The W-EU demo site

Land-to-sea N cascade of the river basins

of the Atlantic façade

(with a focus on embedded sub-basins, Seine & Tagus R.)

Josette Garnier*, Alberto Sanz Cobena*, Luis Lassaletta, Gilles Billen

** coord.*

INMS-5 Meeting

Participants

FRANCE

SU (Sorbonne Univ. *ex Pierre and Marie Curie Univ,* **Paris)**

- Josette Garnier, coord.
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- Vincent Thieu

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- Victoria Bermejo

PORTUGAL

Universidade de Lisboa (Instituto Superior de Agronomia)

- Cláudia Cordovil
- Rosário da Conceição Cameira

1. Context of the region

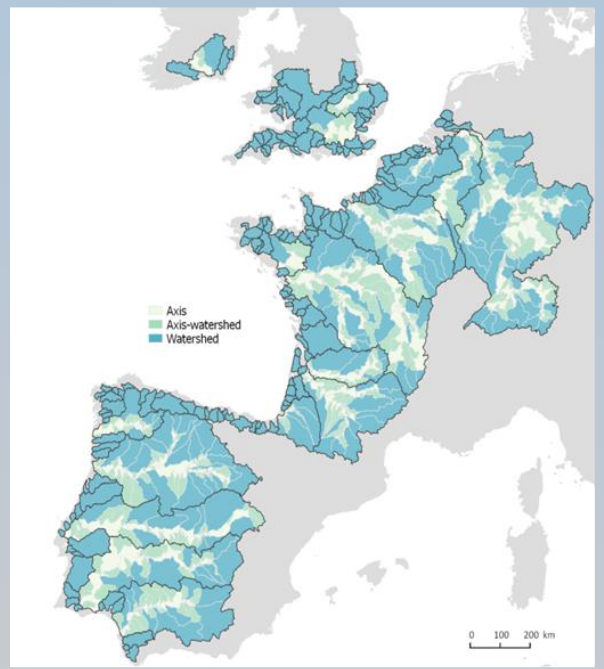
Description of the demo site

Embedded geographical scales

The European Atlantic coast from Gibraltar to the Rhine → Large individual river basins → Small equipped watersheds

Downscaling *Downscaling*

Mediterranean to temperate climate gradient

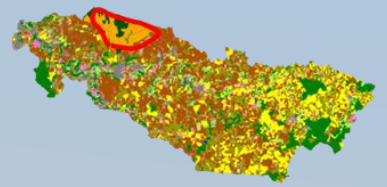


Seine R.

76 270 km²

intensive measurements of processes in the N cascade (crop managmt, N losses,…)

Gd Morin>Orgeval R.

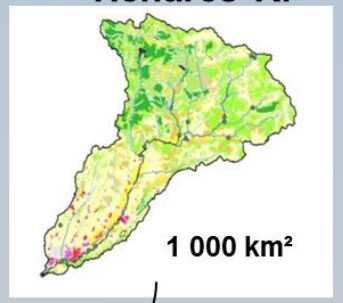


1 000 km²> 100 km²

Tagus R.

81 447 km²

Henares R.



1 000 km²

Upscaling

Known nitrogen threats & benefits: (generally) **too much N** watersheds

- **S**oils erosion
- **G**HG and **A**tmospheric pollution (NH_3 and tropospheric ozone/link with NO_x: impacts on human health)
- **W**ater quality, both surface- (& ground-) waters and coastal issues eutrophication)
- **E**cosystems, biodiversity loss

Room for improvement: scenarios

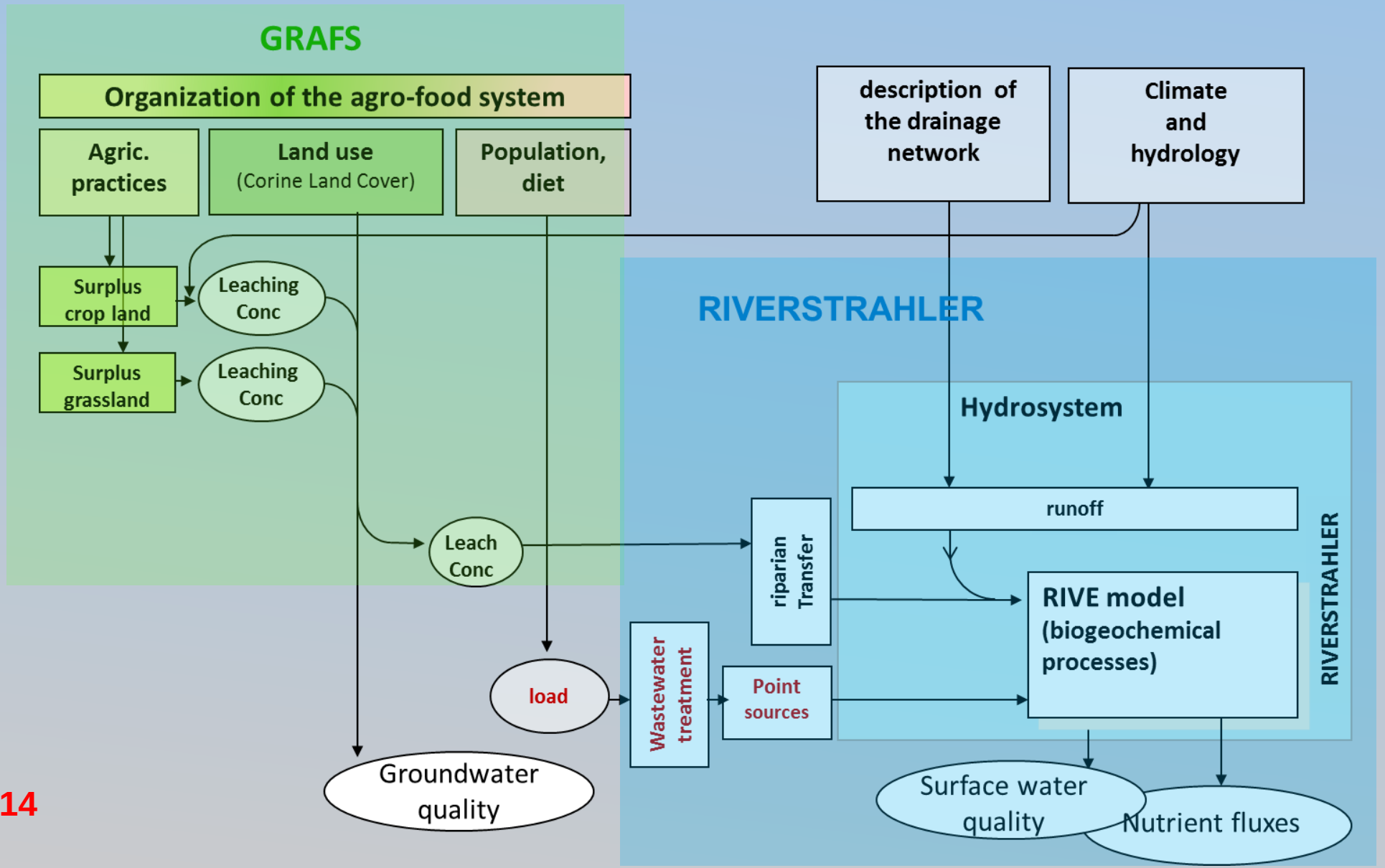
Objectives

- **Describe and model** the current **N flows** through **agricultural**, **atmospheric** and **hydrological systems** of a regional territory along its land-sea continuum, and their major controlling factors

- Establish and assess **various future management scenarios** for reducing coastal eutrophication/hypoxia (nutrient excess and disequilibrium), and pollution of soils, waters, and air in the human environnement associated to reactive N (NH_3, NO_x, N_2O and NO_3^-), Si and P.

