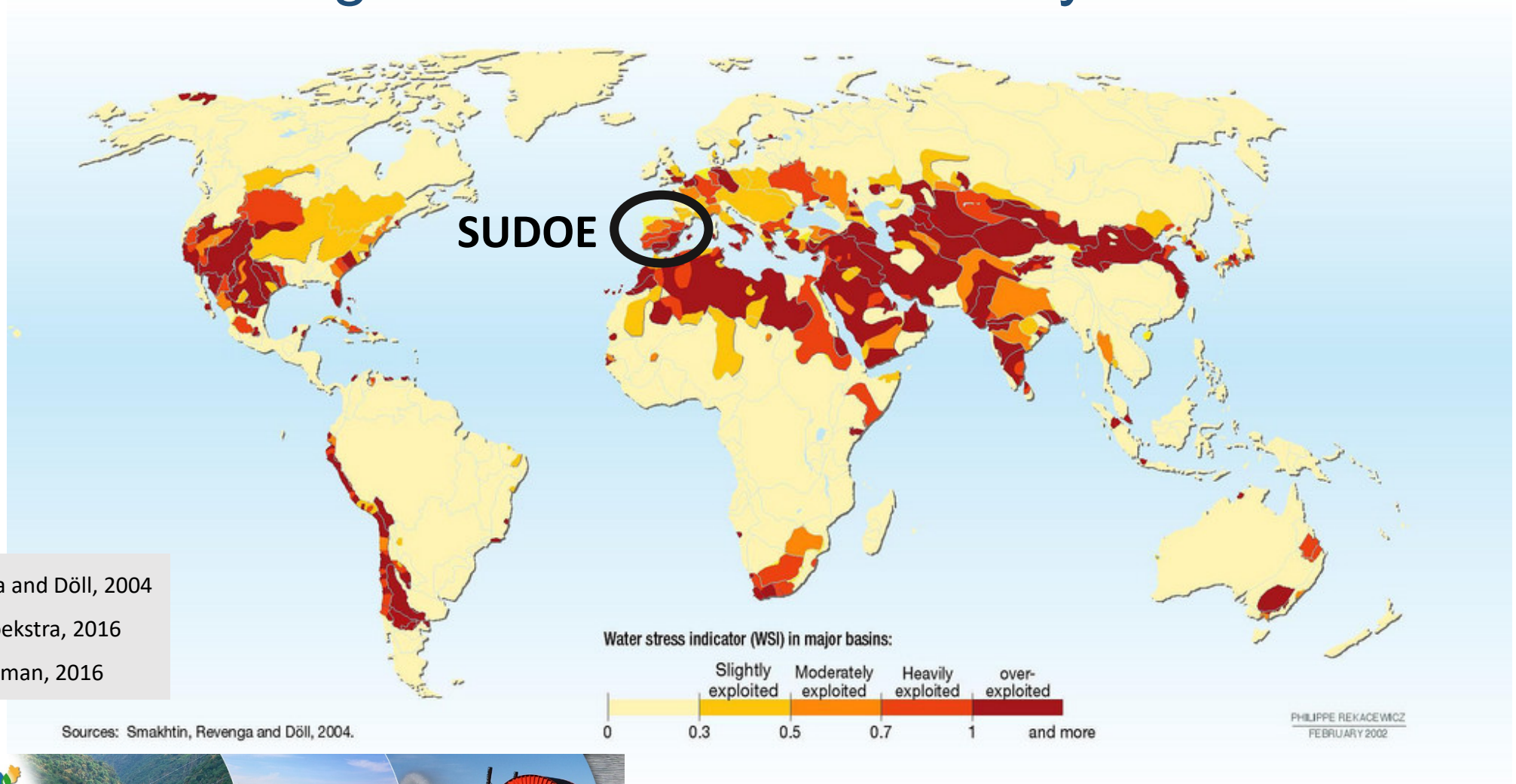
Using SWAT modeling to quantify water regulation functions in South-Western Europe watersheds

Roxelane Cakir [a]*, Mélanie Raimonet [a], Sabine Sauvage [a], Maite Meaurio[b], Juan Luis Lechuga Crespo[b,c], Lorea Flores[c], Laure Rosset [a], Magali Gerino [a], José Miguel Sánchez-Pérez [a]

19th September 2018, 2:40pm

[a] ECOLAB, Université de Toulouse, CNRS, INPT, UPS, Toulouse, France
[b] Hydrogeology and Environment Group, Science and Technology Faculty, University of the Basque Country UPV/EHU, 48940 Leioa, Basque Country, Spain
[c] DESTINO, Departamento de Física Aplicada de la Universidad de Cádiz, Albistur 75 B, 31770, Lesaka, Navarra , Spain
Contact: roxelane.cakir@univ-tlse3.fr

The world's major river basins differ in their degree of freshwater-scarcity stress



Smakthin, Revenga and Döll, 2004

Mekonnen and Hoekstra, 2016

Wang and Zimmerman, 2016

Interreg Sudoe

Aguamod

Development of a water resource management platform during low water periods in the SUDOE region

Talk of Dr. Sánchez-Pérez, session I1, Friday @12am

Increase of freshwater-scarcity stress

Impact on water quality *(nature contribution)*

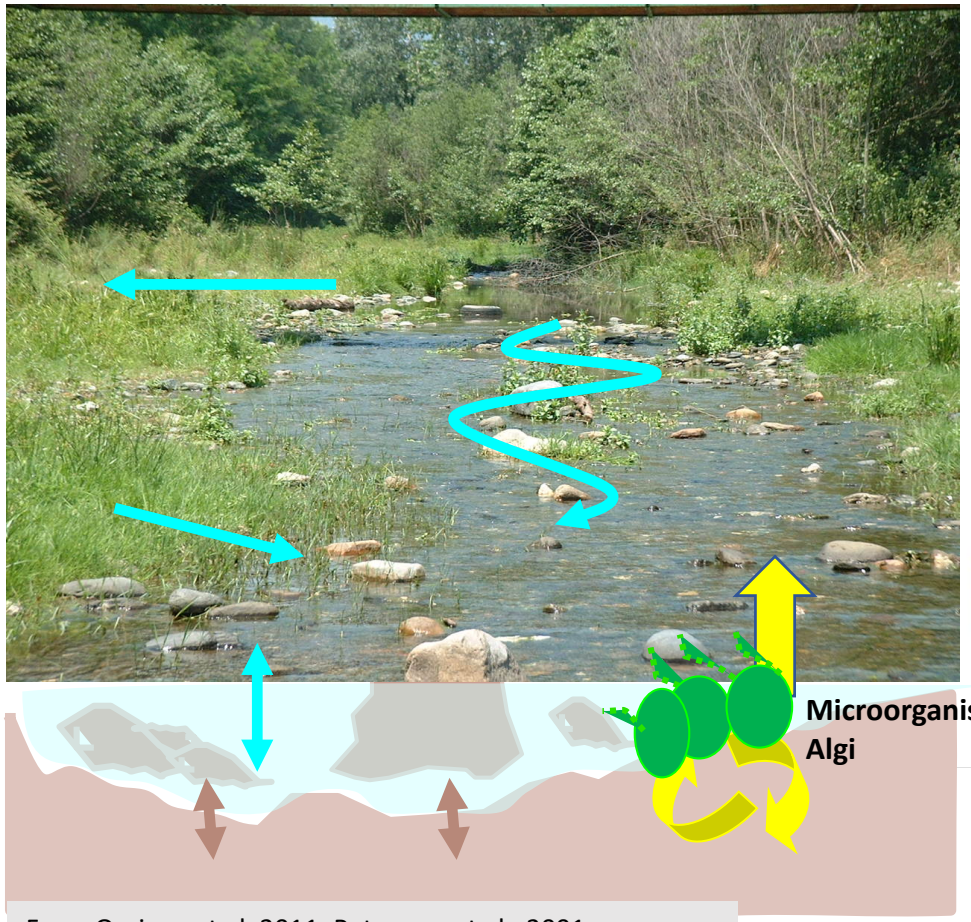
- Discharge
  - Romero et al., 2013
  - 
- Species mobility
  - Vannote et al., 1980
  - Northcote, 1998
  - 
- Environment
  - Banerjee et al., 2013
  - 
- Quality (dilution)
  - Sauvage et al., 2018
  - 

What about the ecological functions of water regulation?

Ecological function = group of physical/biological/biogeochemical processes

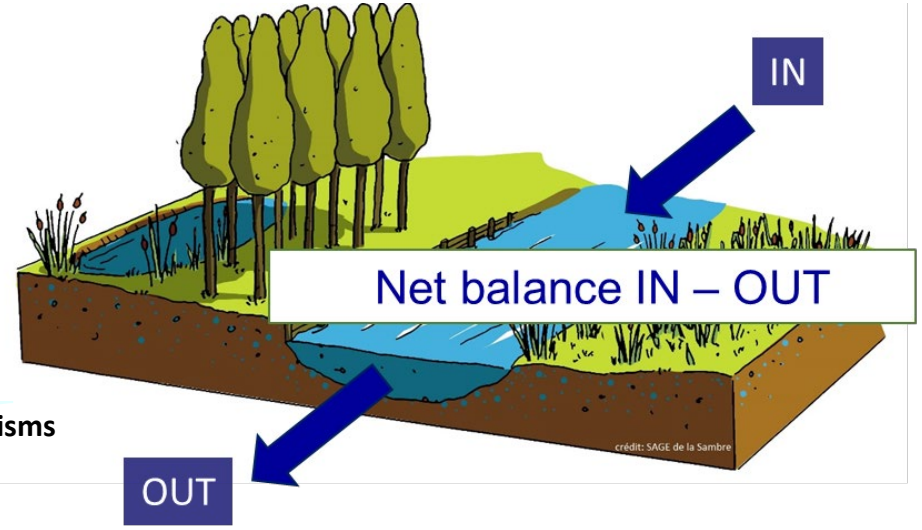
Nature contribution i.e. ecosystem services

Fisher et al. 2009
Momblanch et al., 2009
Francesconi et al., 2016



From Oraison et al, 2011, Peterson et al., 2001

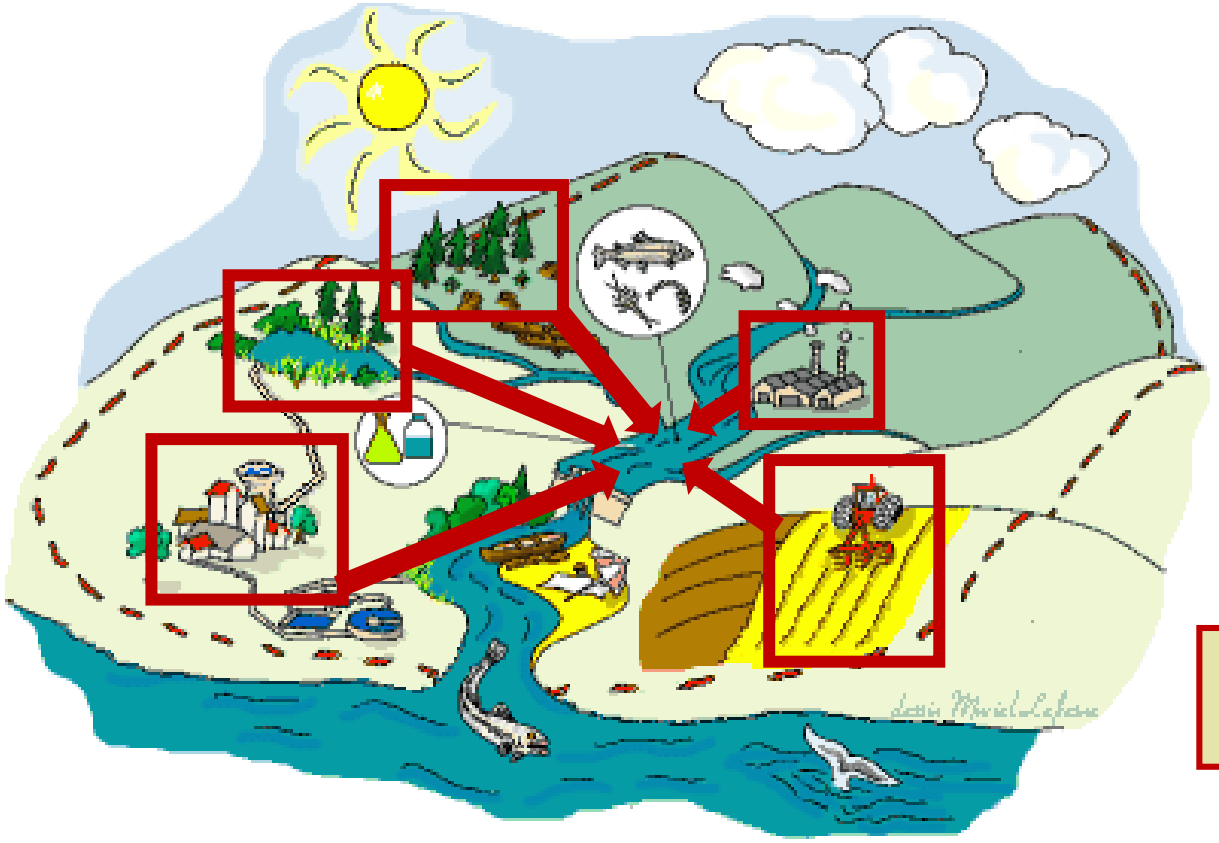
Ecological Functions of water regulation



