

Demonstration Region in the North Atlantic Ocean : French-Spanish Joint Initiative.

CNRS/UPMC, based on Seas-ERA (Emosem) & ANR (Escapade) Projects

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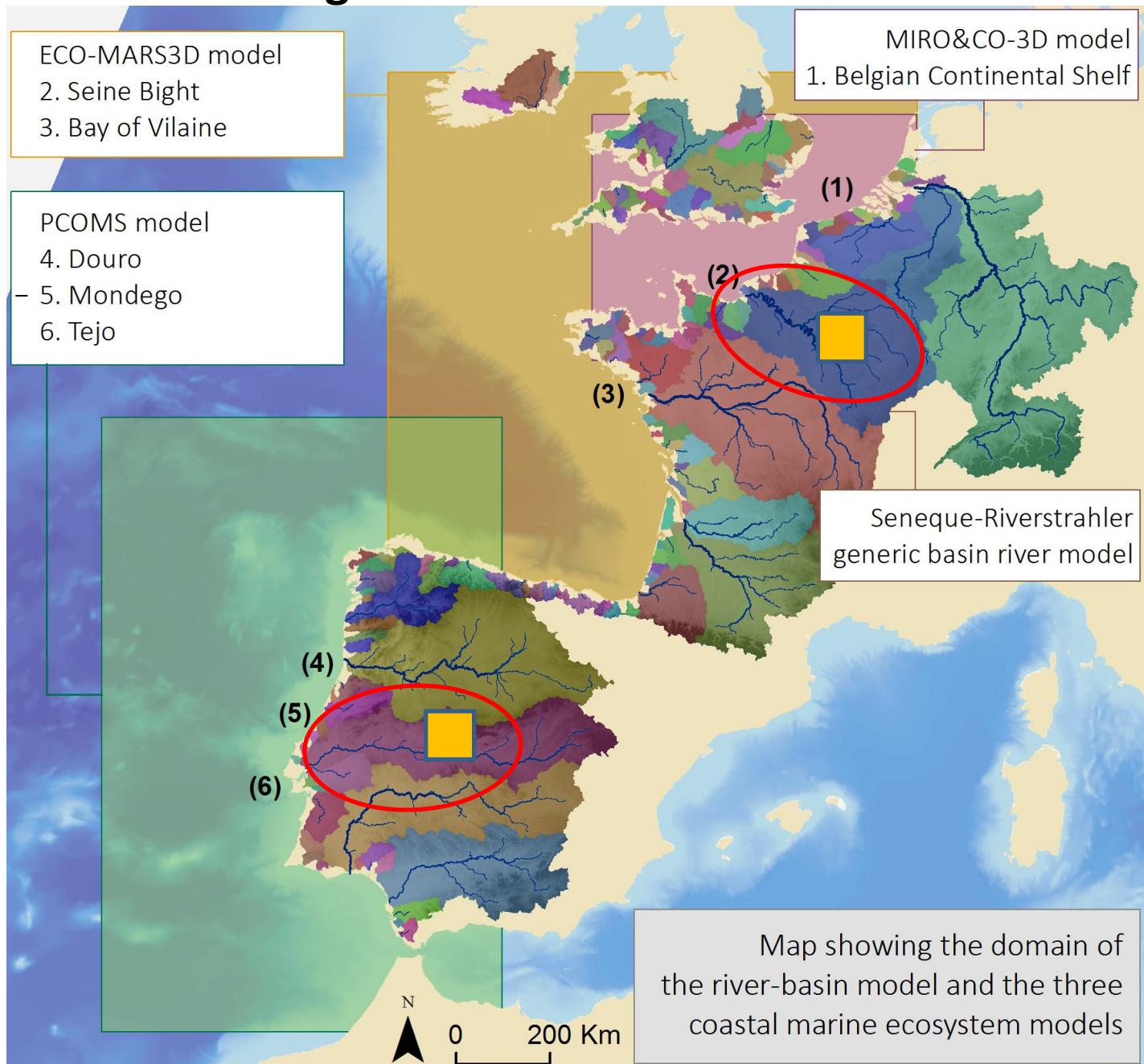
A European demonstration Region

- The European Atlantic coast from Gibraltar to the Rhine
- A downscaling at the basins scale (Tagus & Seine), with contrasting climatic conditions
- Within these two basins, a small catchment for each where intensive experimental measurements of the nitrogen cascade are realised (crop management, drought effects, N deposition, N losses, etc.)

Domain of the demonstration region

NEA : North-East Atlantic Ocean

Reference situation:
2000-2010



Objectives

NB: In the framework of a SeasEra project, a new generic river model (Riverstrahler) of the NEA is being implemented and will be validated with actual riverine discharges and nutrient loads, which will be coupled with coastal seas models in order to:

- **assess** the current **eutrophication** status on the basis of existing literature and state-of-the-art marine ecological modelling
- **focus on sub-regional specificities**, and on **eutrophication consequences** upon ecological structures and processes
- **evaluate** the **reductions** to be undertaken in terms of terrestrial **nutrient input** in the considered **marine subregion** to achieve the potential success regarding **eutrophication** (nutrient excess and disequilibrium, cf. N in excess to Si and P)
- **propose** realistic **scenarios** implying efforts at the level of the watersheds in order to reduce anthropogenic nutrient inputs to the rivers and potentially mitigate the eutrophication nuisances at the coast (e.g. change in agricultural system and practices, EU-WFD)

Terrestrial watersheds of the NEA domain



- 174 basins larger than 300 km²

- 17 main river basins

code	Name	Area (km ²)	Strahler	Nb of objects
291110	Rhine	160 221.4	8	159
291111	Loire	116 981.0	8	110
442352	Duero	97 418.7	8	112
291115	Seine	75 989.5	7	77
442364	Tajo	71 202.1	7	51
442403	Guadiana	67 062.8	6	50
442365	Guadalquivir	57 052.5	7	46
291126	Garonne	55 703.1	7	67
291130	Meuse	32 047.2	6	26
291125	Dordogne	23 902.0	7	25
291133	Schelde	18 949.0	6	22
442355	Miño	16 985.1	7	25
291194	Adour	16 860.9	6	24
83811	Thames	13 513.7	5	6
291146	Vilaine	10 490.4	6	6
83749	Barrow	9 224.3	6	6
83751	Great Ouse	8 442.7	6	6



