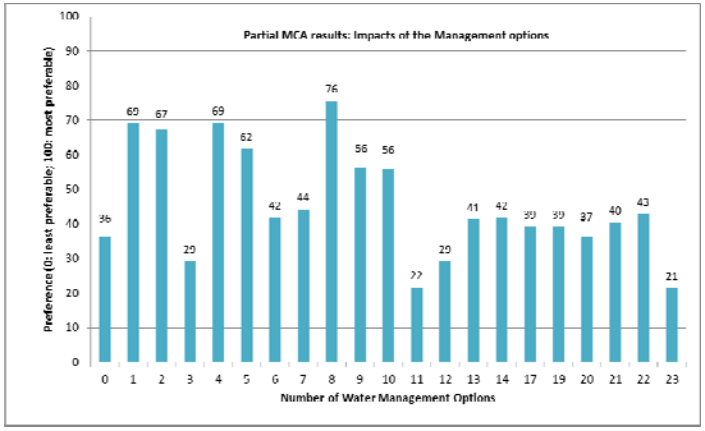
Pedieos:

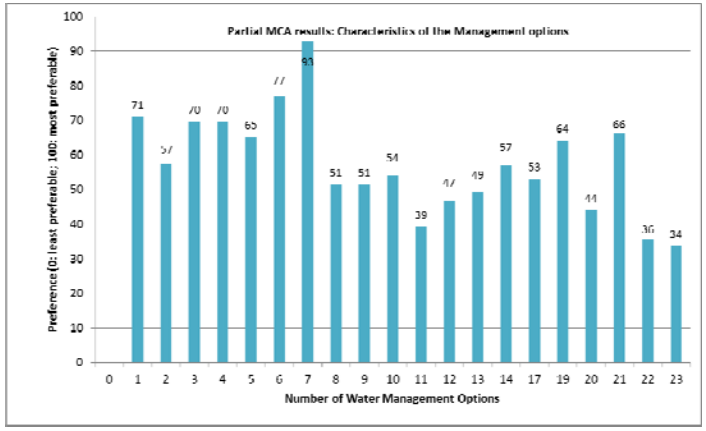
- Dynamic dam water management.
- Enforcement of the Code of Good Agricultural Practices.
- Restoration and maintenance of riverbed.

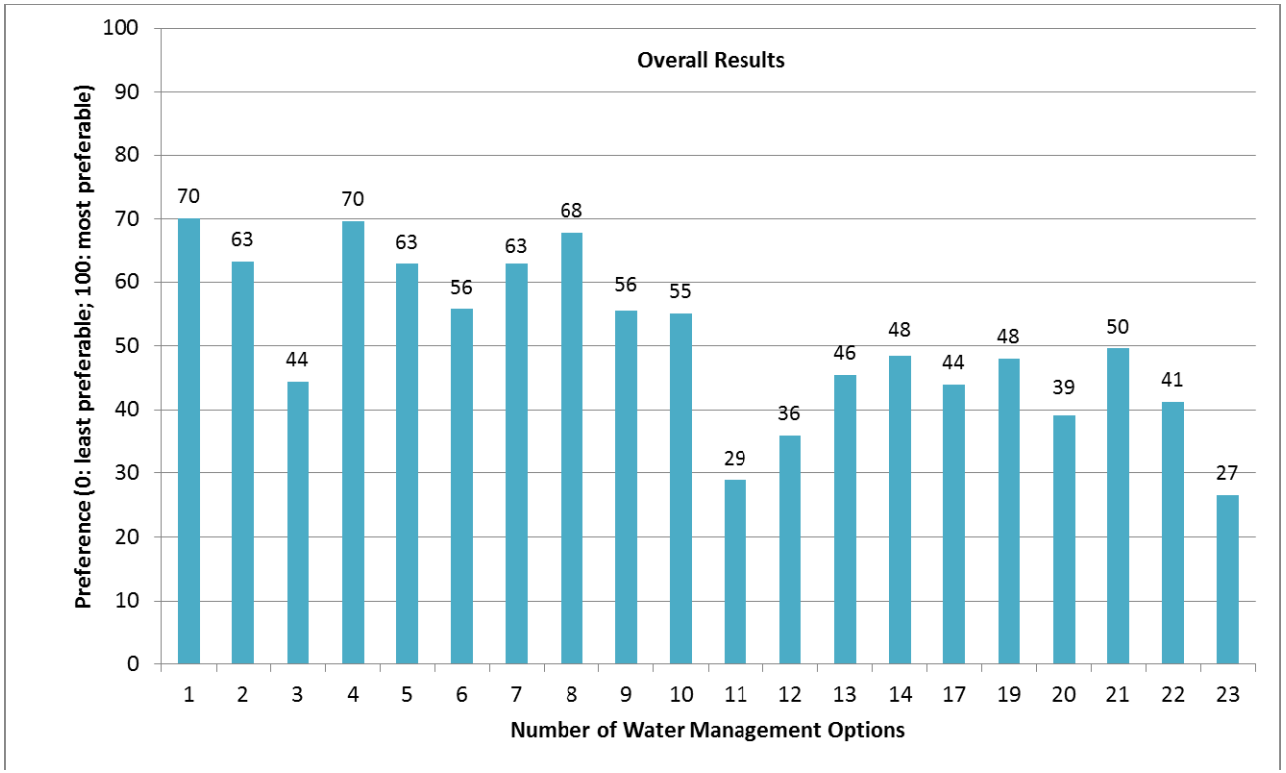
102 options in total!