~~Sediment release~~
Nitrate production

~~Sediment retention~~
Nitrate removal

How are ecological functions evolving along the watershed?

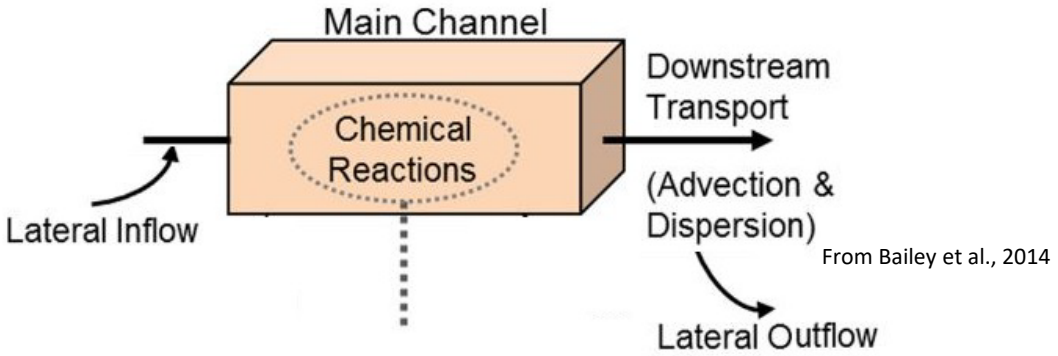


- Hot spots and Hot moments
- Understand ecological functions in differents compartments of the river
- Land use effects

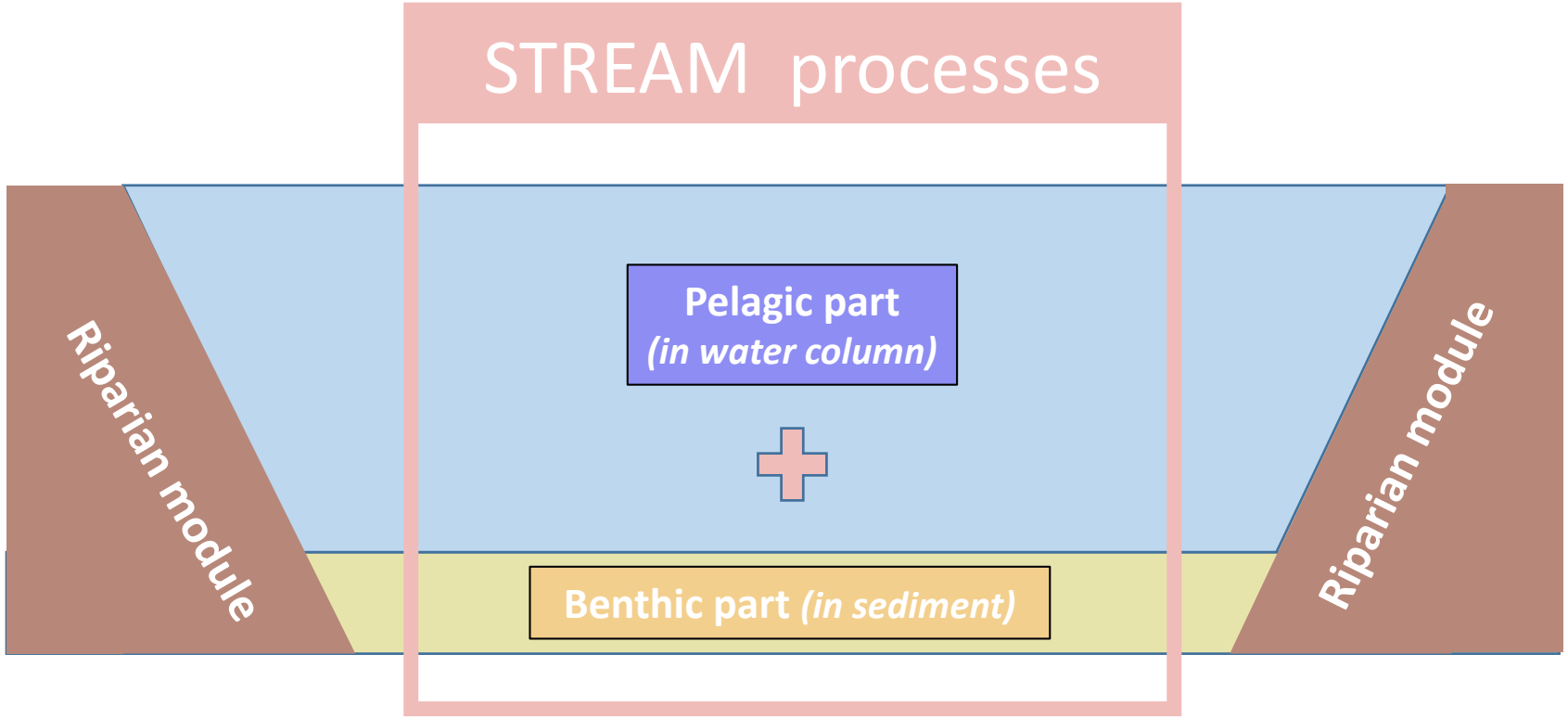
Perfect tool: MODELING

Sauvage et al., 2018
Cakir et al. (in progress)