Data bases gathered

Hydrological Data

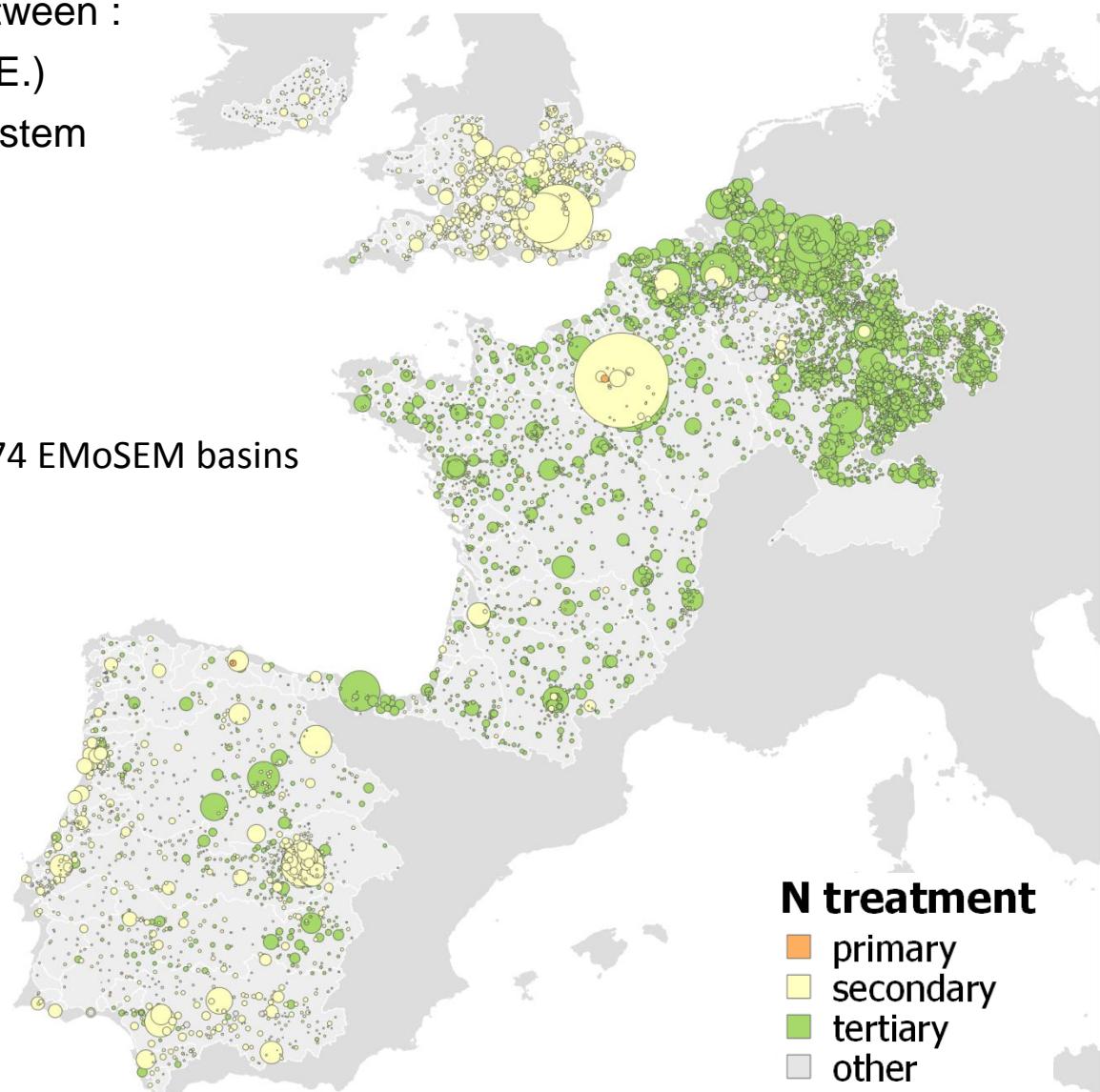
Country	Producer
PT	SNIRH (Serviço Nacional de Informação de Recursos Hídricos) – INAG (Instituto da água)
ES	CEDEX (Centro de Estudios y Experimentacion de Obras Publicas)
FR	Banque Hydro
	Hydronet - Vlaamse Milieumaatschappij
BE	Aqualim - Région wallonne
	Voies hydrauliques - Région wallonne
NL	Waterbase - Ministry of infrastructure and the Environment
DE	GRDC (Global Runoff Data Centre)
CH	Federal Office for the Environment (FOEN)
UK	CEH (Centre for Ecology and Hydrology)
IE	Hydronet - Environmental Protection Agency (EPA)
	Office of Public Work (OPW)

Water Quality Data

Country	Producer
PT	SNIRH (Serviço Nacional de Informação de Recursos Hídricos) – INAG (Instituto da água)
ES	Confederación Hidrográfica
FR	5 Water Agencies
BE	RHME
CH	Federal Office for the Environment (FOEN)
UK	Environment Agency
IE	Hydronet - Environmental Protection Agency (EPA)

Point sources within the NEA domain

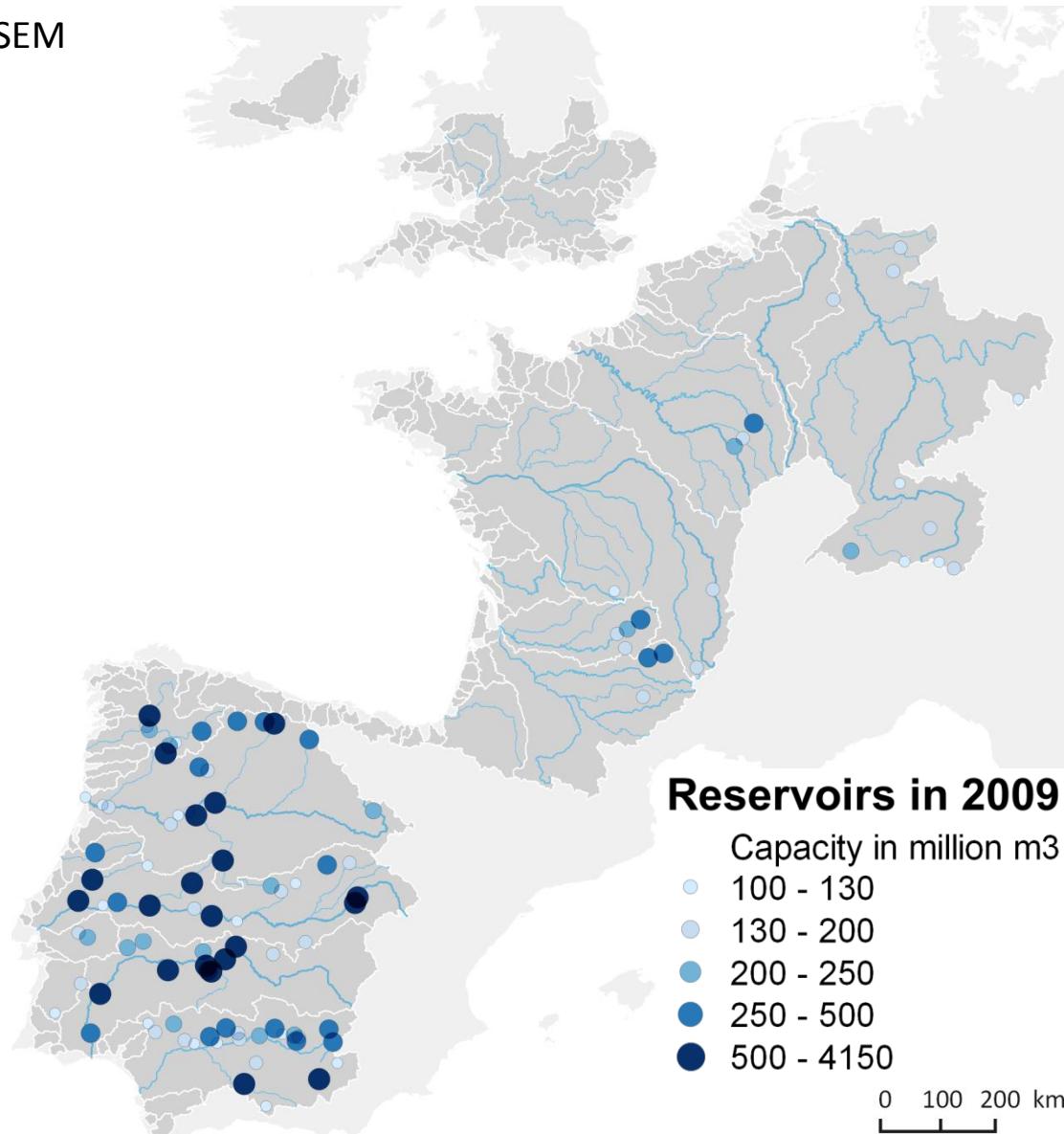
- Data source : Waterbase UWWTD EEA, 2012
- Complex database providing link between :
 - Agglomeration loads (> 2000 I.E.)
 - Rate of collection to sewage system
 - Connection(s) to WWTP
 - Treatment type (for N and P)
 - Sensitivity of “receiving area”
- 176 millions of I.E. treated within the 174 EMoSEM basins