  NB: these prospective (not prescriptive) scenarios will be based on emerging "weak signals" (organic food, circular economy, reconnection of crop/livestock, sobriety in way of life, …)

The GRAFS-Riverstrahler approach



Year: 2014

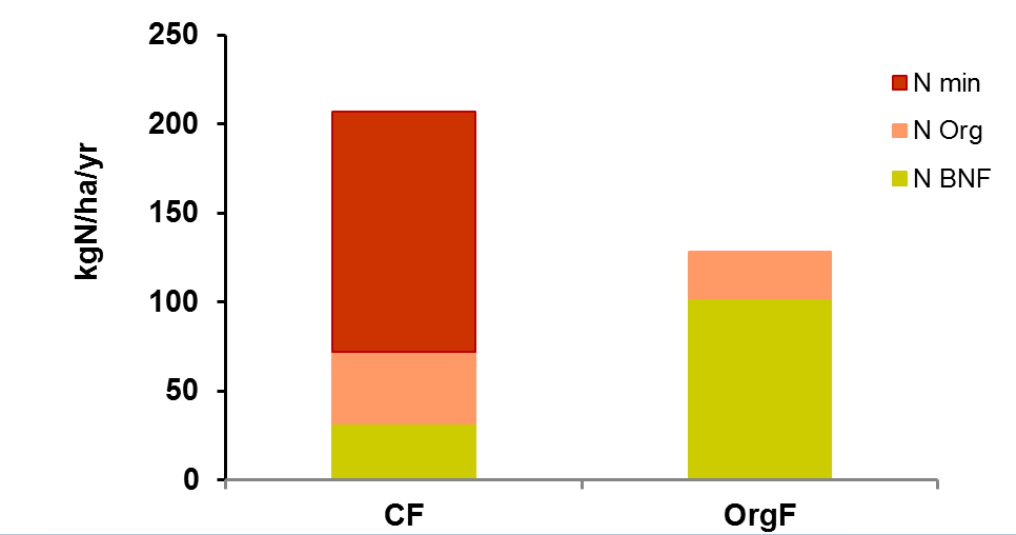
Priority indicators of N management

- **Autonomy** of the **farmers** in terms of N inputs
- **N Soil** surface balance
- **Autotrophic vs. Heterotrophic regions**

- Reactive N **atmospheric emissions and deposition**
- N retention at the **catchment scale**
- Surface- and ground- **water concentrations**
- **NUE**

- Potential **eutrophication** at the CZ : ICEP-N (and ICEP-P)

Key findings: Autonomy of the farmers in terms of N inputs



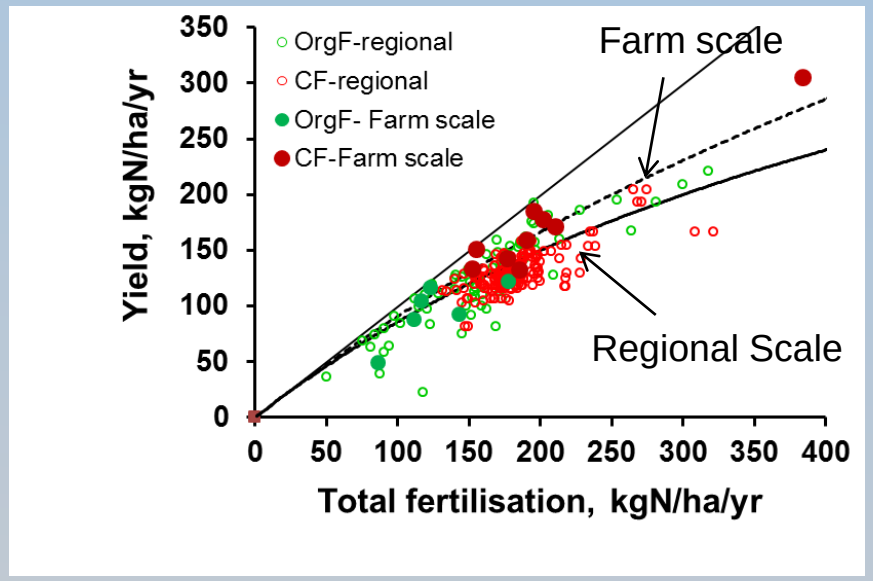
- **Org F:** 80 % of the N inputs from BNF, 20 % of exogenous organic
- **CF**: 15 % of the N inputs from BNF, 20 % of exogenous organic, 65% of mineral synthetic

➔ **38 % less fertilization in OrgF**
➔ **Autonomy of Org. Farming**

Garnier et al., 2018

N Soil surface balance

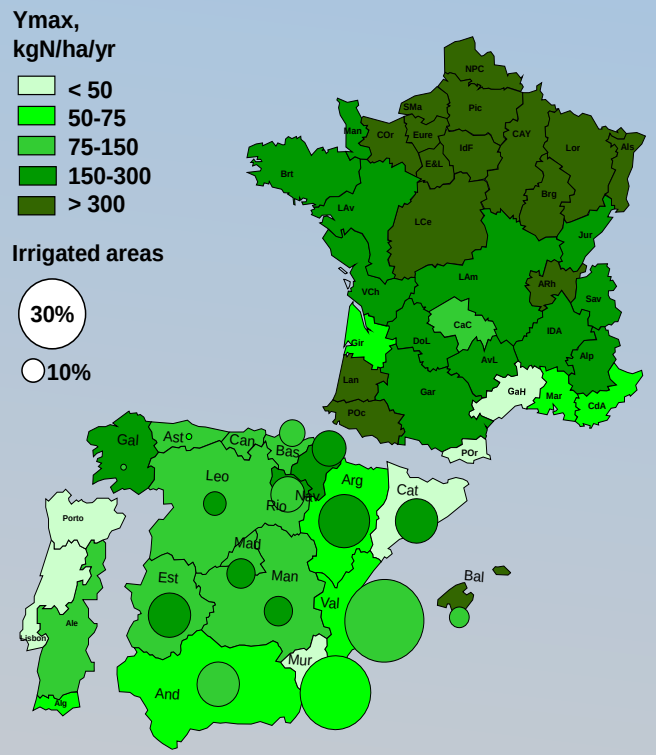
Anglade et al., 2015



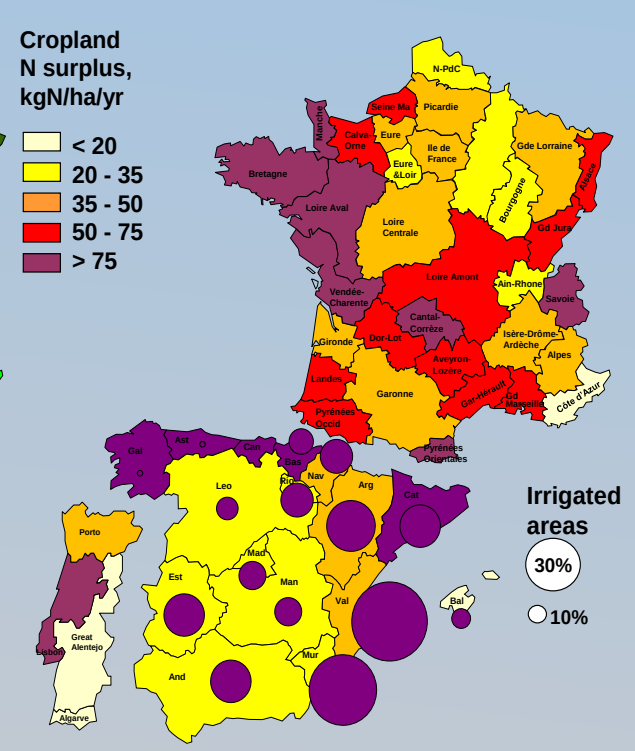
- A better agronomical performance for the farms involved in an experimental processes