Methodology:
SWAT processes in-stream

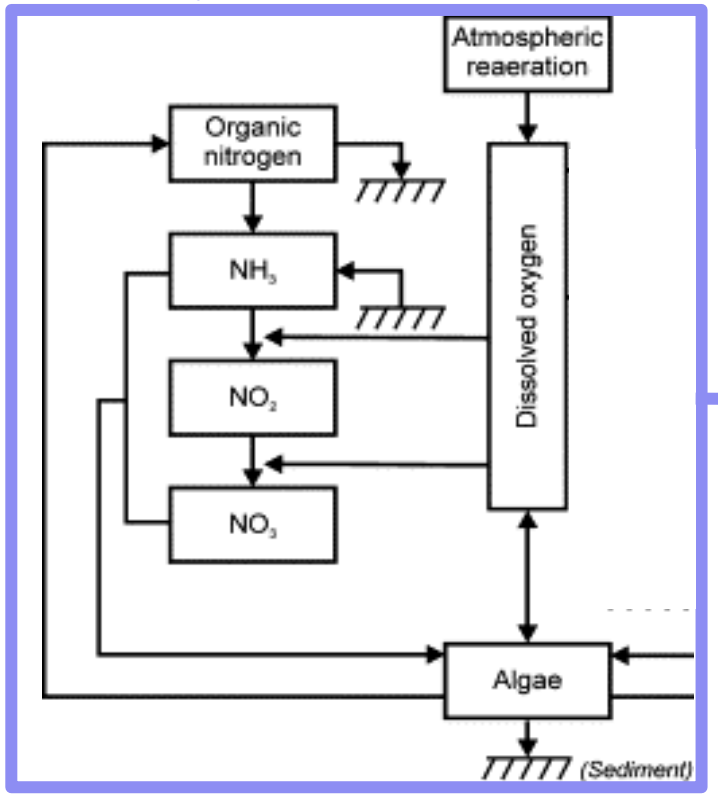


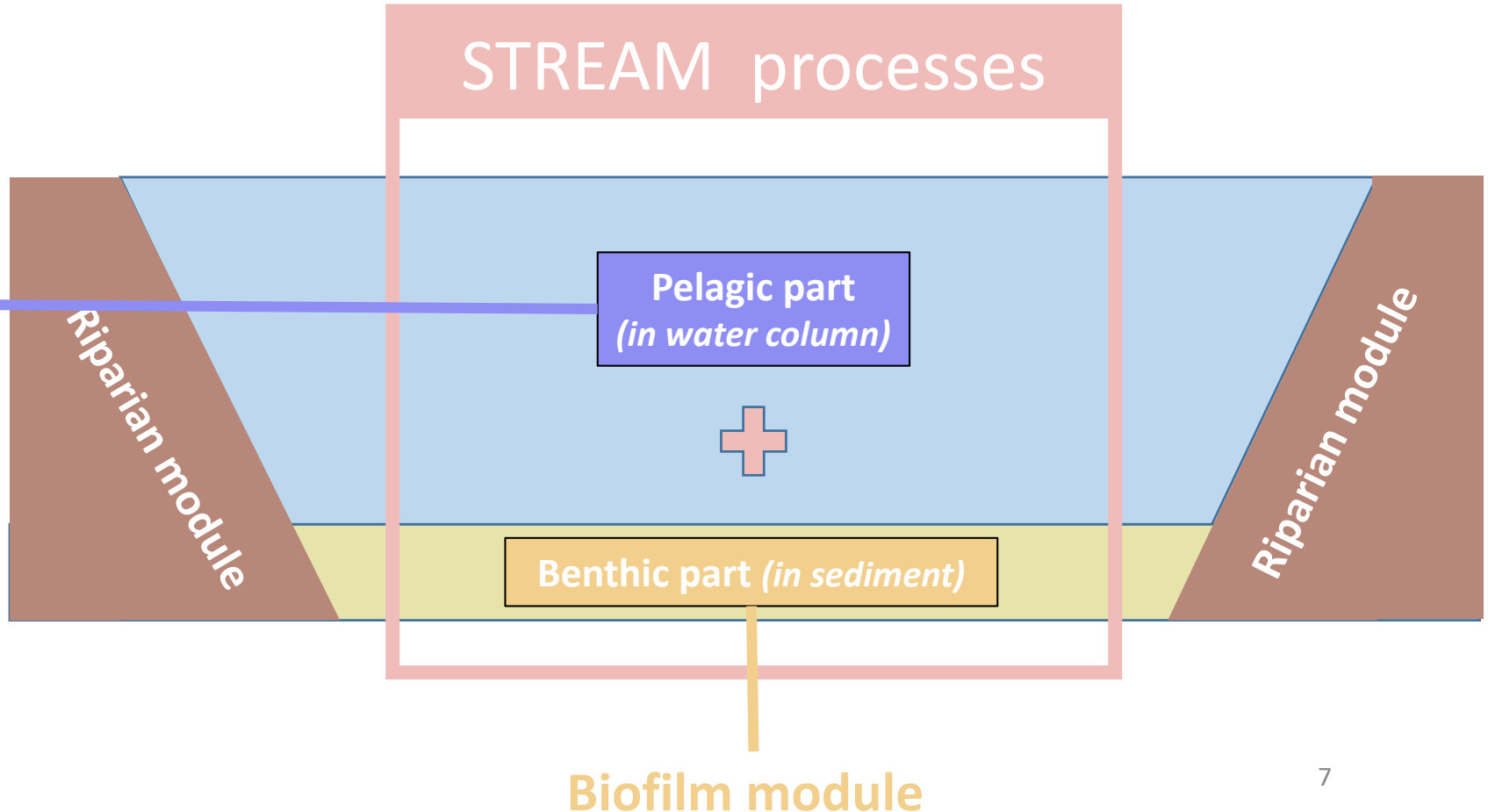
From Bailey et al., 2014



Methodology:
SWAT processes in-stream

QUAL2E module





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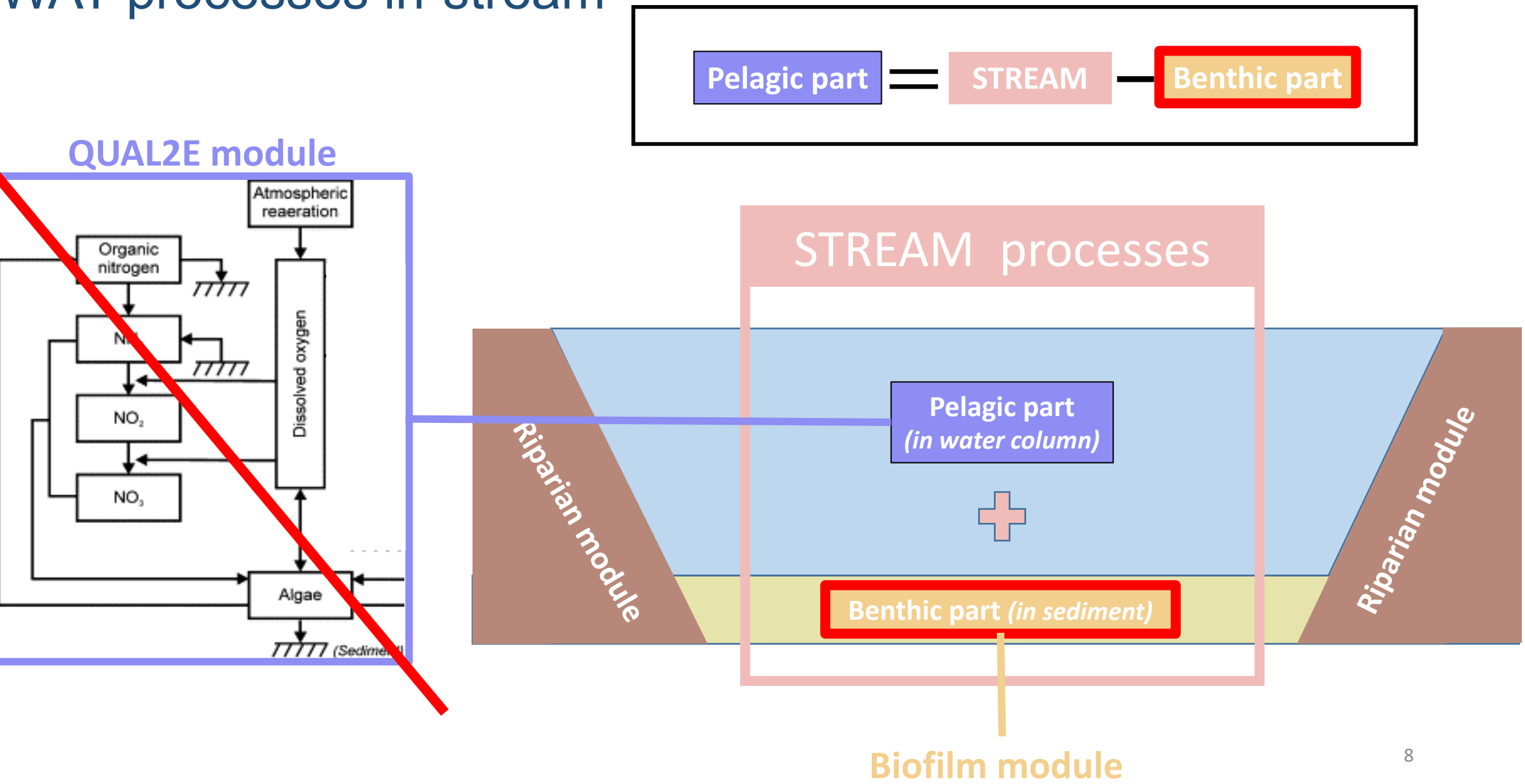
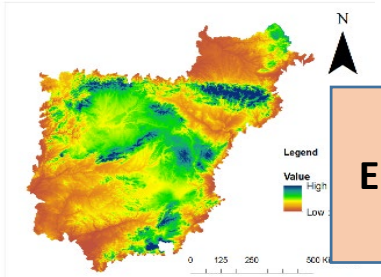
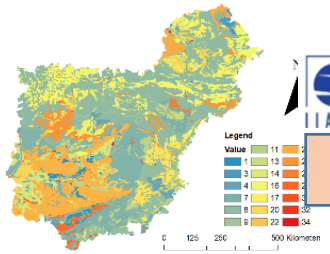


The conceptualization in SWAT of the SUDOE

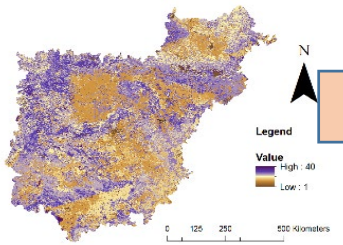
- Subbasin ~ Streames: **263**
- HRUs: 12 834
- Resulting areas: 633 000 km^2



Digital Elevation Model



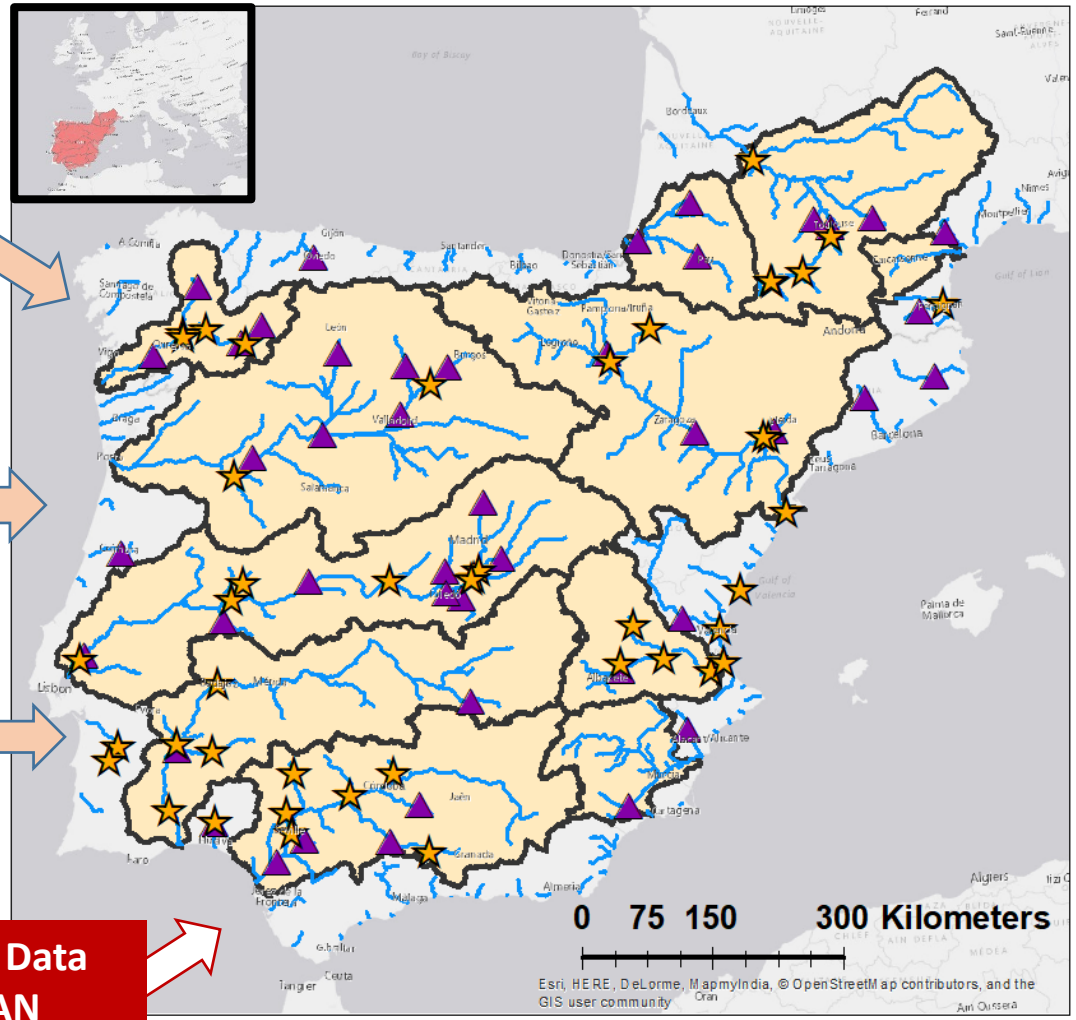
Soils



Land use

Precipitation, Temperature, Wind speed, Solar radiation Relative humidity

Climate Data MESAN



N

Human activities:

- 44 dams
- 44 wastewater treatment plants

Sampling stations

- 19 hydrological stations
- 28 physical-chemical stations

Legend

Type

- Treatment plant
- Dams
- Outlets
- Streams
- Main watersheds

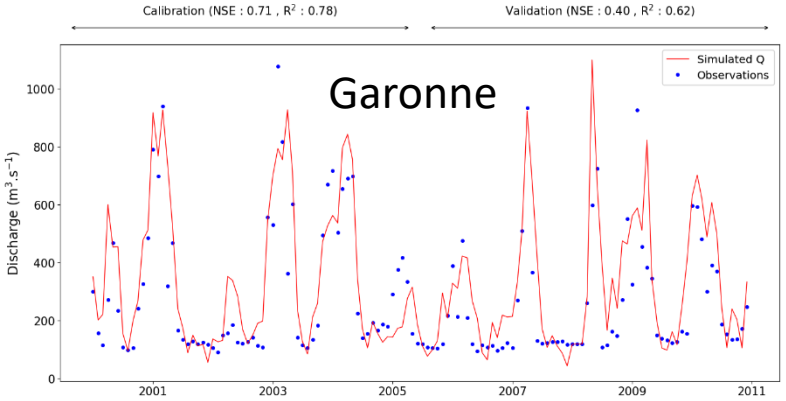
Hydrology validation/calibration

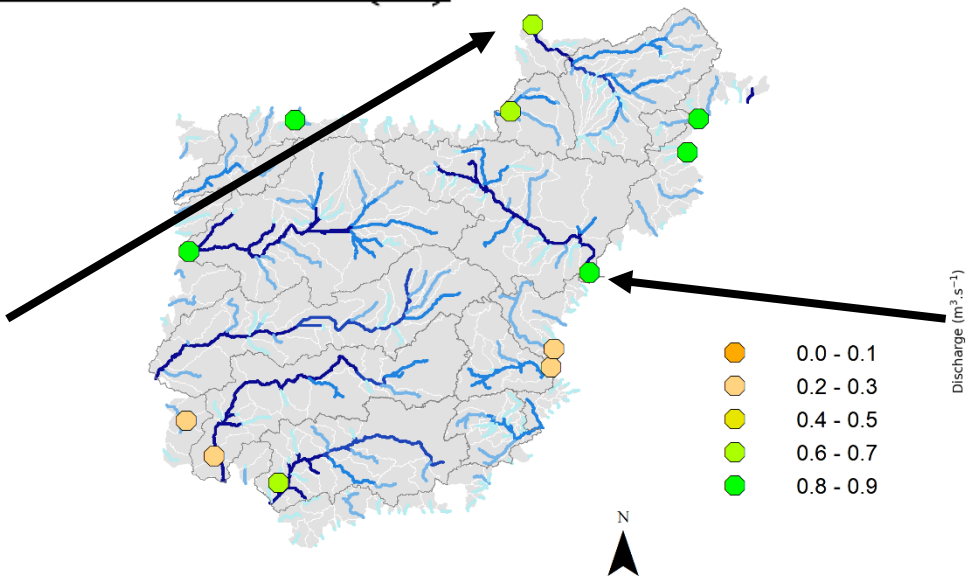
Monthly scale

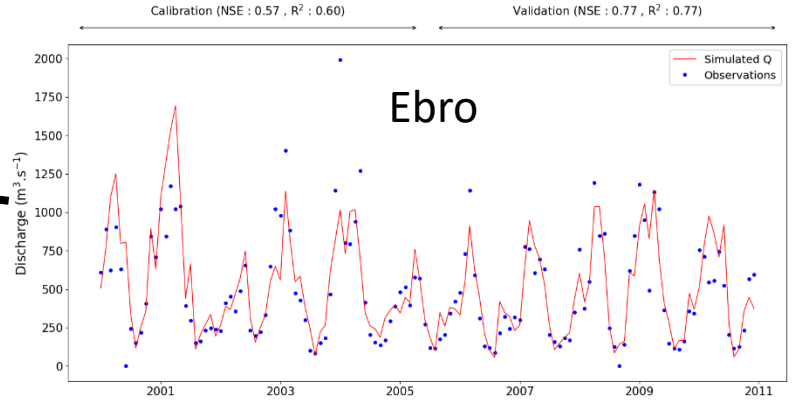
Calibration 2000/05

Validation 2006/10

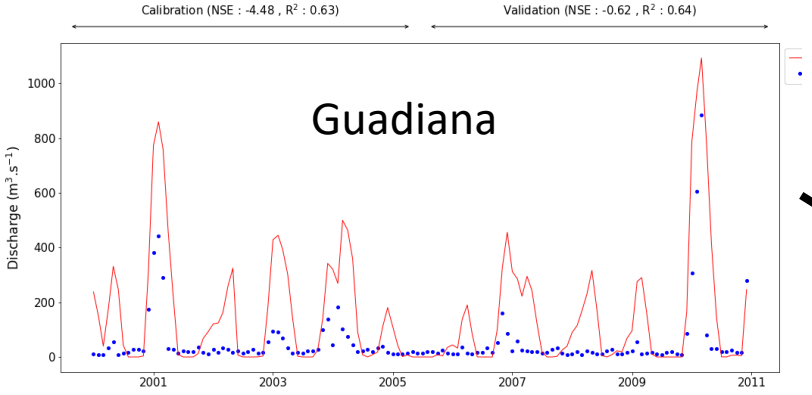
Correlation coefficient (R^2)

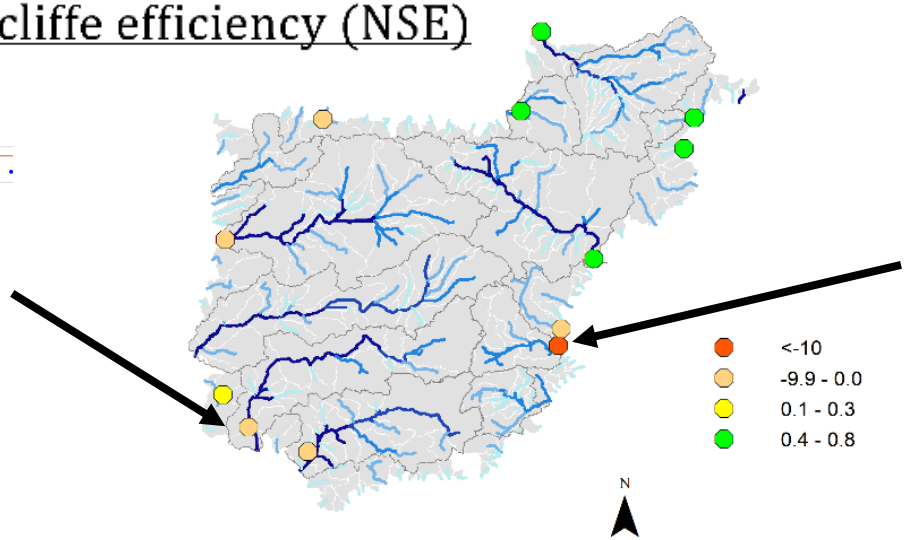


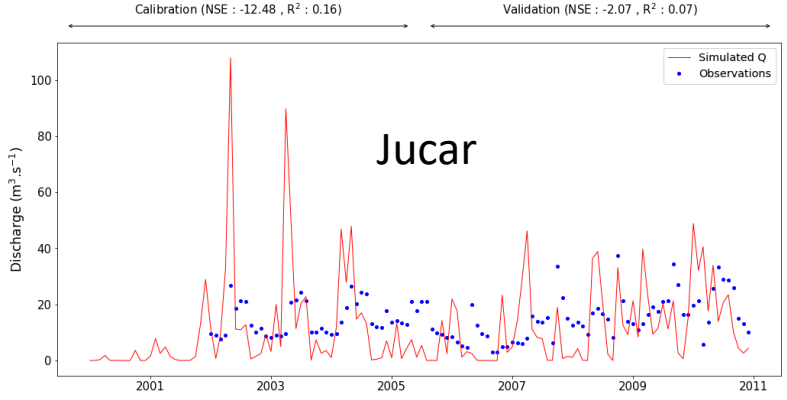




Nash-Sutcliffe efficiency (NSE)