Point sources: Reservoirs within the NEA domain

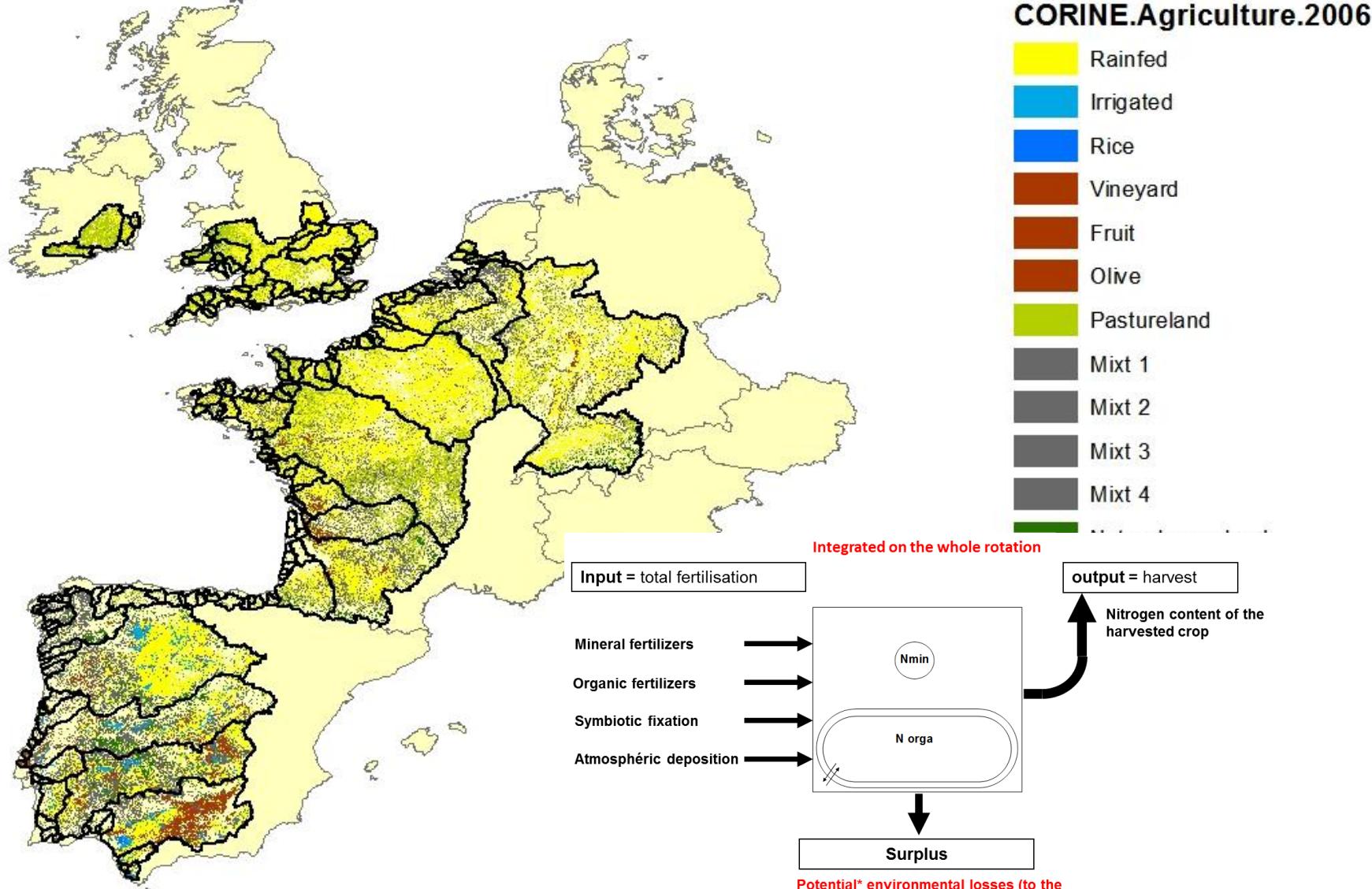
- Data source : GranD Database
(Global Water System Project 2014)
- More than 350 reservoirs within the EMoSEM domain
- Selection criteria:
 - storage capacity > 100 Mm³
 - within basin > 4000 km²

name	Area (km ²)	Storage (Mcm)	Number
Rhine	160221	1321	9
Loire	116981	435	3
Duero	97418	7538	17
Seine	75989,5	744	3
Tajo	71202	11678	17
Guadiana	67062	13039	12
Guadalquivir	57052	6107	23
Garonne	55703	758	3
Meuse	32047	182	1
Dordogne	23902	1024	4
Miño	16985	2278	7
Sorraia	7697	370	2
Mondego	6662	450	1
Sado	6531	237	2
		104	46 160