Key findings: Agricultural indicators

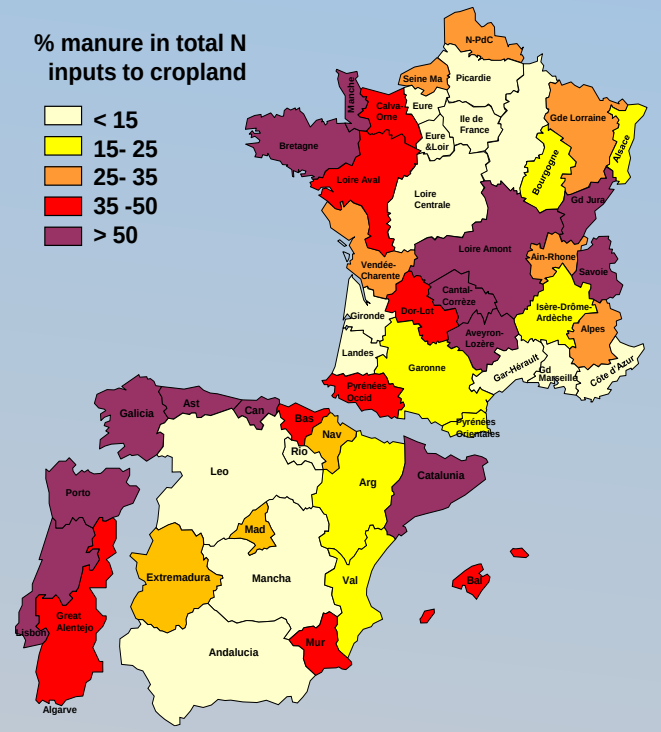
Yield max



Cropland surplus



% manure

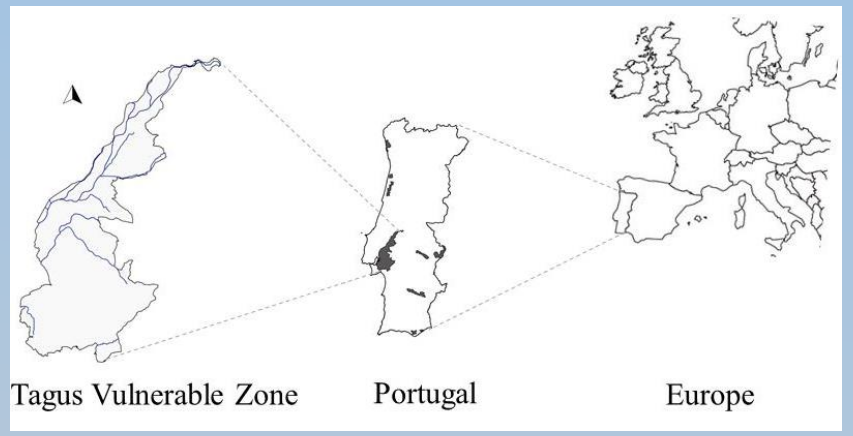


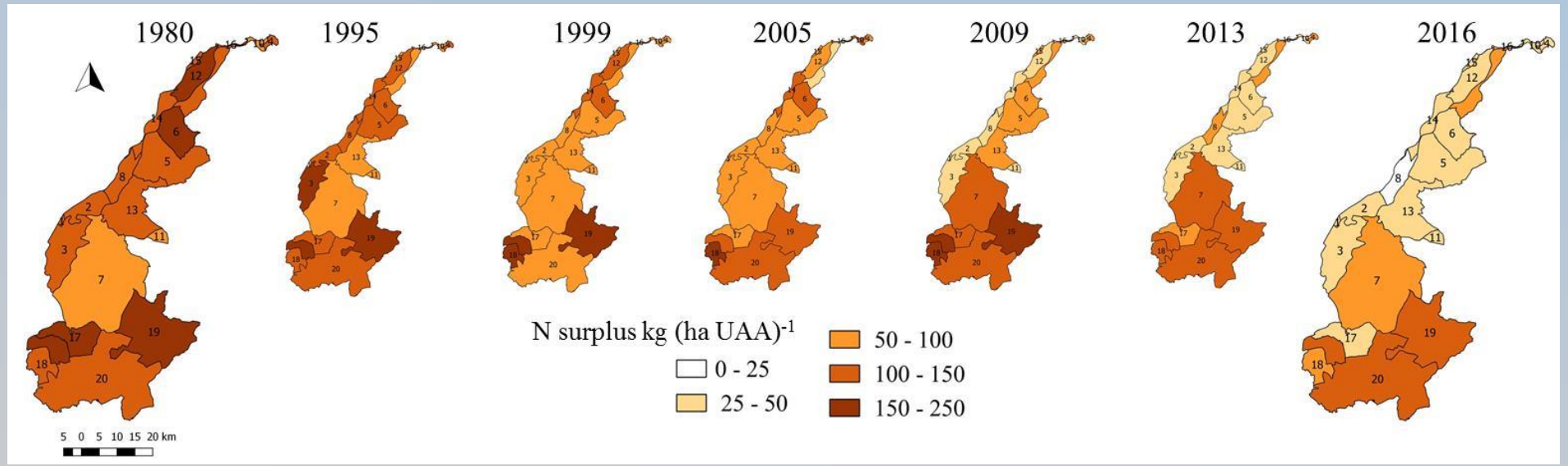
(Billen, Lassaletta, Garnier, … Sanz Cobena…, 2019. Agroecosyst. Diversity)

Key findings: Gross N surplus. Evolution of the spatial distribution

NB: *from the farm scale to national and macroregional scales*

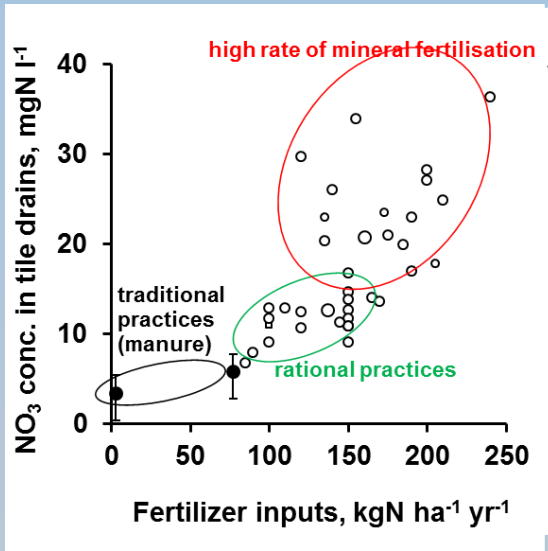
Example of the Tagus Vulnerable Zone in Portugal.