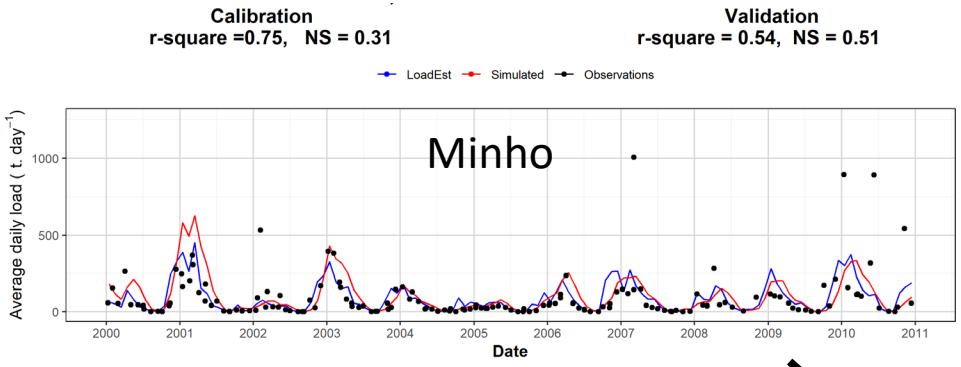


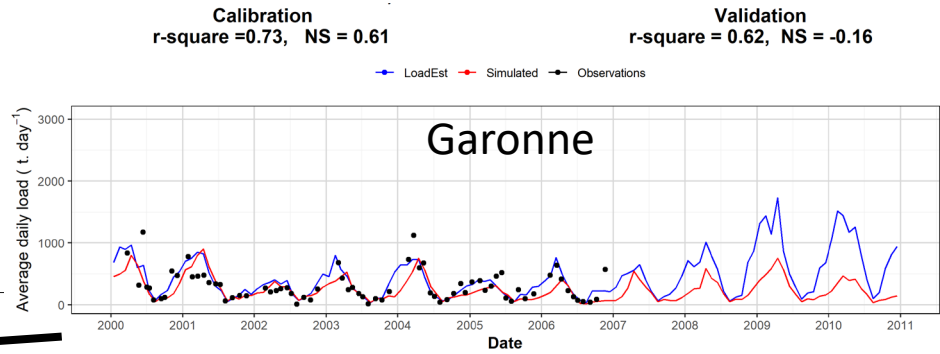


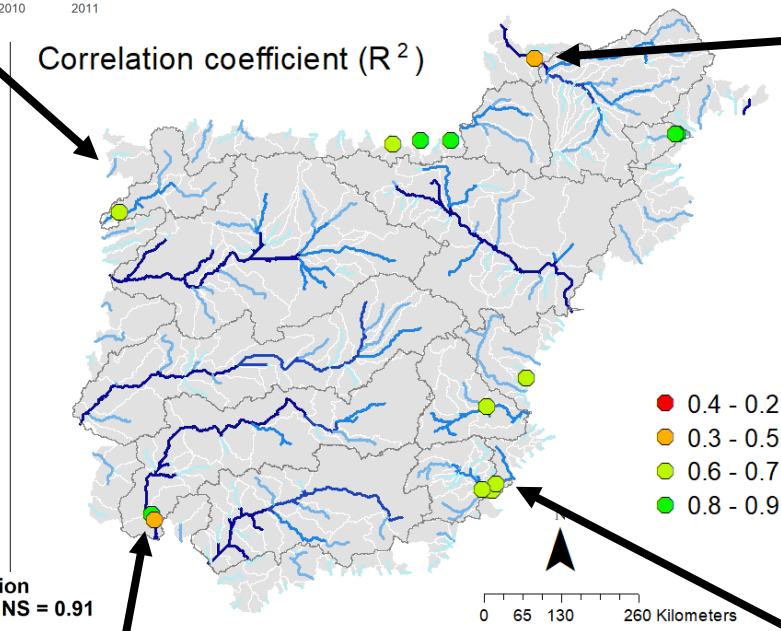
Nitrate calibration/validation

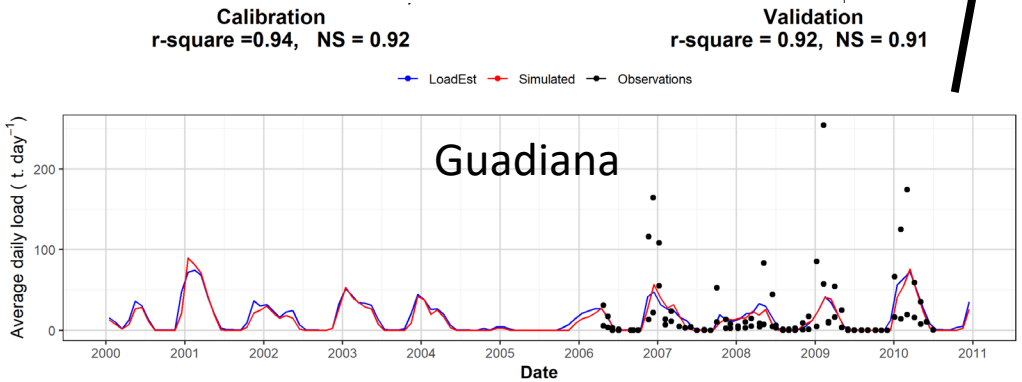
2000/05

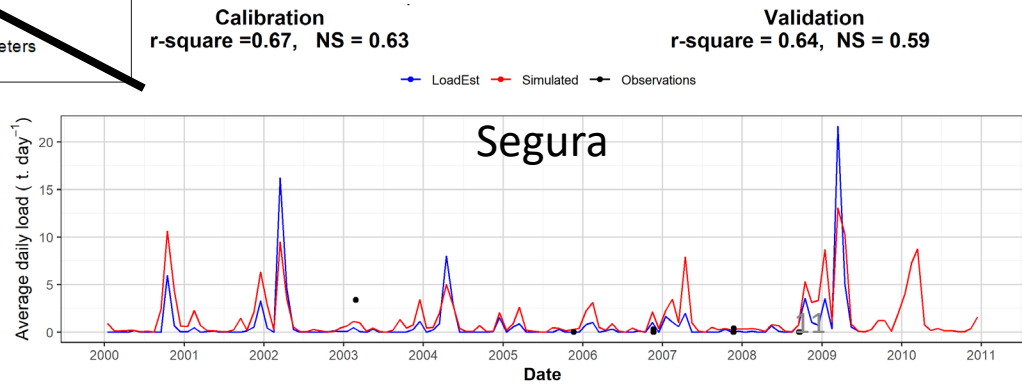
2006/10



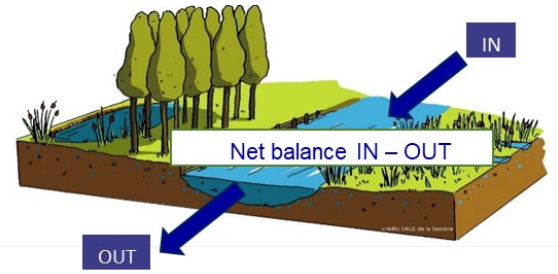








Preliminary results: Seasonal variation

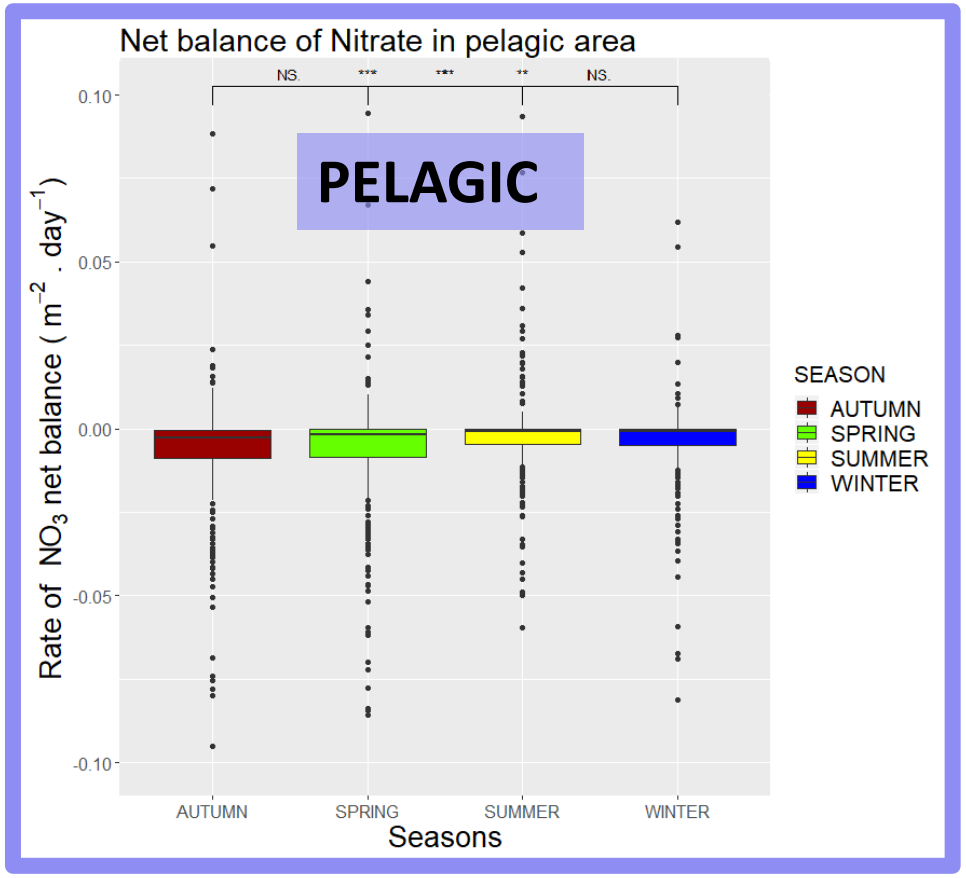


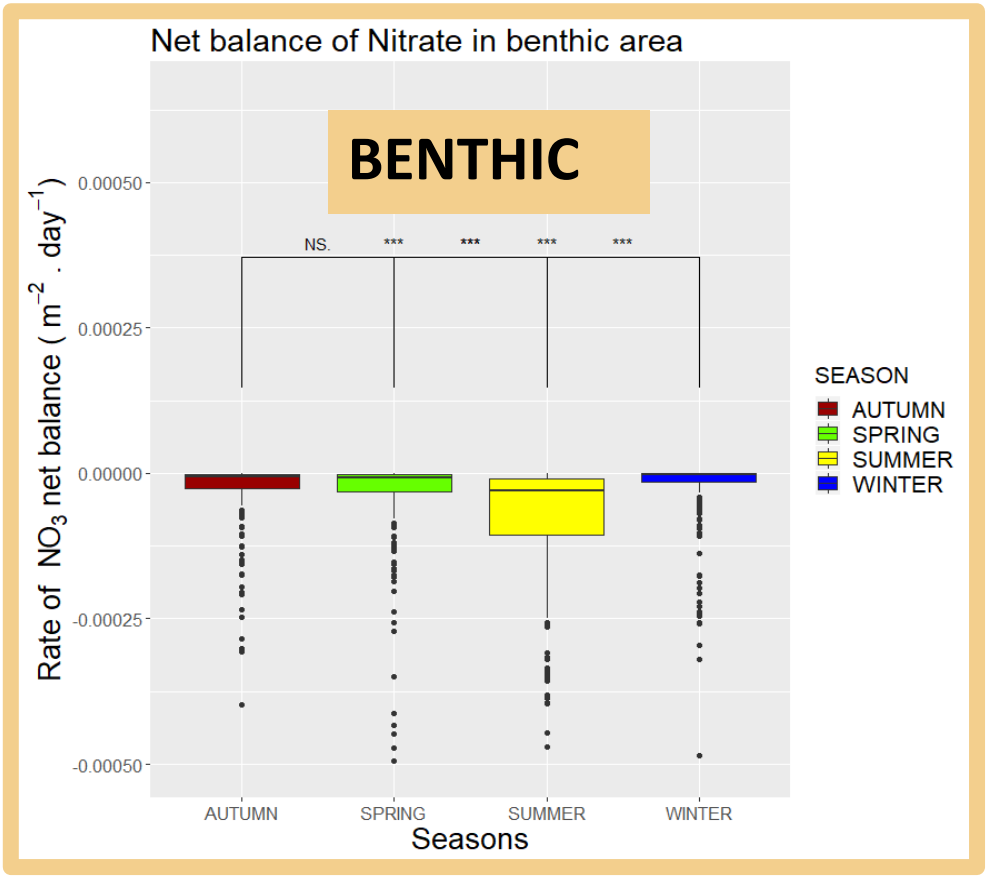
STREAM processes

Pelagic part
(in water column)