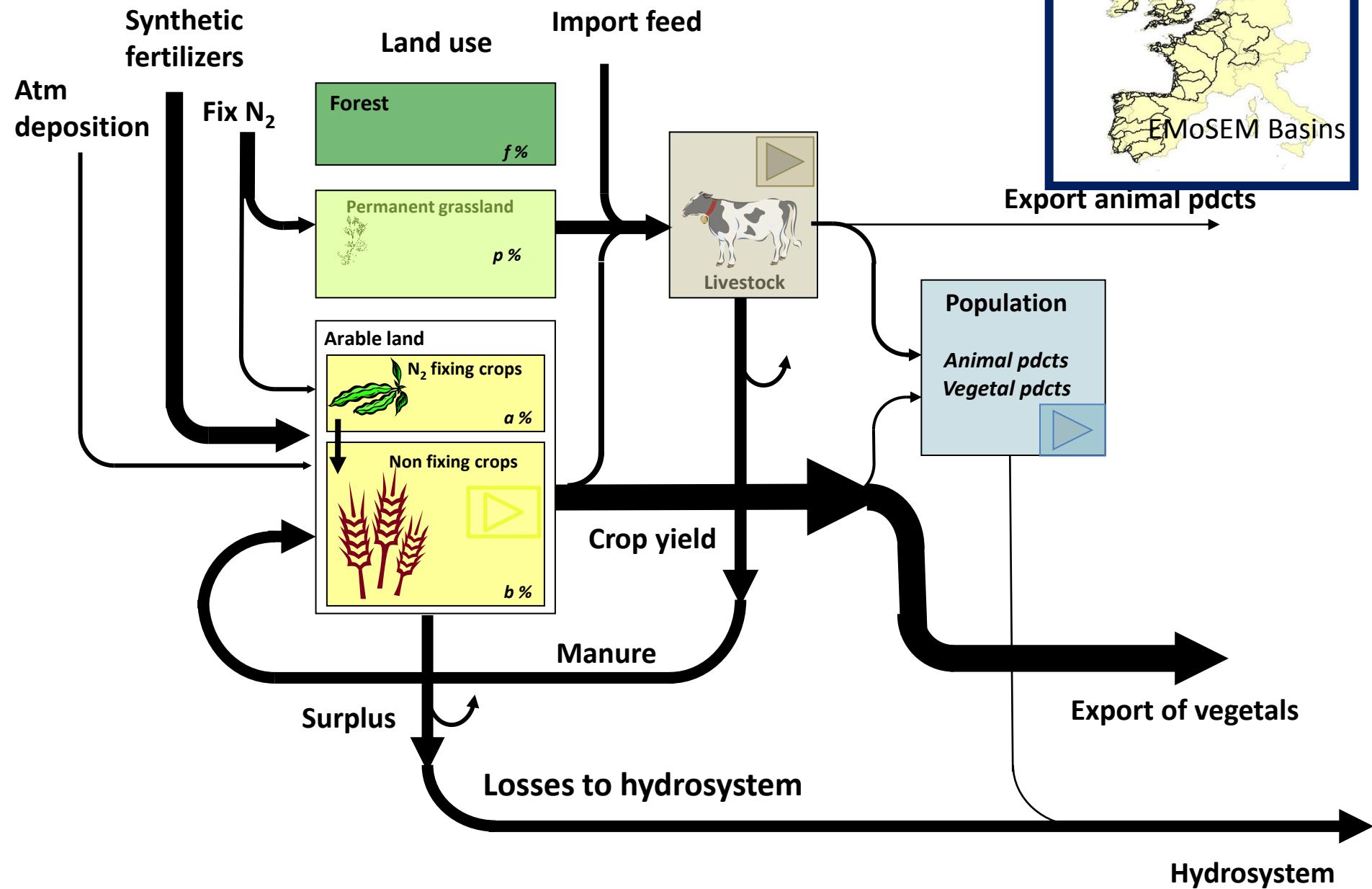
Diffuse sources within the NEA domain

- From land use

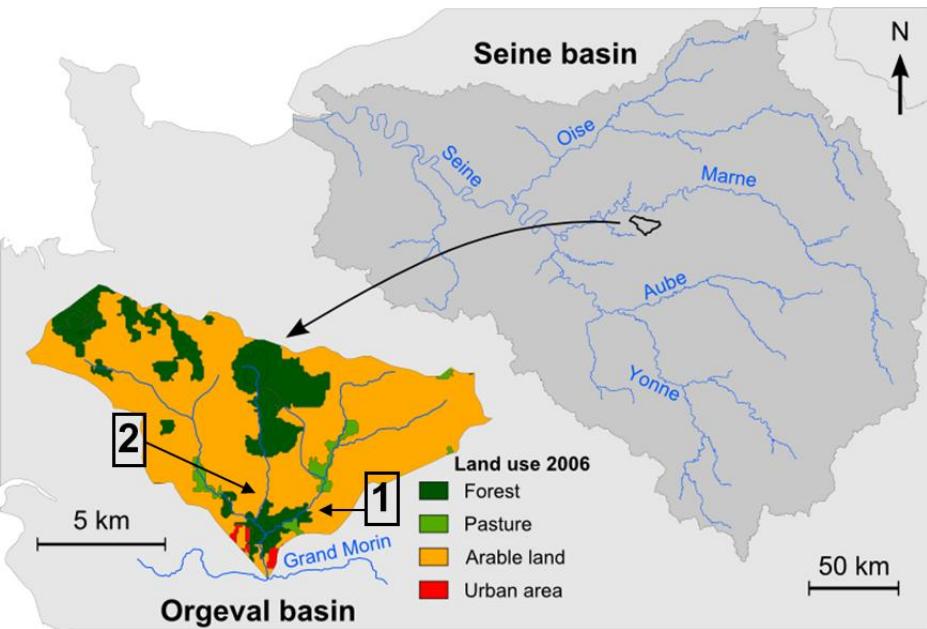


- From the agri-food system

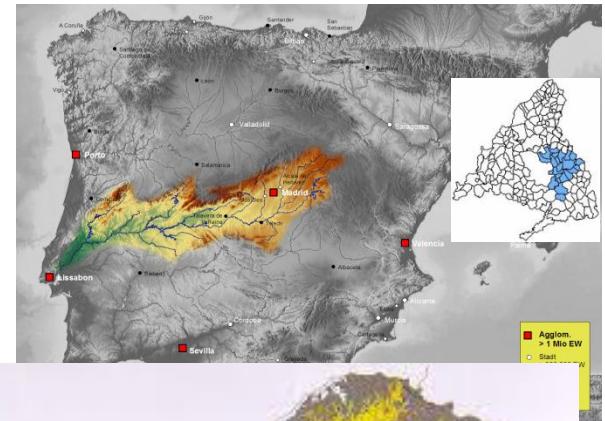
The water-agri-food system of the demonstration Region