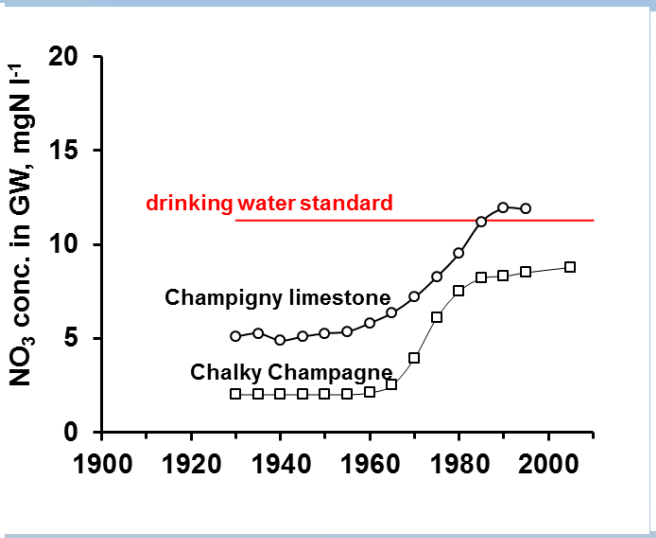


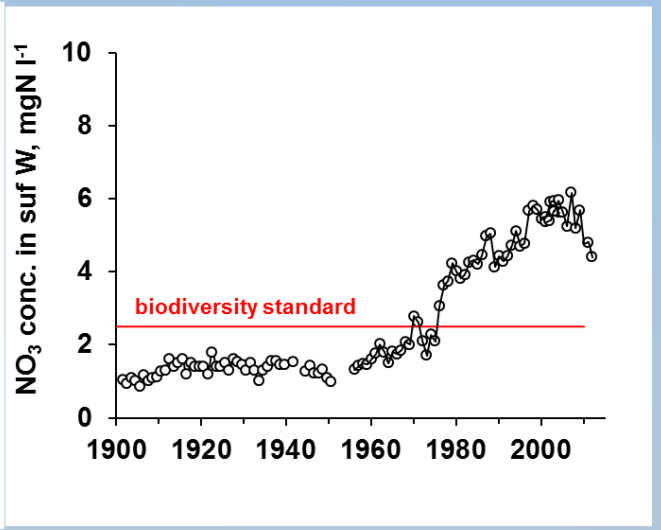


Cameira et al., 2019, Land Use Policy

Key findings: N surface and groundwater concentrations



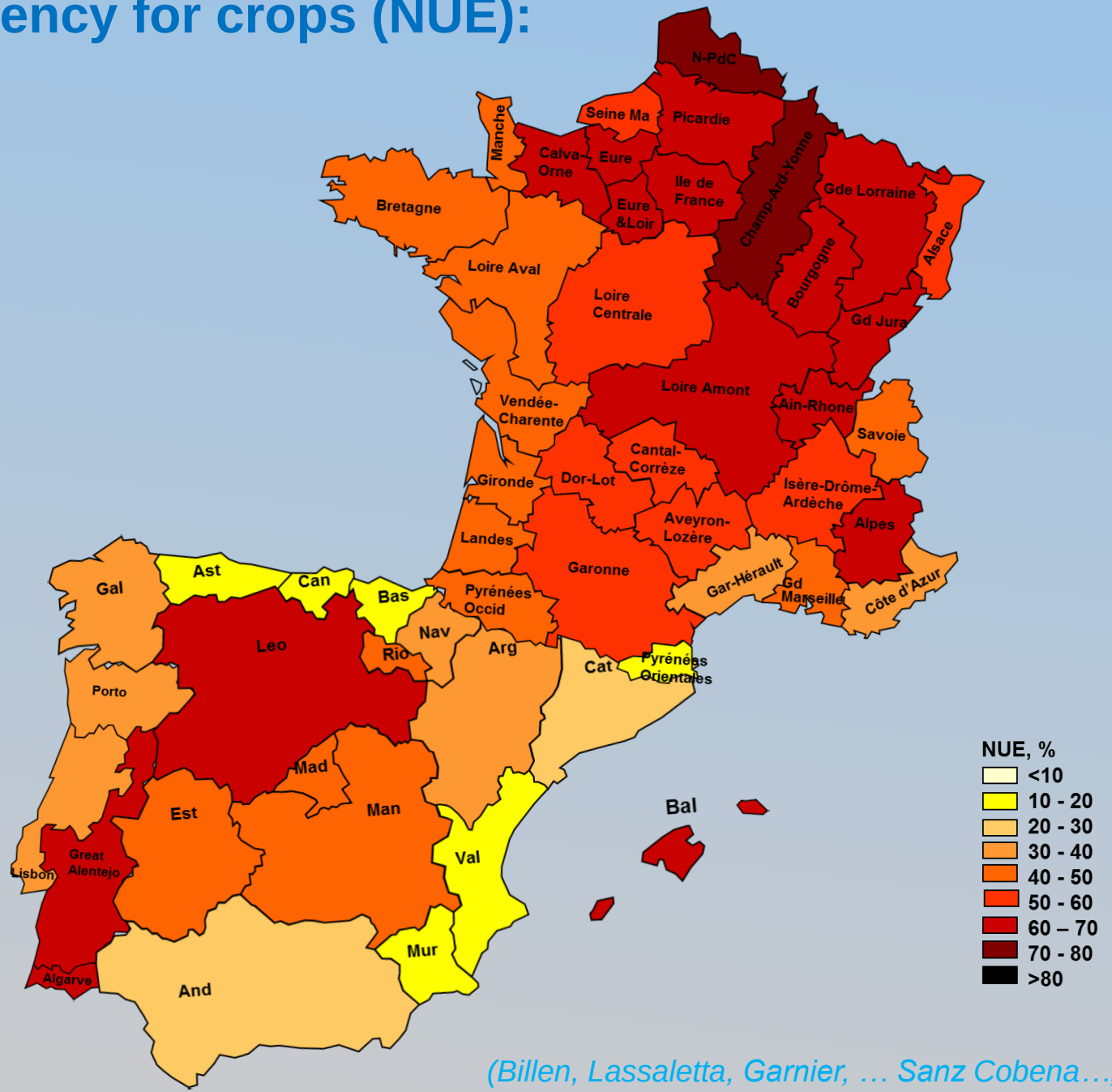




- Increasing N leaching with agricultural practices
- Increasing groundwater contamination and exceedance of the standard for drinking water
- Increasing surface water concentration and threat for biodiversity

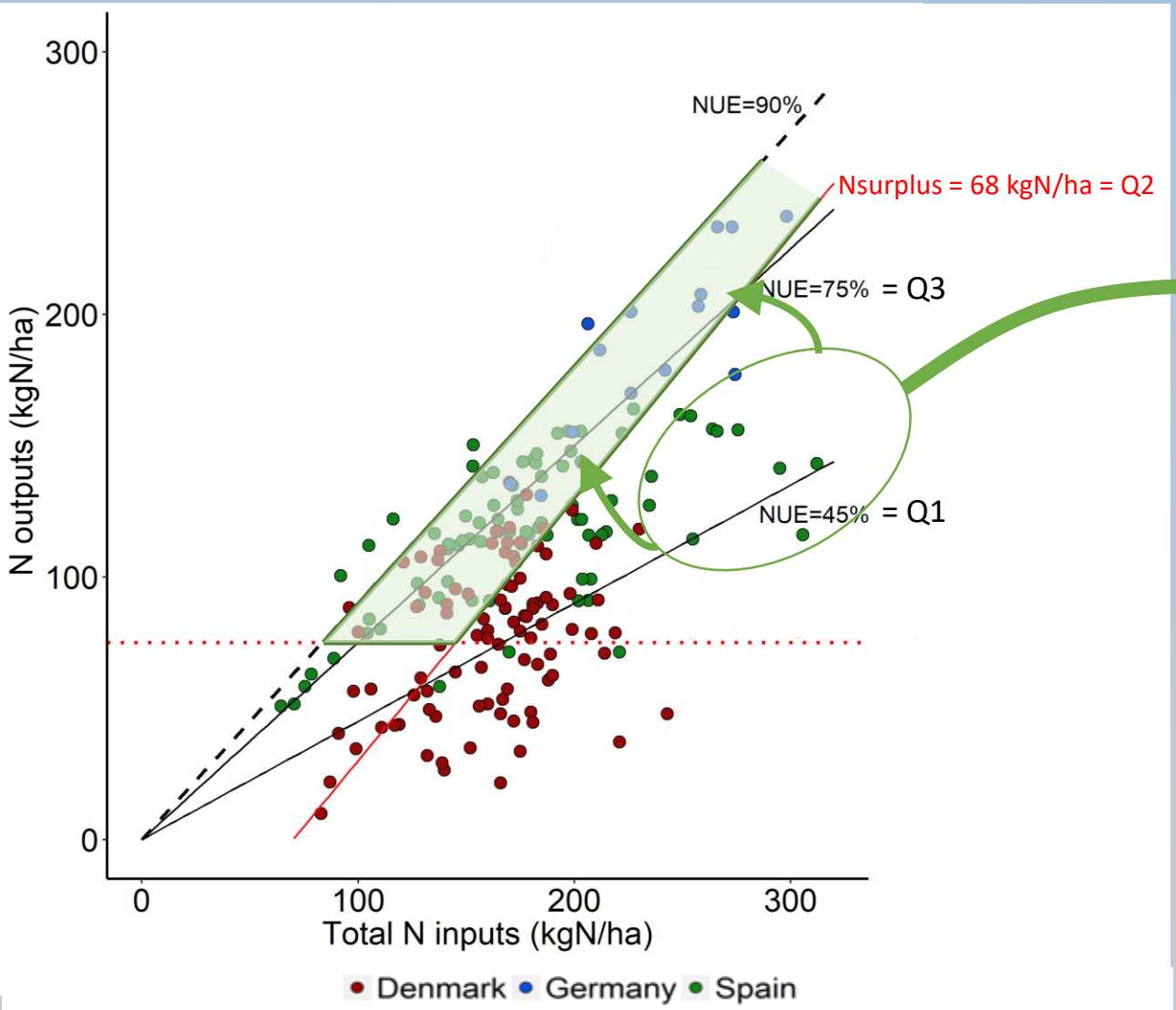
(Garnier et al., 2020, HEC)

Nitrogen use efficiency for crops (NUE):



(Billen, Lassaletta, Garnier, … Sanz Cobena…, 2019. Agroecosyst. Diversity)

Performance indicators: Nitrogen use efficiency indicators (link with Task T1.1.3)



Regionally adapted maximum surplus

Defining transition pathways

Definition of current NUE, Surplus and output

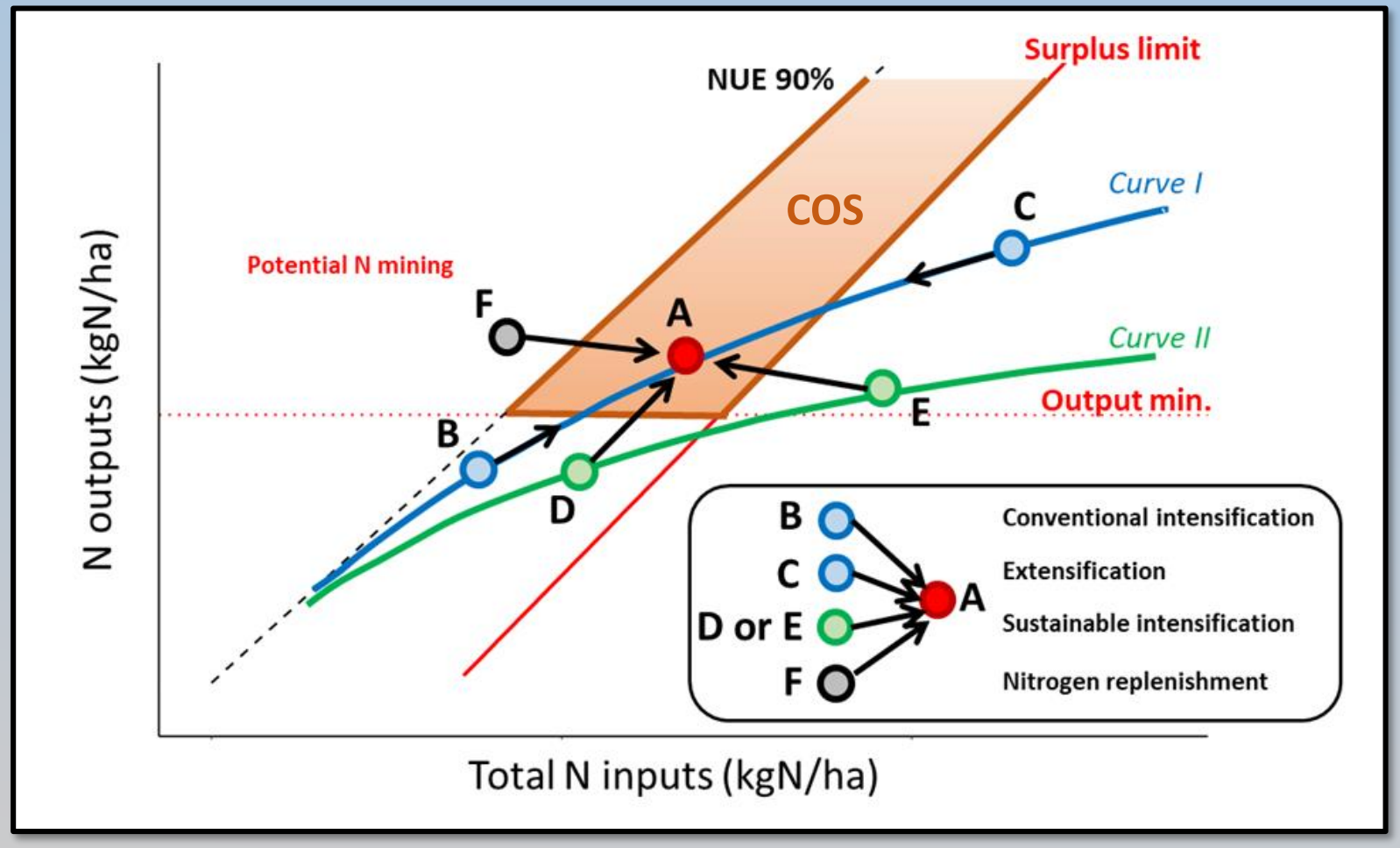
Regionally adapted minimum desirable output