Adaptation in the Mediterranean river basins

BeWater project: example of multi-criteria analysis

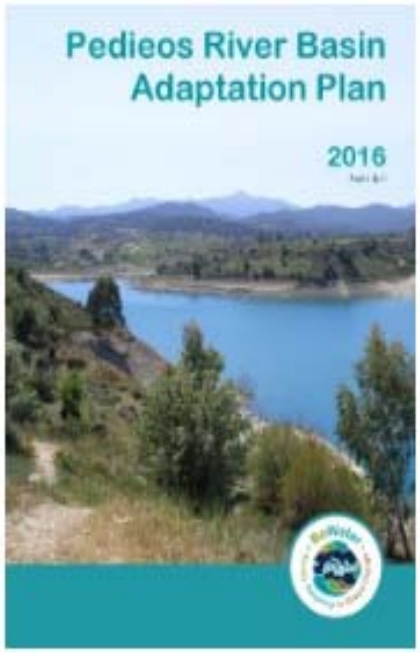


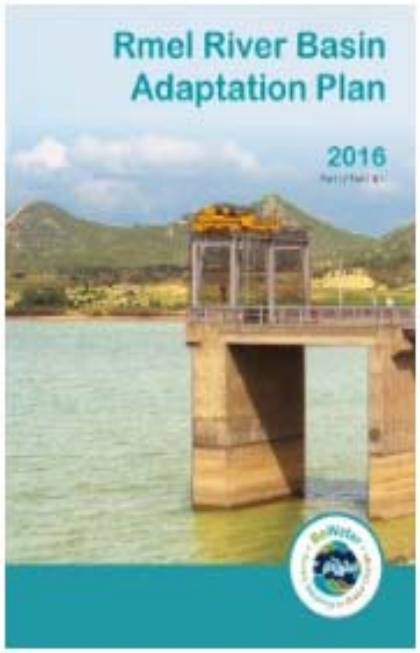


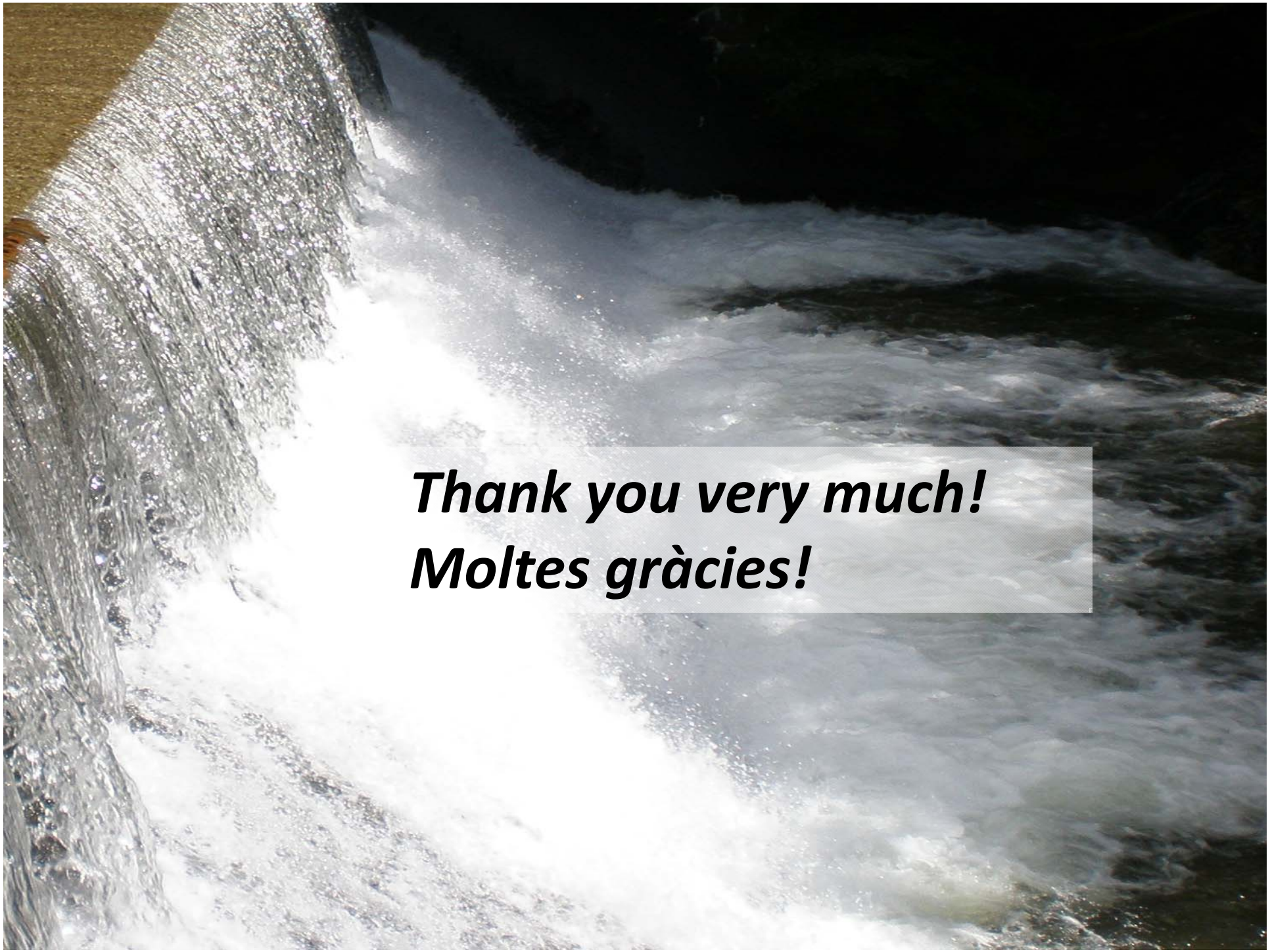


Adaptation in the Mediterranean river basins

BeWater project: 4 river basin adaptation plans






Thank you very much!
Moltes gràcies!