The catchment scale: The Orgeval catchment in the Seine Basin (100 km²)

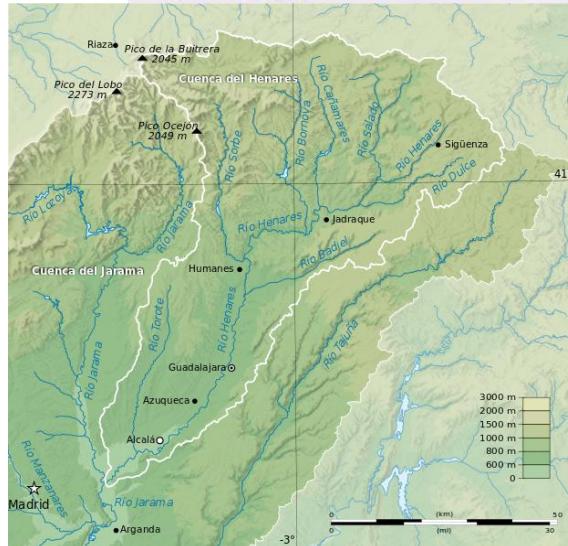


Escapade project (ANR)



The Henares catchment in the Tagus river Basin

NEREA, Agrisost project

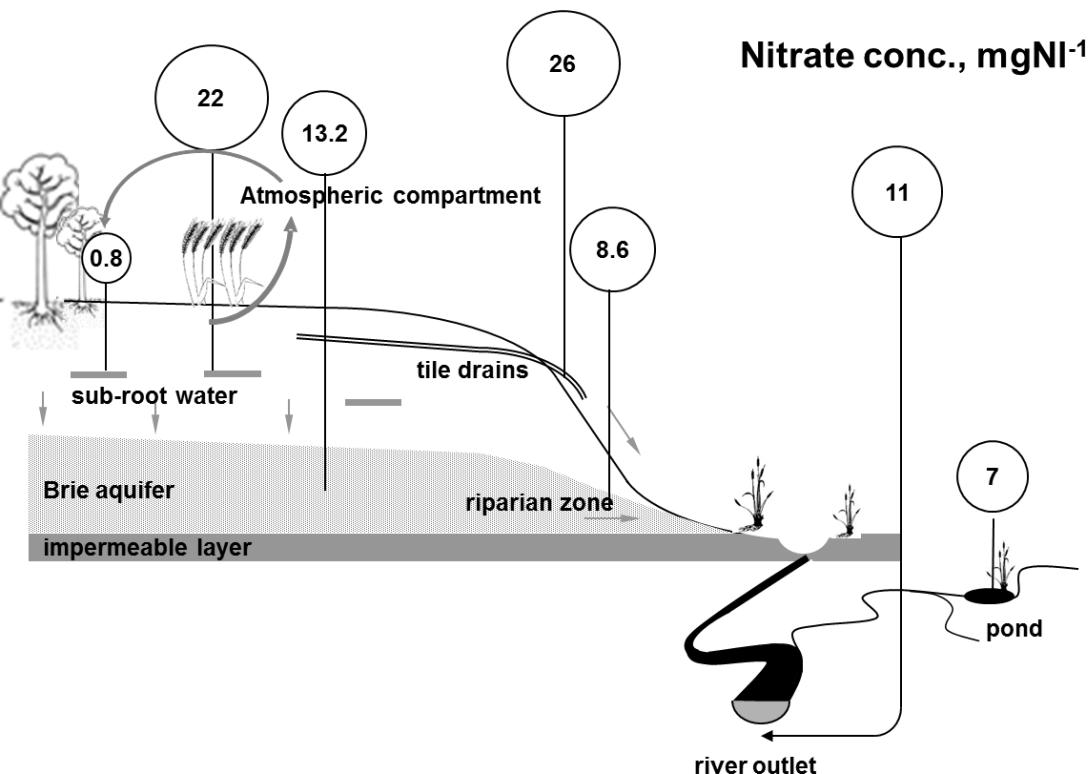


The catchment scale: important results for imagining scenarios

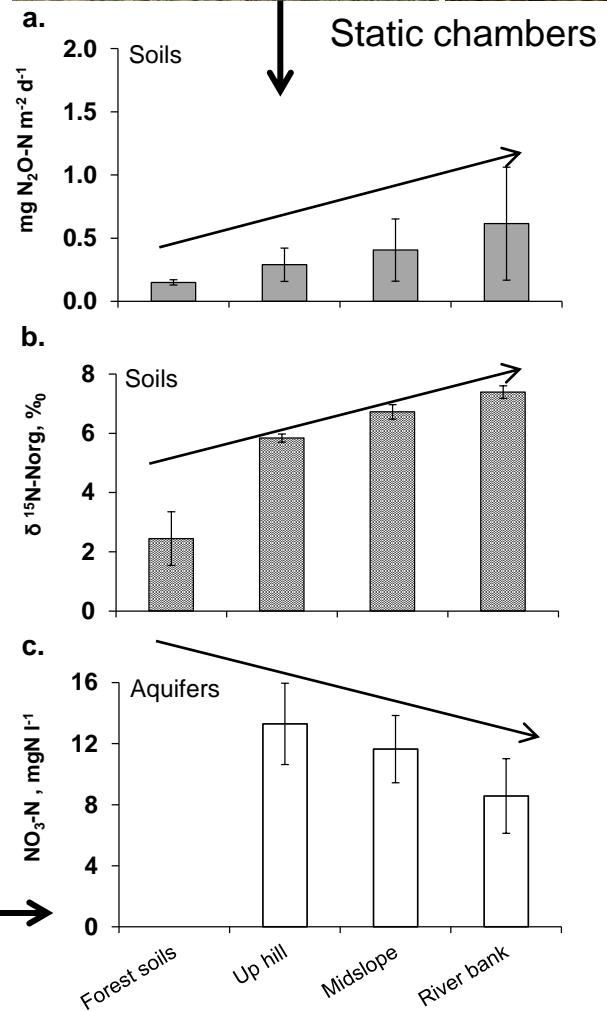
→ focused on intensive field measurements on water, soil, plant & atmosphere and their interactions

- **Atmospheric** emissions:
 - GHG and Nr emissions from managed croplands: influence of irrigation and N/P fertilizing.
 - Dispersion and deposition of NH₃ in natural ecosystems.
 - Ecotoxicity associated with atm pollution in grasslands, croplands & forests:
- **Water** & **N management**: Nitrate leaching in irrigated/rainfed cropping systems and pastures.
- **Soil**: erosion, soil C balance, N pools and restoration of degraded soils.
- **Plant**: yield, C/N balance and crop quality (yield scaled emissions)