Definition of the regional
Characteristic Operating Space COS

EUNEP 2019 & Quemada et al. 2020 Agr. Syst

Performance indicators: Nitrogen use efficiency indicators (link with Task T1.1.3)

Defining transition pathways



Different scales and systems adapted to the specific region story

Same framework, logic and representation!

Questions:
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EUNEP 2019 & Quemada et al. 2020 Agr. Syst

Reference situations and potential scenarios for the W-EU demo site

GAP scenario: good agricultural practices, reasoned fertilization

O/S scenario: openness and specialization, i.e. intensification and specialization in an open global market

A/R/D scenario: autonomy, crop and livestock reconnection, demitarian diet

- Reduction of N contamination
- Reduction of GHG
- Reduction of eutrophication
- No use of pesticides

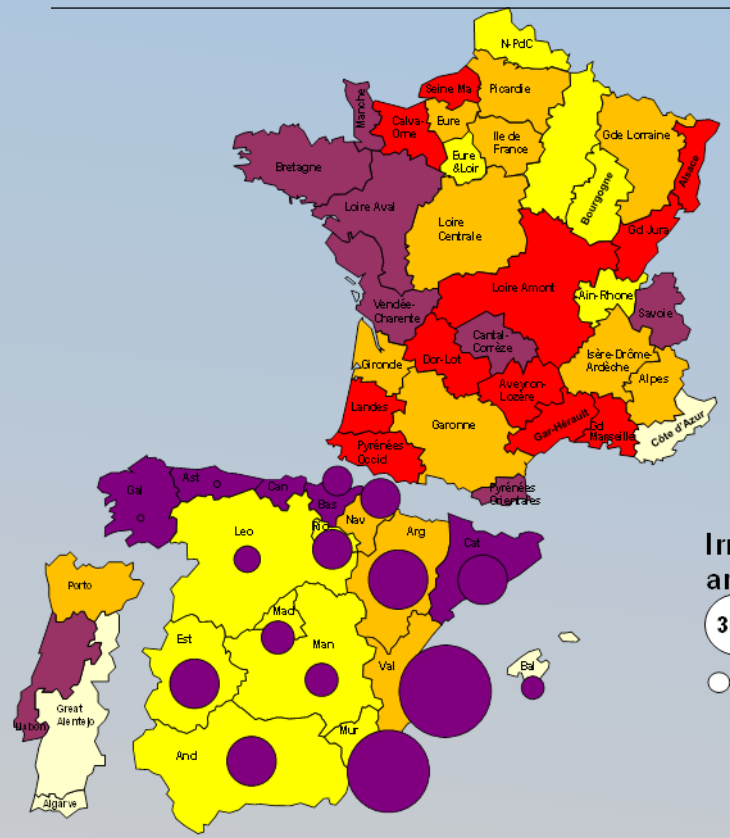
New scenarios in construction : vegetarian, vegan, sustainable intensification

Results of scenarios: N surplus

Cropland
N surplus,
kgN/ha/yr

- < 20
- 20 - 35
- 35 - 50
- 50 - 75
- > 75

Current system



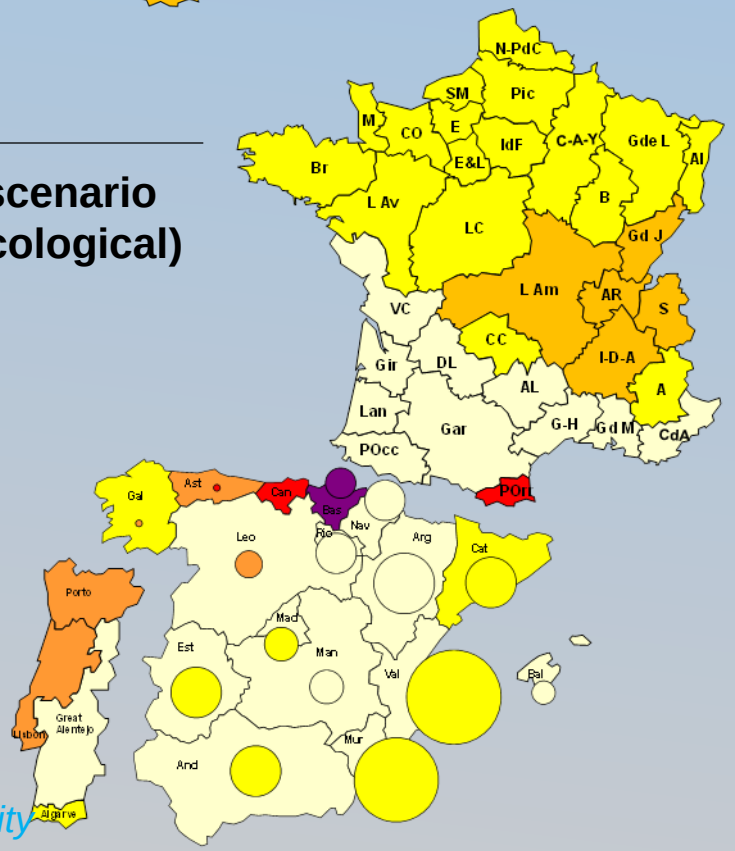
Irrigated areas

- 30%
- 10%

O/S scenario (liberal)

To be done for the whole domain

A/R/D scenario (agro-ecological)

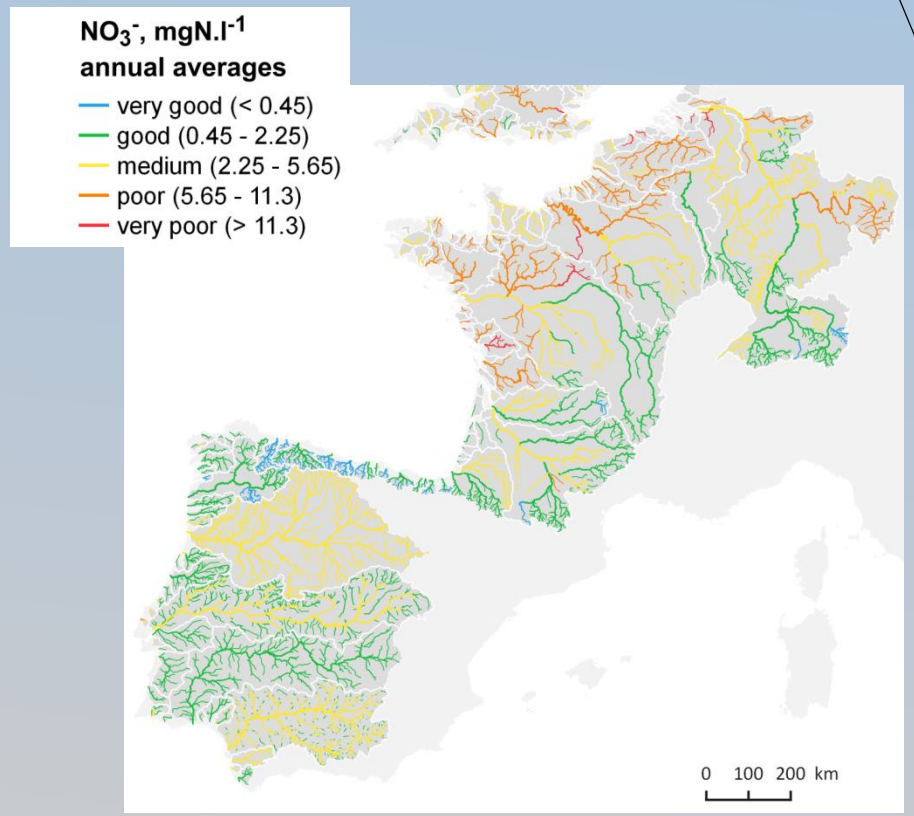


Billen, Le Noë, Garnier, 2018, STOTEN
Billen, Lassaletta, Garnier, … Sanz Cobena., 2019, Agroecosyst. Diversity