Production

Removal

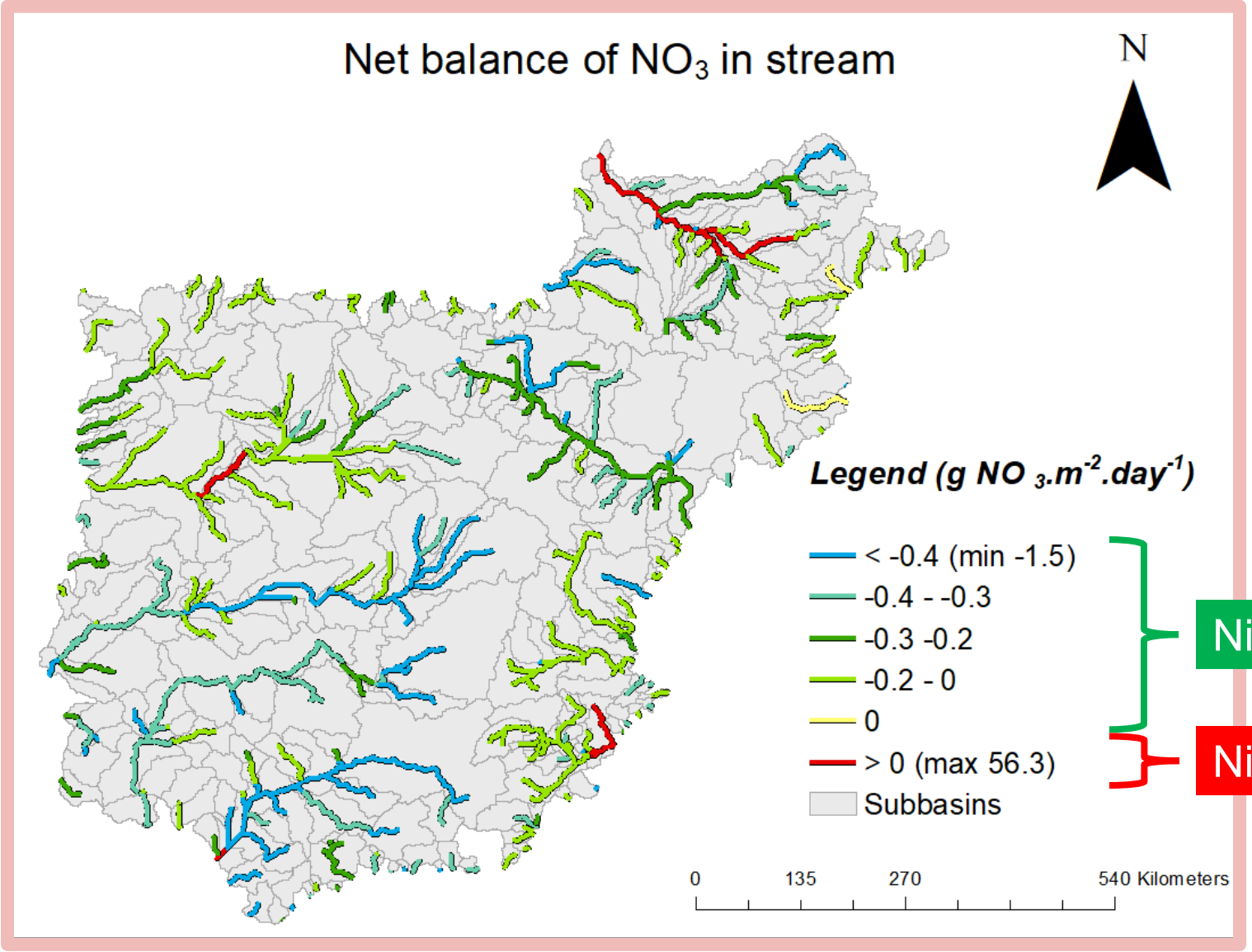




- Benthic part is influenced by seasons
- Retention higher during Summer

Preliminary results: Spatial variation

Interannual net balance of NO_3 in stream



STREAM processes

Pelagic part *(in water column)*

+

Benthic part *(in sediment)*

Highest production and removal in main streams

Nitrate removal

Nitrate production

Preliminary results: Spatial variation

Net balance of NO_3 by compartments

STREAM processes

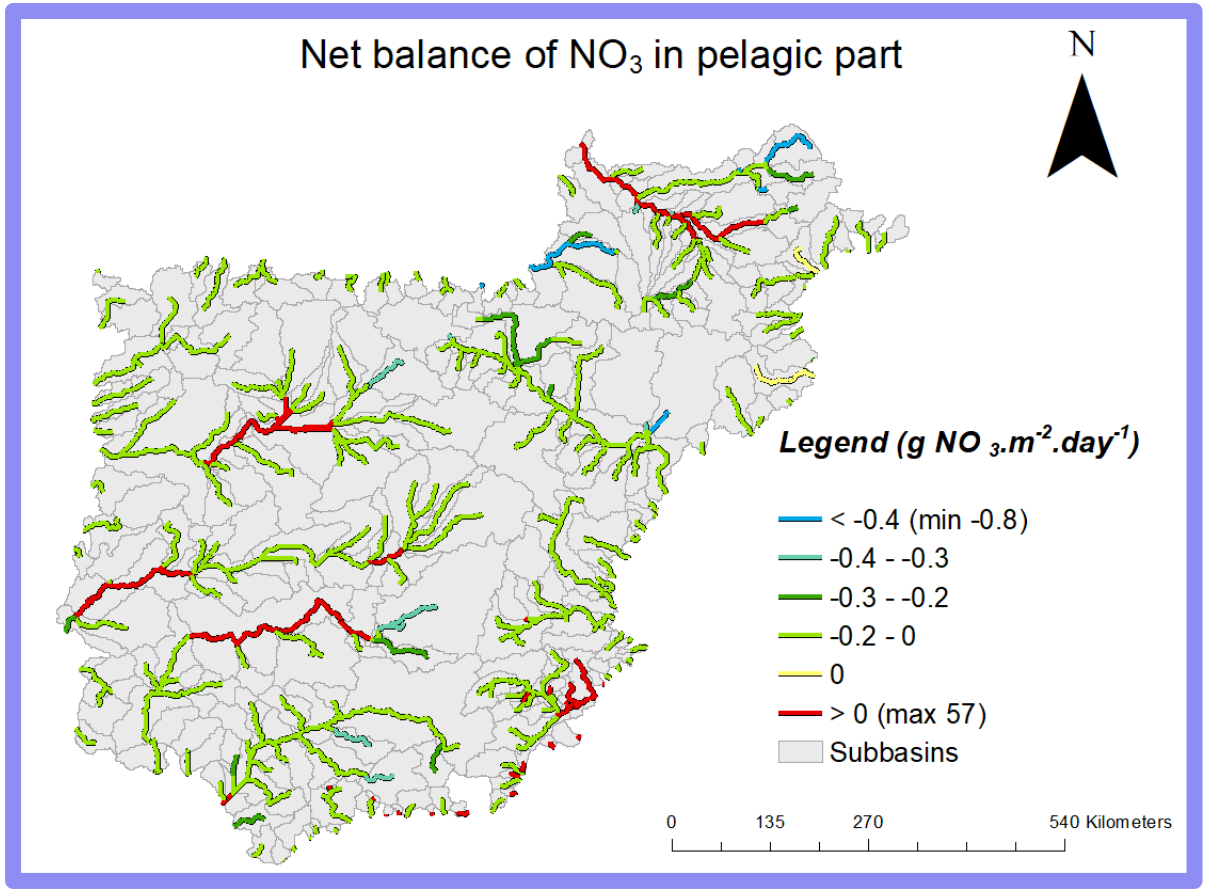
Pelagic part *(in water column)*

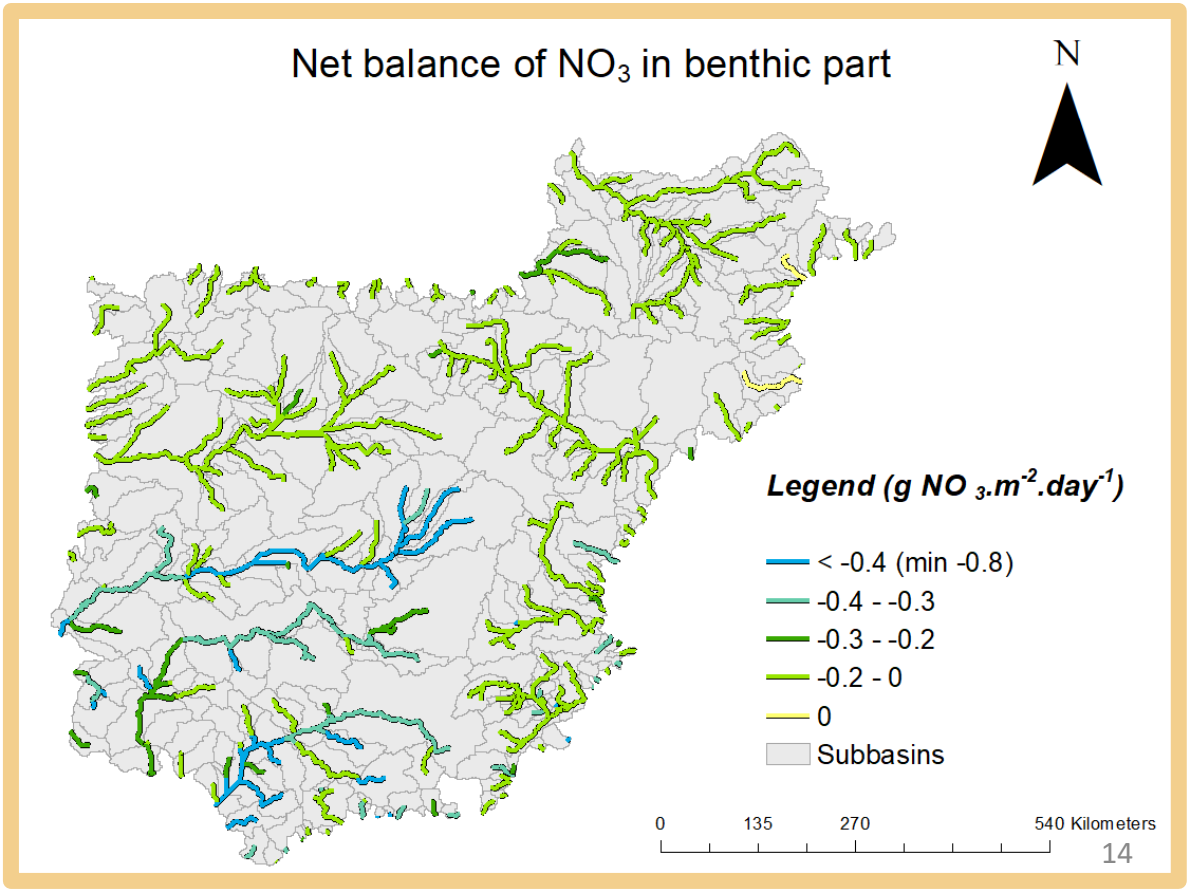
+

Pelagic part: Production ++

Removal +

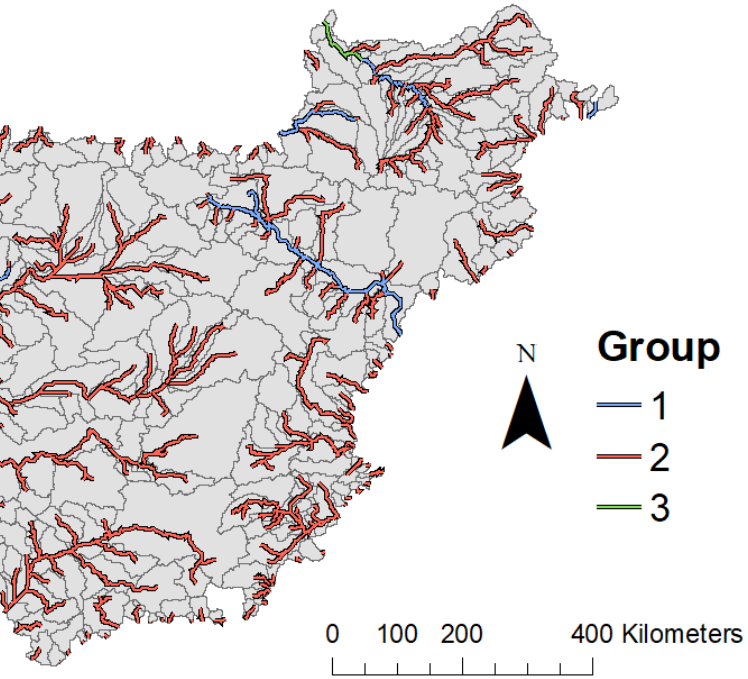
Benthic part: Removal +++

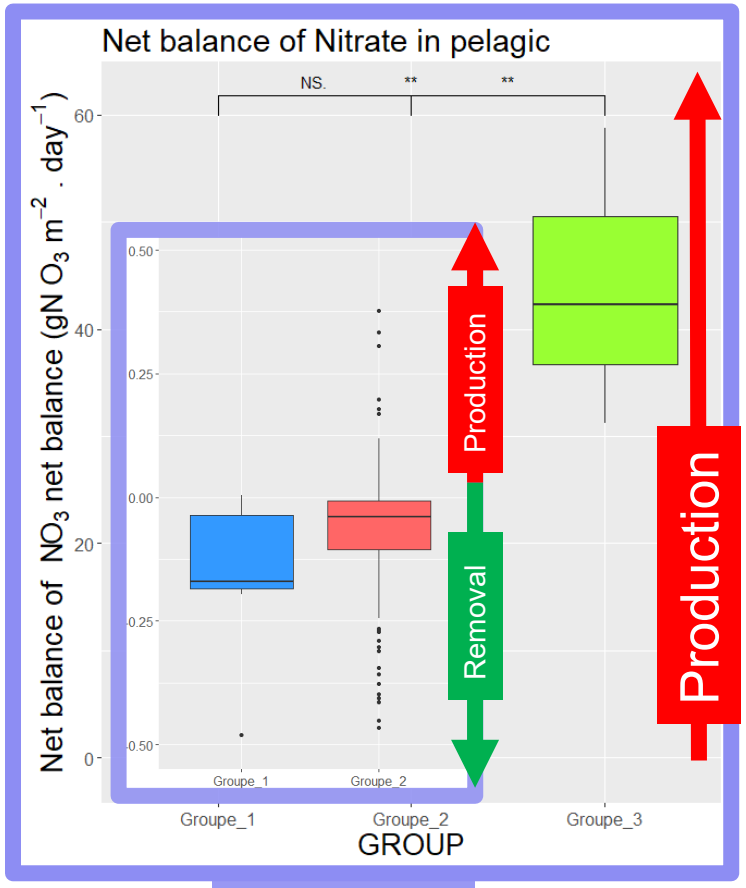