N cascade within the Orgeval catchment



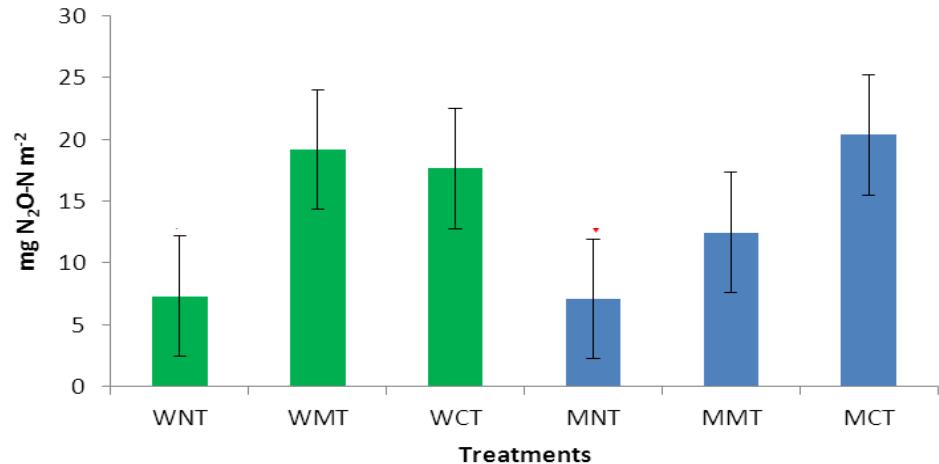
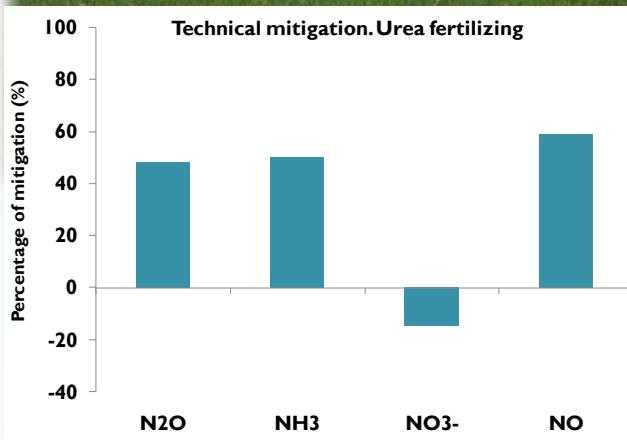
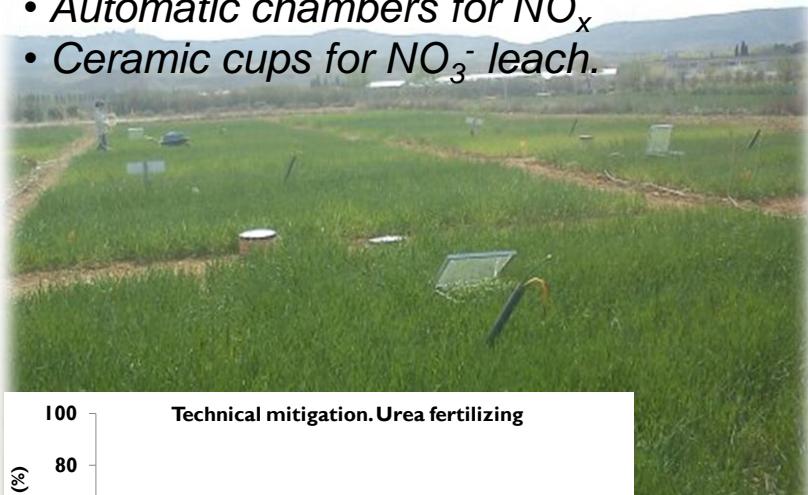
Installation of piezometers and sampling



→ Independant measurements all indicating denitrification in a slope

“El Encín” and “la Higueruela” field stations (Tagus basin, Henares catchment).

- Automatic chambers for NO_x
- Ceramic cups for NO_3^- leach.



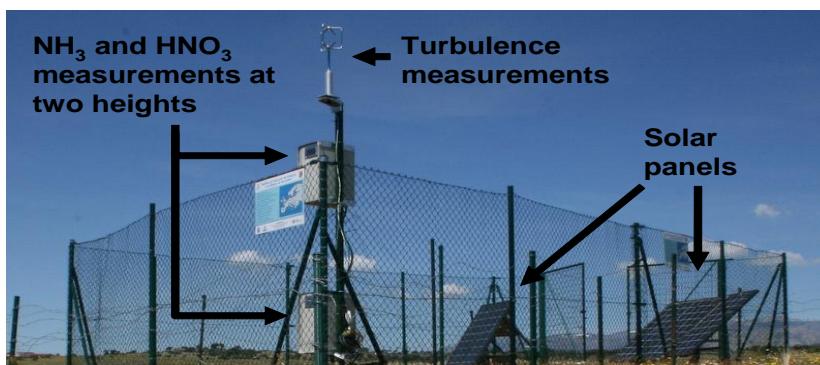
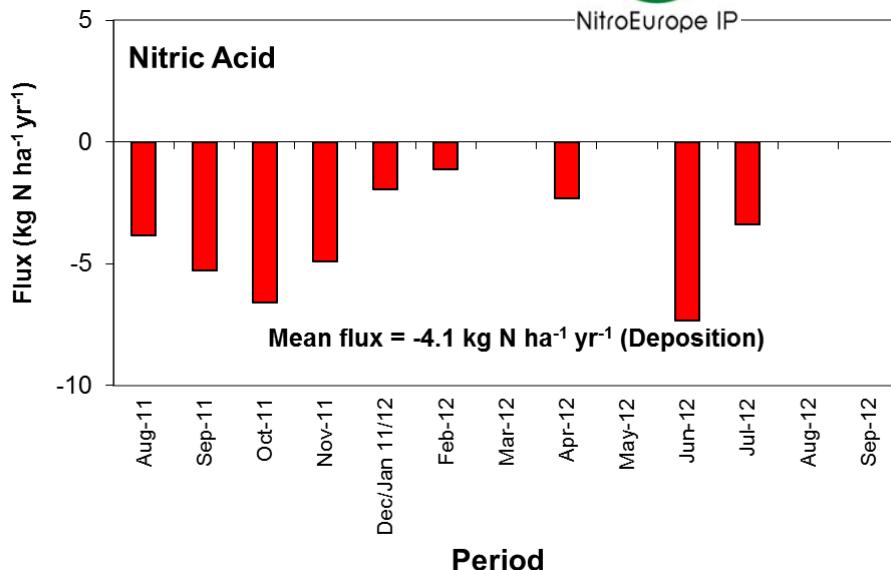
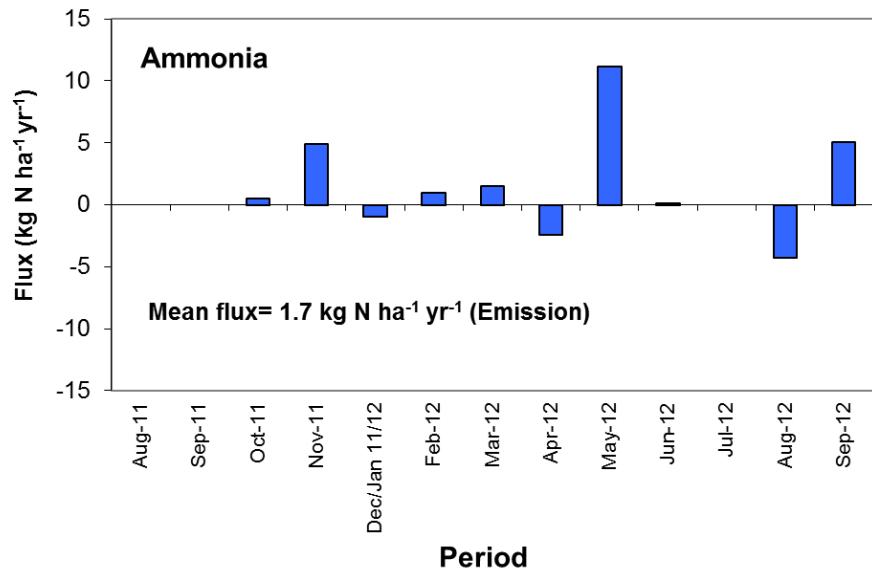
- Micromet. techniques for NH_3
- Static chambers for N_2O