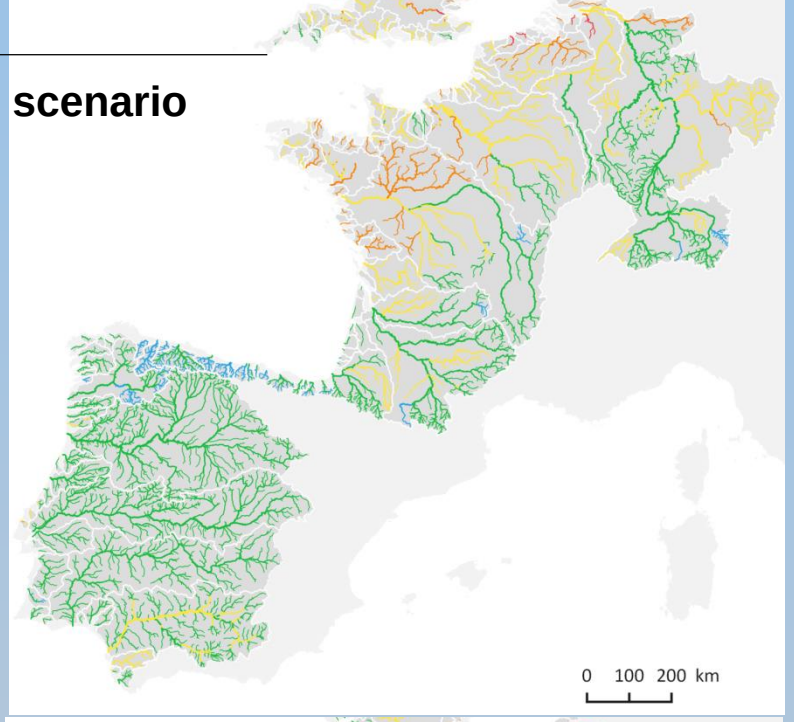
Resulting water quality

➔ *The GAP scenario improves surface water quality but a further specialisation (O/S, not yet done at this scale) could worsen the situation*

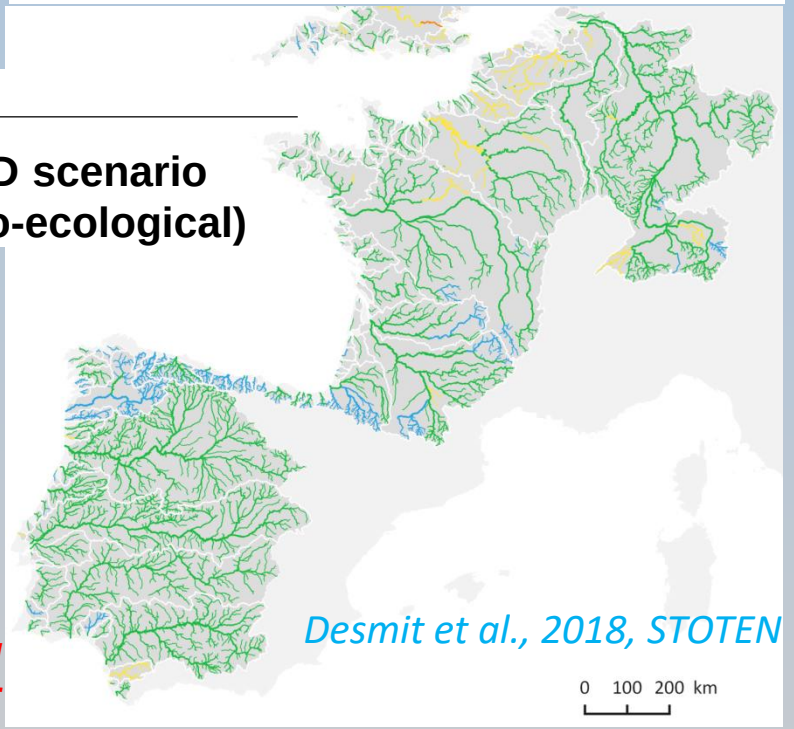
Current system



GAP scenario



A/R/D scenario (agro-ecological)

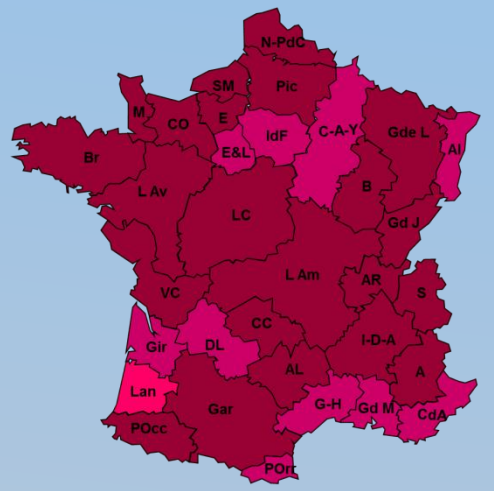


Desmit et al., 2018, STOTEN

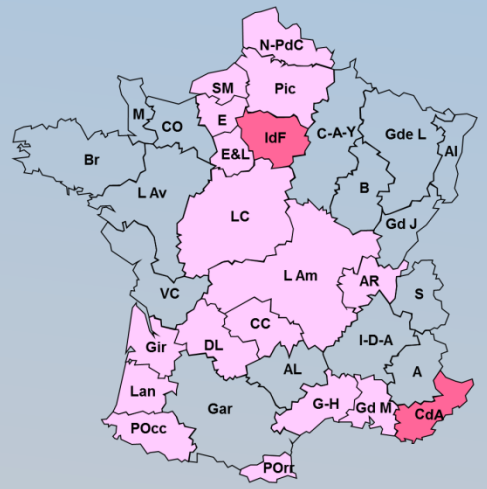
➔ *The A/R/D scenario allows meeting drinking water standards for ground- and surface water*

Resulting GHG (N_2O)

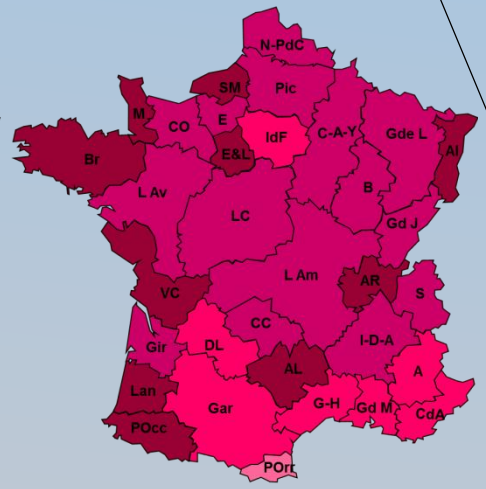
O/S scenario (liberal)



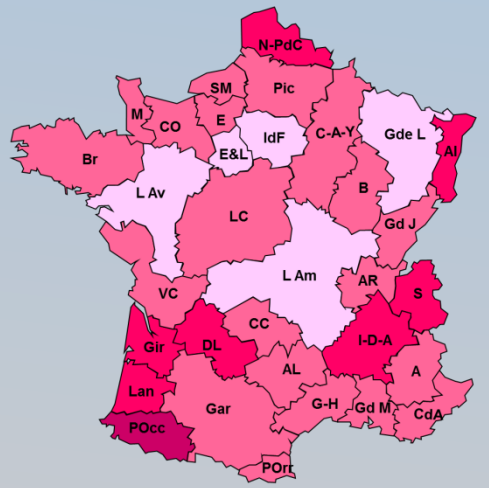
1906



Current system



A/R/D scenario (agro-ecological)