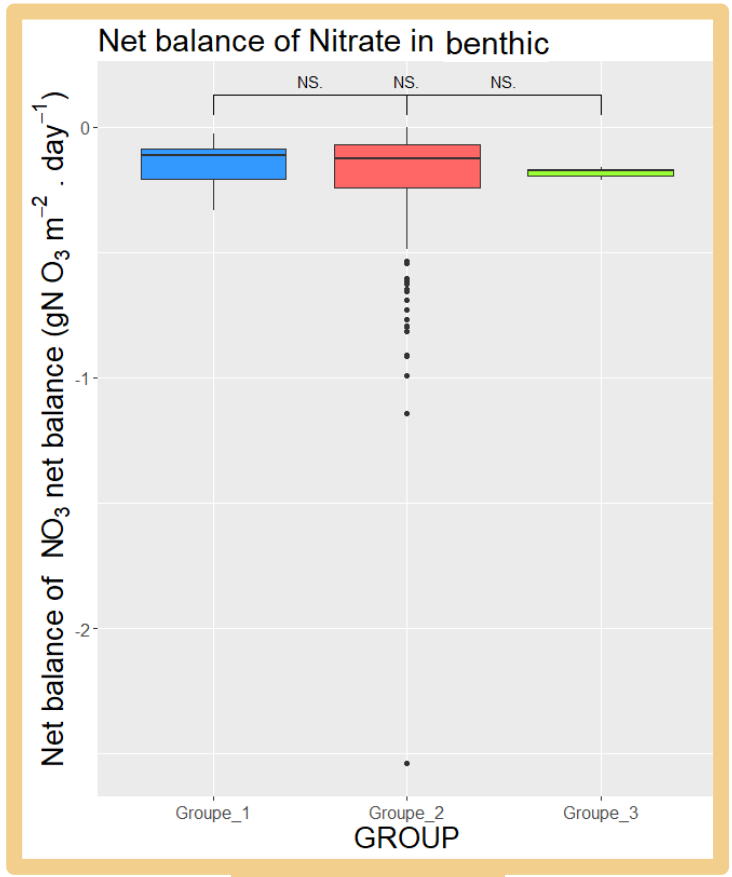
Preliminary results: Spatial variation

Spatial Analysis clustering





PELAGIC



BENTHIC

Groupe_1
Groupe_2
Groupe_3

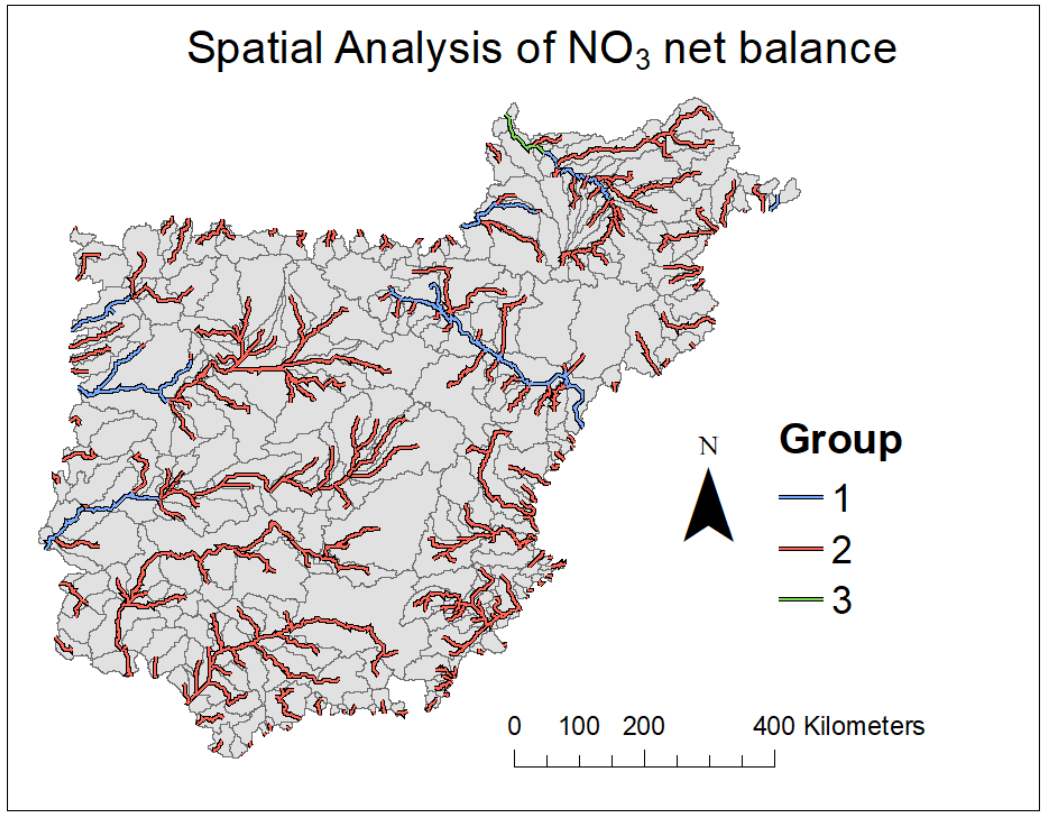
Pelagic defined groups

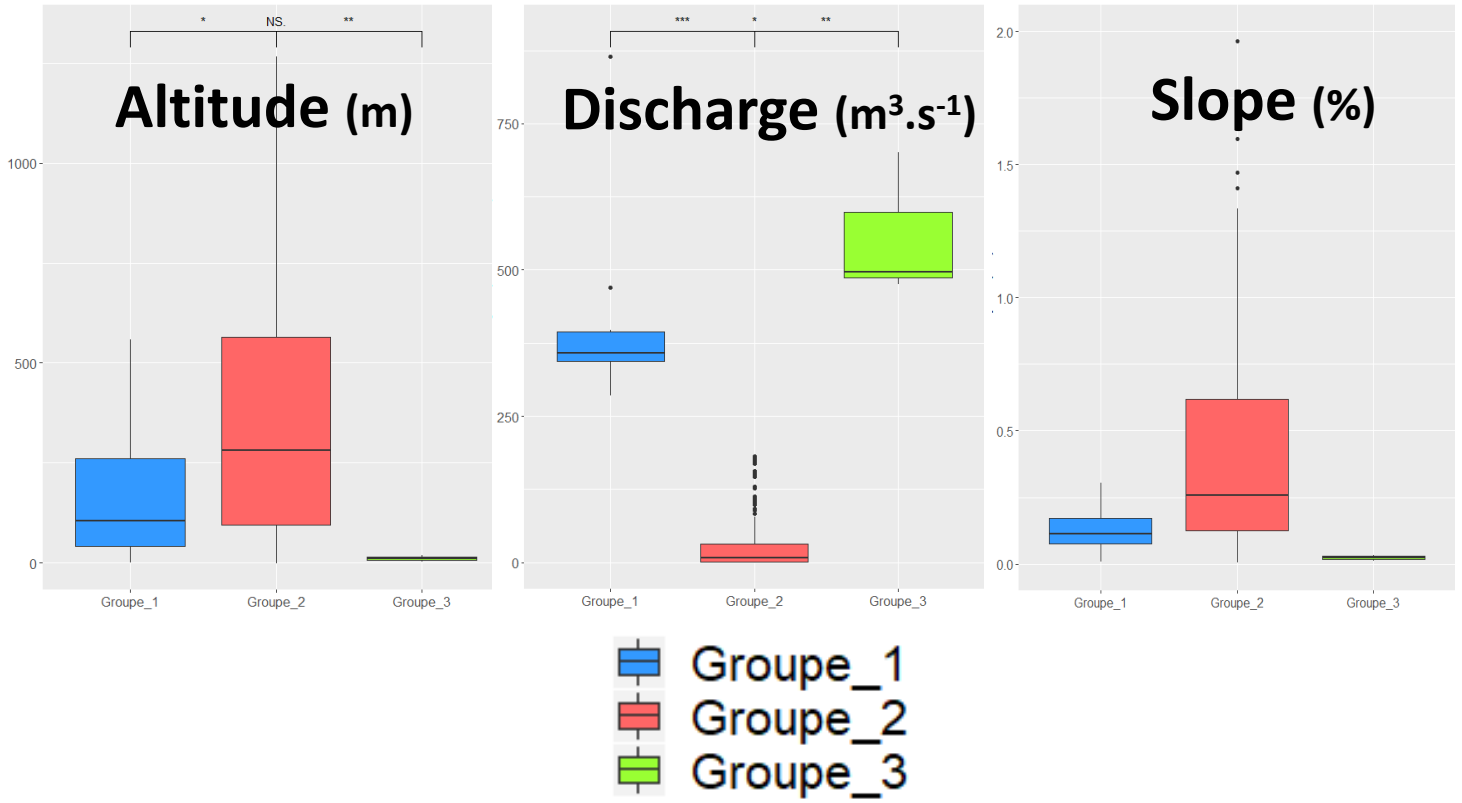
Group 1 & 2: Removal

Group 3 : Production

Preliminary results: Spatial variation

Control parameters of pelagic part





Production Area:

- Small altitude
- High discharge
- Low slope

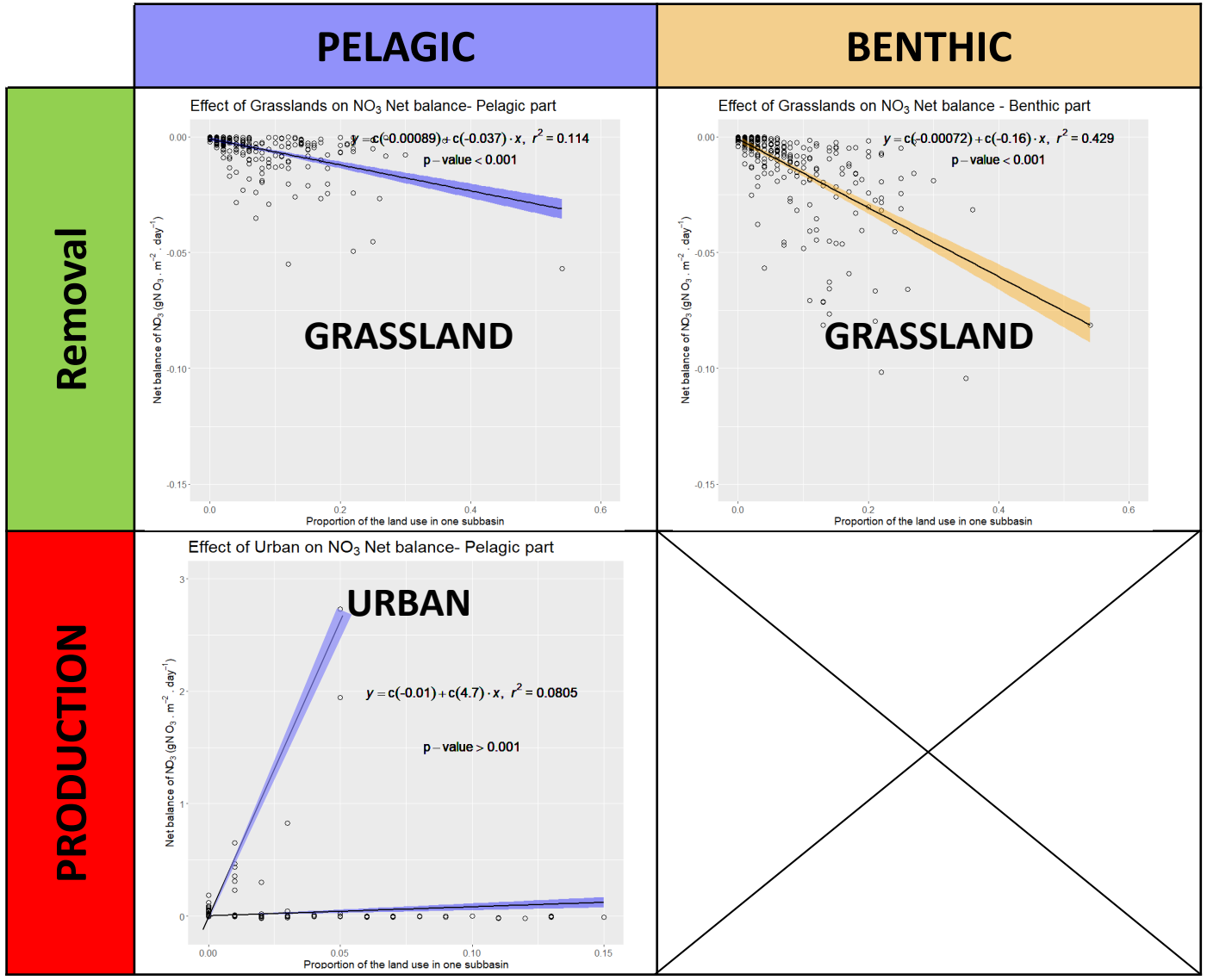
Removal area:

- Lower discharge
- higher slope

Preliminary results: Spatial variation

Land use impacts

Land Use	PELAGIC	BENTHIC
Agriculture	++	++
Agroforestry	+	++
Bare Rocks	+	+
Forest	+	++
Grasslands	+	++
Pasture	+	+
Urban	+++	+



To go further:

Ecological function = group of **physical**/biological/biogeochemical processes

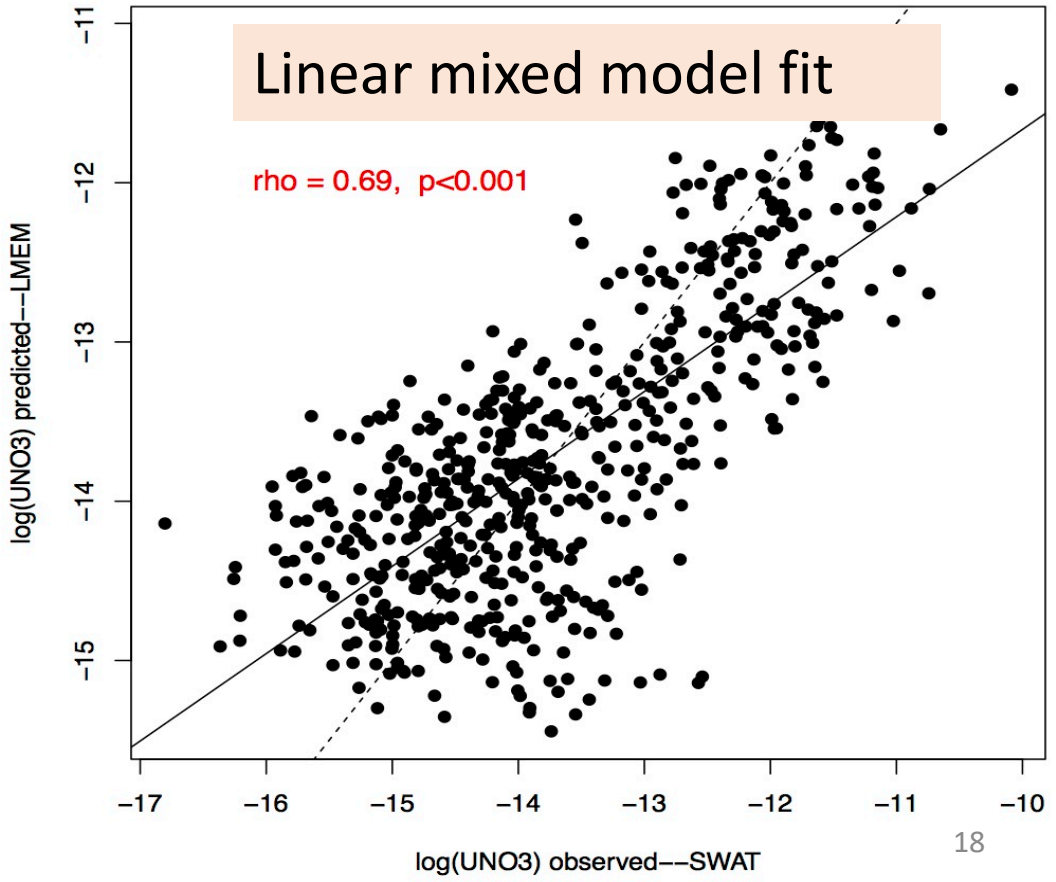
Relationships between Net balance of NO3 and indicators?

$$Net\ balance\ of\ NO_3 = \mathrm{f}(\boldsymbol{Slope, Altitude, Froude}, [NO_3], [PO_4], MPCE\ )$$

Froude :

$$Fr = \frac{v}{\sqrt{gh}}$$

with v : water velocity,
g : gravity acceleration,
h : water level



Dr. Flores et al., (in progress)

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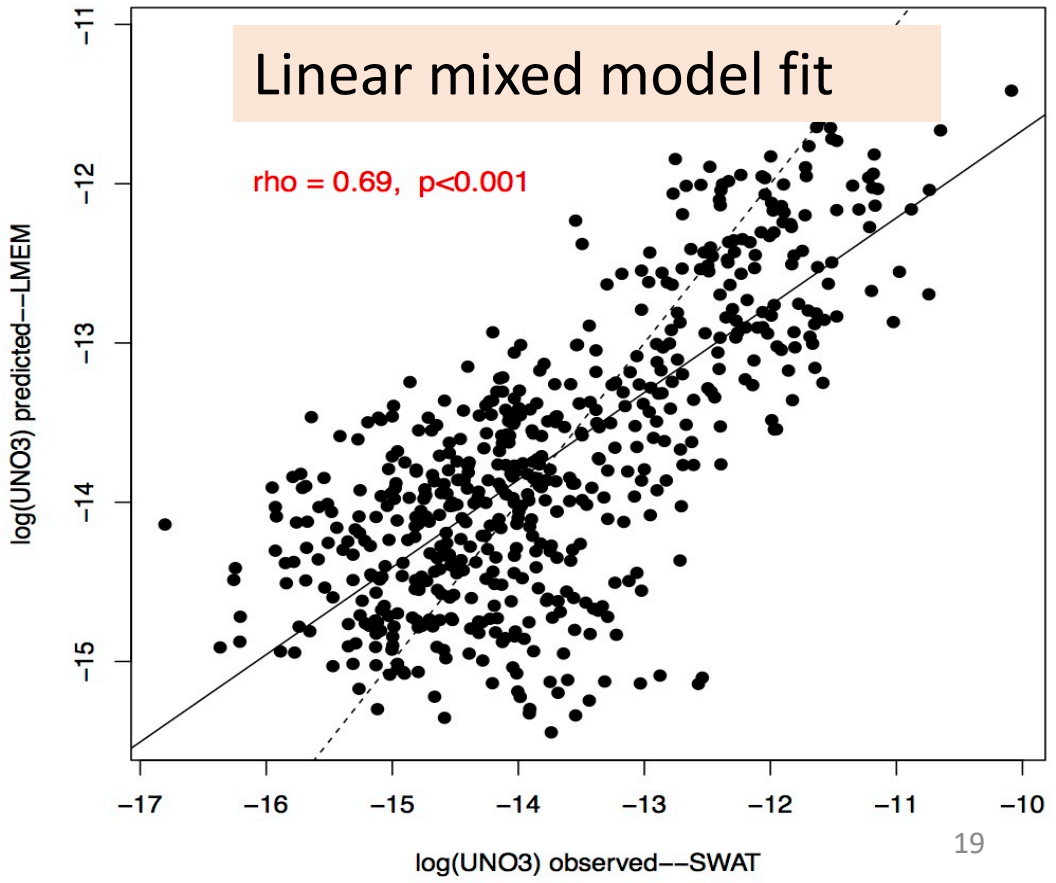

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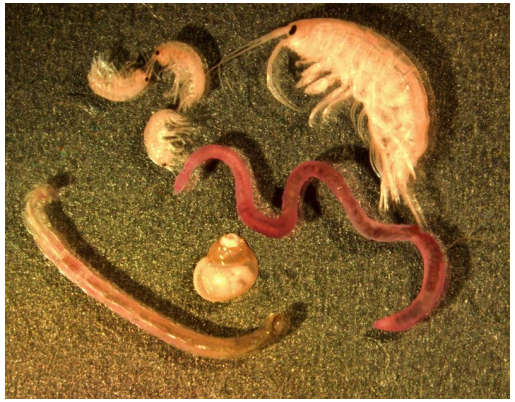
$$Net\ balance\ of\ NO_3 = \quad \mathrm{f}(Slope, Froude, Altitude, [NO_3], [PO_4], \boldsymbol{MPCE})$$

MPCE :
indicator based on the structure of the invertebrate community



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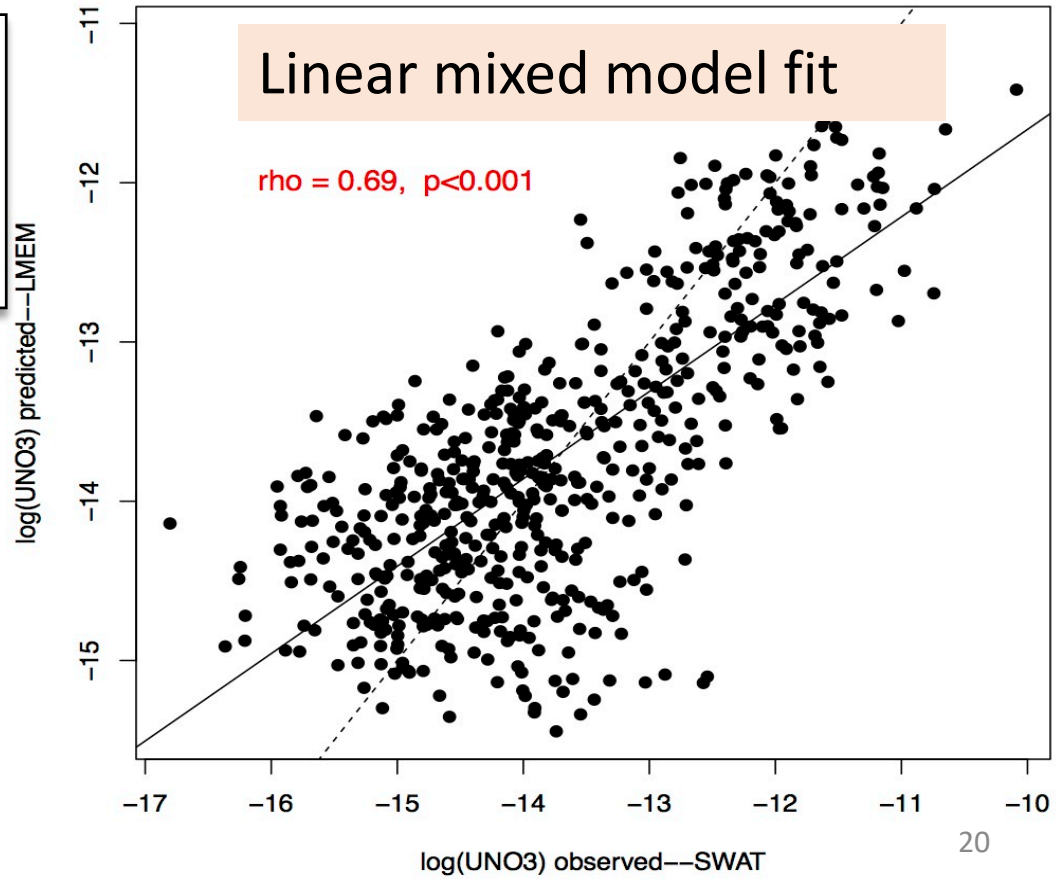

Conclusion

	Compartments		
	STREAM =	PELAGIC +	BENTHIC
Season effects			
Spatial effect			
Land Use effect			

Conclusion

Production

	Compartments		
	STREAM =	**PELAGIC** +	**BENTHIC**
Season effects		**NS**	
Spatial effect	**+ +**	**+ +**	**NS**
Land Use effect		Urban **++**	

Removal

	Compartments		
	STREAM =	**PELAGIC** +	**BENTHIC**
Season effects	**+ +** *(summer)*	**NS**	**+ +** *(summer)*
Spatial effect	**+**	**+**	**NS**
Land Use effect		Agriculture **+ +**	Grassland **+ +**

Perspectives

	Compartments		
	STREAM =	PELAGIC +	BENTHIC
Control factors - Physical - Biochemical - Biogical	*f(control factors)* Slope, Altitude, Froude, Q $[NO_3]$, $[PO_4]$ MPCE	*To be continued*	*To be continued*

- Modelling ecological functions thanks to control factors
- What about human impacts?
- What about climate change?

What about ecological functions under climate change?

Talk of Dr. Raimonet, today @5pm

Session C1: Climate Change Applications

Building D.2. 16

Interreg Sudoe

European Regional Development Fund

Aguamod

Development of a water resource management platform during low water periods in the SUDOE region

Thank you for your attention.