Crop management strategies (irrigation, N fertilizing, tillage). Effect on Nr emissions in agrosystems.



“Dehesa de Navalvillar” (open savanna, Tagus basin).



Conditional time-averaged gradient (COTAG) system

La Higueruela experimental area (Tagus basin)



Soil-Plant-Atmosphere (OTCs)

4 ozone x 3 nitrogen treatments

Atmosphere: plant absorption fluxes,
VOCs plant emissions

soil GHG and Nr emissions

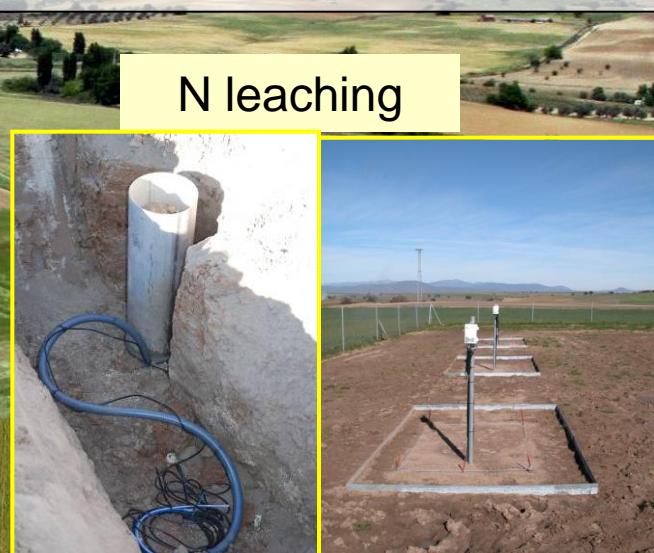
Plant: gas exchange fluxes, yield, C/N
balance , crop quality

Soil: emissions, N pools

Atmospheric N deposition



N leaching



Tres Cantos monitoring area (Tagus basin)



Soil-Plant-Atmosphere

in Mediterranean broadleaf evergreen forest

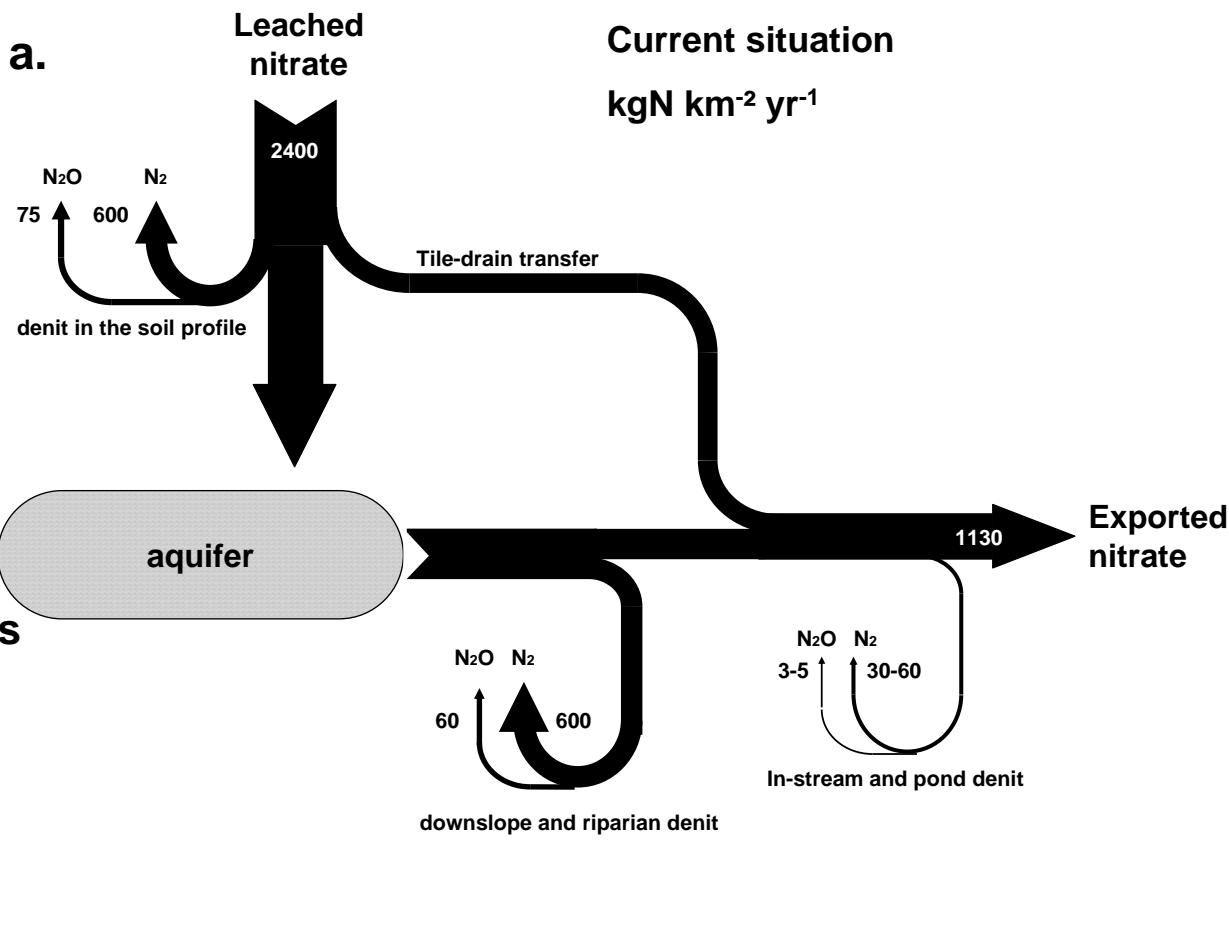
Atmosphere: atmospheric deposition (wet + dry)
gases and particles