N_2O emission
kgN-N_2O/km²/yr

- <50
- 50 - 75
- 75 - 125
- 125 - 175
- 175 - 250
- > 250

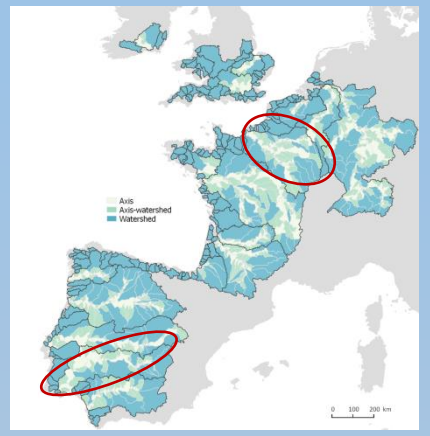
(Garnier, Sanz Cobena, Lassaletta,…, Billen, 2019, STOTEN)

Adressed Issues

Critical

Potentially critical

Not critical



N management issues		Tagus	Seine
Water issues	Low water periods		
	Reservoirs		
	Point source pollution		
	N retention		
Agricultural issues	Crop mineral fertilisation		
	Livestock and Crop manure fertilization		
	Irrigation		
Atmospheric emissions & pollution	Ammonia		
	Nitrous oxide		
	Ozone		
Coastal Potential Eutrophication	N:P:Si nutrient deliveries vs. upwelling		

Perspectives: opportunities and barriers

NB: Combating N contamination of water, agricultural system fragility, N emission and coastal eutrophication, slowing down climate change…

- **Enhance and promote <u>success stories</u>**
  - Increase in organic conversion (CAP, Farm2 Fork/Green Deal, new EU legislation on organic farming, Jan 2021).
  - Circular economy development.
  - Solutions for NH_3 scenarios abatement.
  - New determinations of regional based N_2O emission factors (collaboration with GRA).

- **Strategy to use the N joint-up approach to overcome <u>barriers</u> to achieving good N management**
  - **Education** at school (children) and University (students)
  - **Territorial animation** (farmers and citizen) to support deep changes in the agro-food system (and more generally the way of life) towards a socio-ecological transition and socio-environmental sustainability,
  - Communication on **One health**: pesticides issues, animal protein over consumption, etc.
  - **Re-invent the agro-food system** for :
    - ✓ Ensuring farmers wellfare (e.g. economic autonomy in terms of inputs, …)
    - ✓ Selling their work products at the right price
    - ✓ Providing food of high quality for everybody

Interreg-SUDOE project (2020-2022):
Submitted in October 2019 (stage II), Sanz Cobena et al.

Next steps

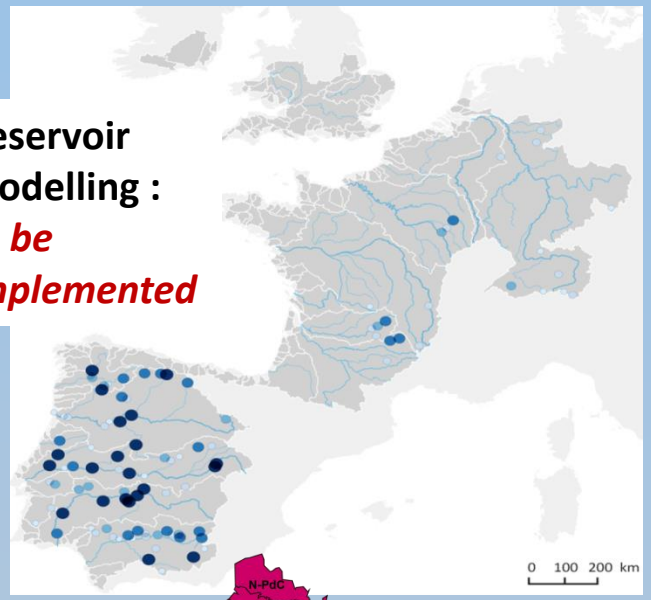
- Collecting the data of reservoirs, many in Mediterranean countries, for their generic implementation in the Grafs-Riverstrahler approach.

- Documenting the controlling factor for NH_3 volatilisation, N_2O emissions, ozone formation, … and their interactions.

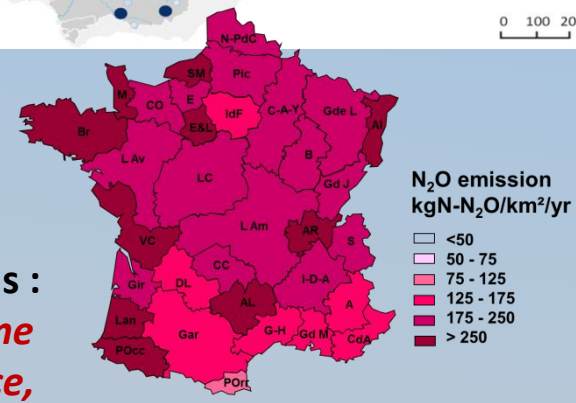
Interreg Sudoe

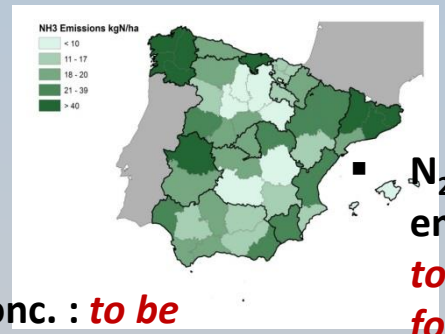
Interreg-SUDOE project (2020-2022):
Submitted in October 2019 (stage II), Sanz Cobena et al.

- Reservoir modelling : ***to be implemented***



- NH_3 emissions : ***to be done for France, Portugal***



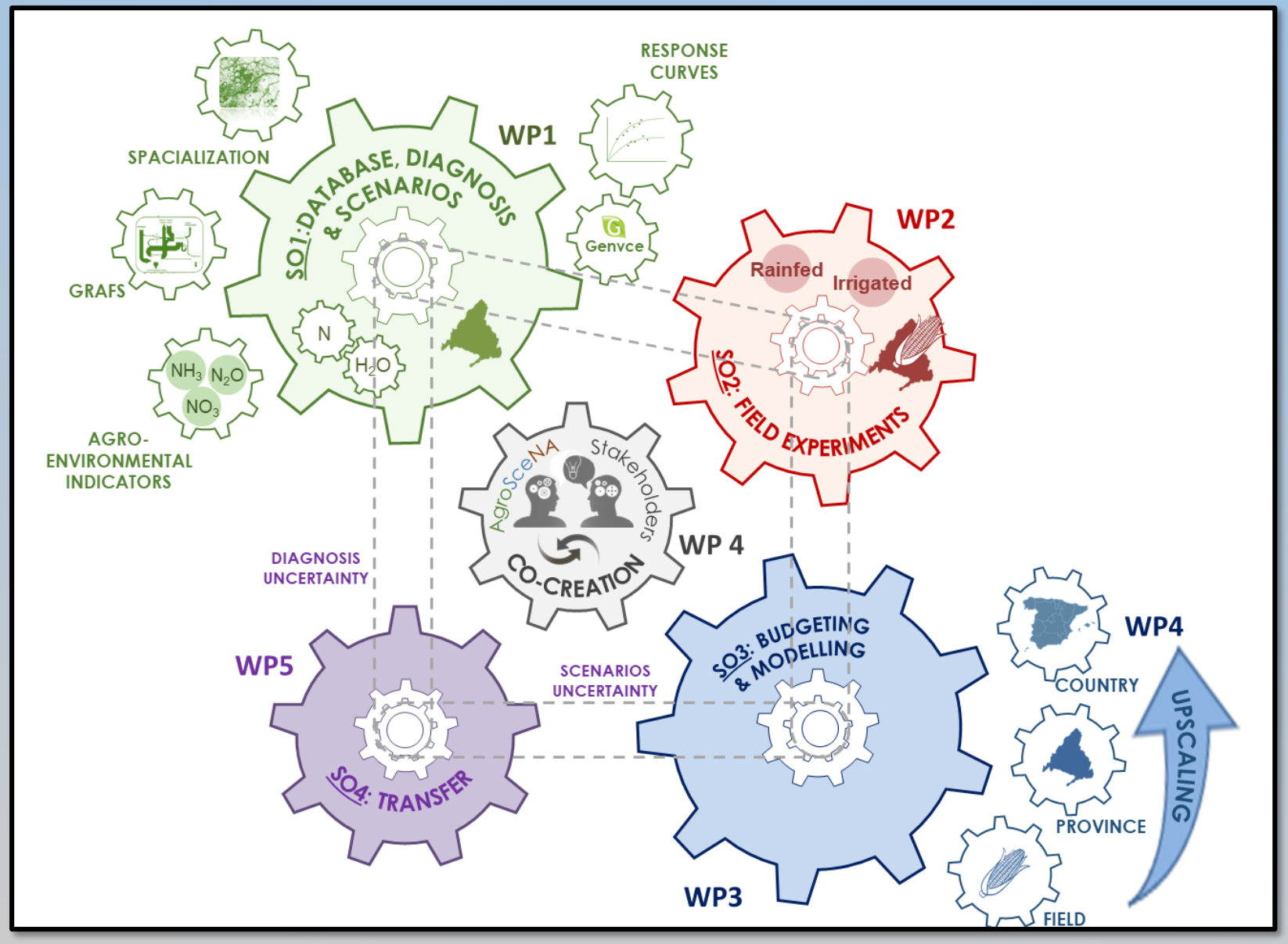


- N_2O emissions : ***to be done for Spain, Portugal***

- Ozone conc. : ***to be done for the whole domain***

AgroSceNA-UP: Upscaling Crop Management Scenarios for sustainable Mediterranean cropping systems through Nitrogen loss Abatement: from the plot to the national scale.

Project Funded by National Ministry of Science (2020-2022). *PI: A. Sanz-Cobena & L. Lassaletta*

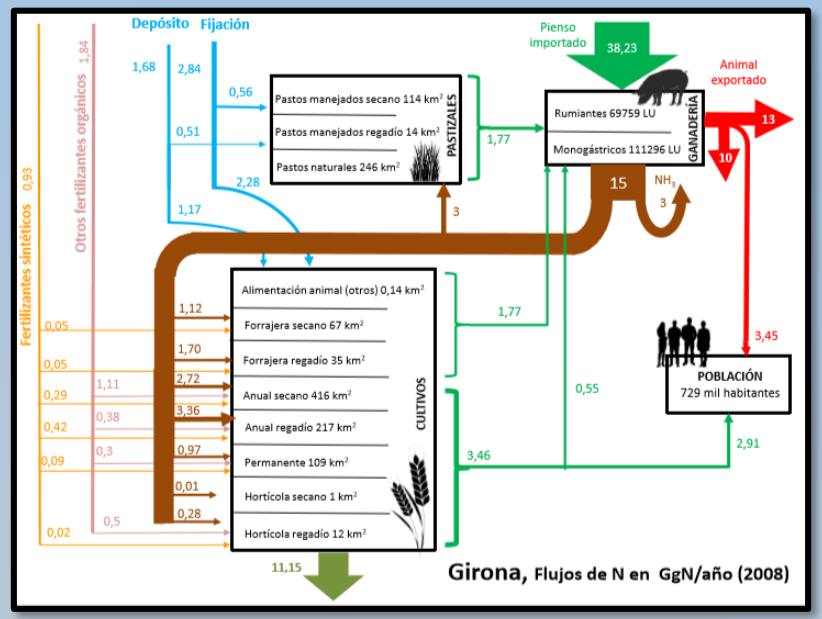


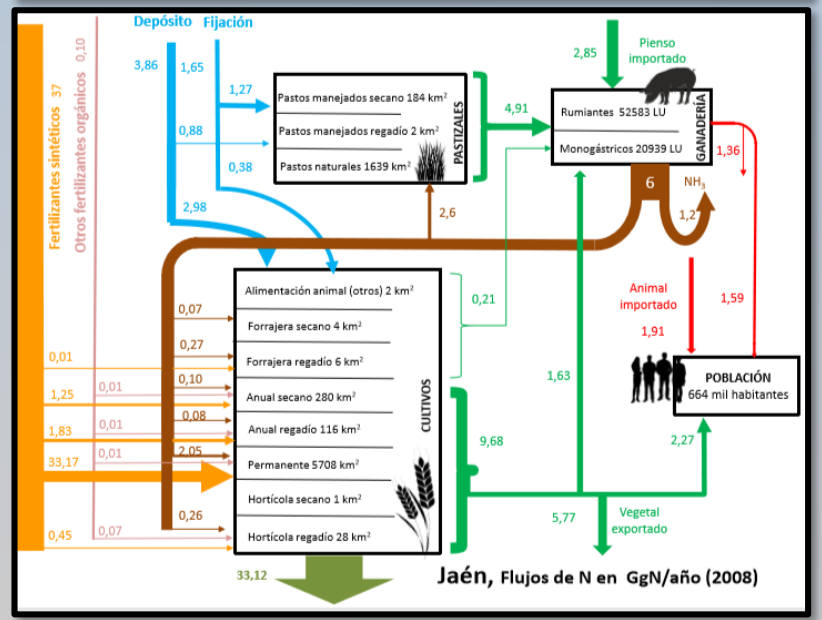
1. **Diagnosis:** the current situation
2. **Co-creation** and **spatialization**
3. **Scenarios** construction
4. **Up-scaling** from the field to the province and the country level

AgroSceNA-UP (2020-2022): Upscaling Crop Management Scenarios for sustainable Mediterranean cropping systems through Nitrogen loss Abatement: from the plot to the national scale

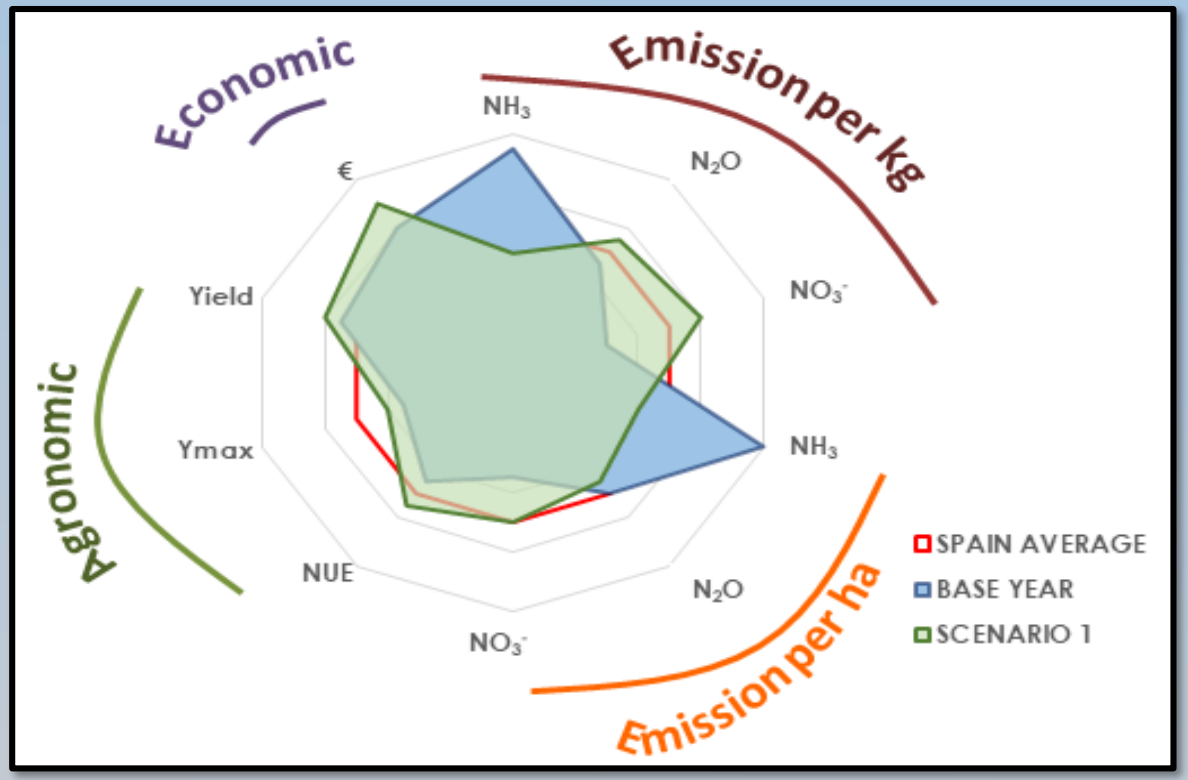
PI: A. Sanz-Cobena & L. Lassaletta







Contrasted regions, different solutions!!!!



Diverse indicators

OFB, project : NUTS-STeauRY

Submitted in October 2019, Accepted in May 2020, Thieu, Garnier et al.

- To deploy, at the scale of metropolitan France, the latest developments in the modelling of nutrient transfers in the nutrient continuum, GRAFS-RIVERSTRAHLER-GEM
- to inform basin managers (mainly water agencies) of results produced by this land-to-sea model chain for a dialogue and co-construction of scenarios

➔ mitigation for rebalancing the nutrient deliveries to the coastal environments.

➔ recommendations for an integrated management of riverine inputs to the sea

Many thanks for attention !

❑ W-EU demo site

FRANCE

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