Plant: gas exchange fluxes, C/N balance, growth

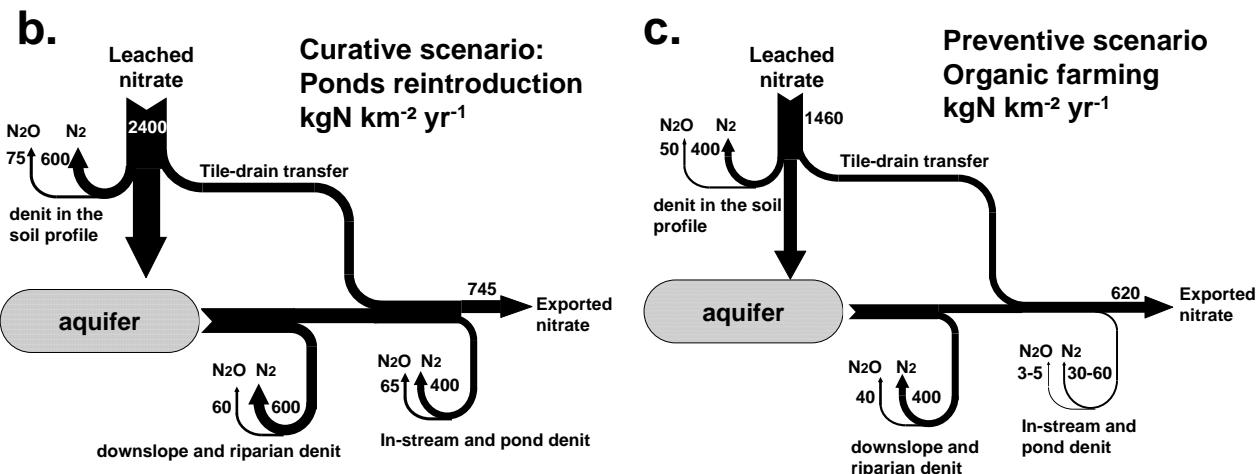
Soil: soil chemistry, water chemistry, N pools



Curative vs. preventive scenarios in the Orgeval catchment



- Curative, e.g. drainage ponds
- Nitrate reduction but N_2O increase
- preventive, e.g. organic agriculture
- Nitrate and N_2O reduction



Conclusions

A demonstration region including watersheds within :

- ✓ a range of population density from 50 to 400 inhab. Km⁻²
- ✓ a range in hydrological regime and climate

All the domain characterized by :

- ✓ An intensive agriculture
- ✓ The application of European policies

A relevant regional domain for a world wide N assessment

- ✓ Six countries concerned : Germany, The Netherlands, Belgium, UK, France, Portugal, Spain
- ✓ The Water-agrofood system to be documented in terms of N for the whole domain
- ✓ A model chain allowing to explore scenarios for the future

Existing collaborations and partners

- ✓ The research Groups of Spain
- ✓ The research Groups of France
- ✓ Others (UK)?

References

(relevant for the nitrogen cascade from land to sea)

- Garnier J., Billen G., Vilain G., Benoit M., Passy P., Tallec G., Tournebize J., Anglade J., Billy C, Mercier B., Ansart P., Sebilo M., Kao C. (in press). Curative vs. preventive management of nitrogen transfers in rural watersheds: lessons from the case of the Orgeval watershed (Seine River basin, France). *J. Environmental Management*
- Lancelot C, Thieu V., Polard A., Garnier J., Billen G., Hecq W., Gypens N. (2011). Ecological and economic effectiveness of nutrient reduction policies on coastal *Phaeocystis* colony blooms in the Southern North Sea: an integrated modeling approach. *Sciences of the Total Environment* 409: 2179–2191. doi:10.1016/j.scitotenv.2011.02.023.
- Passy, P., Gypens, N., Billen. G., Garnier, J., Lancelot, C., Thieu, V., Rousseau V., Callens, J. (2013). A Model reconstruction of riverine nutrient fluxes and eutrophication in the Belgian Coastal Zone since 1984. *J. Mar. System.* 128: 106–122. <http://dx.doi.org/10.1016/j.jmarsys.2013.05.005>.
- Romero E., Garnier J., Lassaletta L., Billen G., Le Gendre R., Riou P., Cugier P. (2012) Large-scale patterns of river inputs in SW Europe: seasonal and interannual variations and potential eutrophication effects at the coastal zone. *Biogeochemistry* 113, 481-505. DOI 10.1007/s10533-012-9778-0.
- Thieu V., Billen G., Garnier J., Benoit M. (2010). Nitrogen cycling in a hypothetical scenario of generalised organic agriculture in the Seine, Somme and Scheldt watersheds. *Reg Environ Change.* 11:359–370. DOI 10.1007/s10113-010-0142-4

(relevant for the N cascade from land to atmosphere & groundwater. Effect of crop management practices)

- Sanz-Cobena, A., Sanchez-Martín, L., García, L., Vallejo, A. 2012. Gaseous emissions of N_2O and NO and NO_3^- leaching from urea applied with urease and nitrification inhibitors to a maize (*Zea mays*) crop *Agriculture, Ecosystem & Environment* 149: 64-73
- Abalos D., Sanz-Cobena, A., Misselbrook, T., Vallejo, A. 2012 Effectiveness of urease inhibition on the abatement of ammonia, nitrous oxide and nitric oxide emissions in a non-irrigated Mediterranean barley field. *Chemosphere* 89: 310-318
- Abalos D., Sanz-Cobena, A., García-Torres, L. van Groenigen, J.W., Vallejo, A. 2013 Role of maize stover incorporation on nitrogen oxide emissions in a non-irrigated Mediterranean barley field. *Plant and Soil* 364: 357-371
- Sanz-Cobena A., García-Marco S., Quemada M., Gabriel J. L., Almendros, P., Vallejo A. 2014. The role of cover crops in irrigated systems: N_2O , CO_2 and CH_4 emissions. *Science of the Total Environment*.
- Sanchez-Martín, L, Sanz-Cobena, A., Meijide, A, Quemada, M, Vallejo, A. 2010. The importance of the fallow period for N_2O and CH_4 fluxes and nitrate leaching in a Mediterranean irrigate agroecosystem *European Journal of soil science* 61: 710-720
- Sanchez-Martín, L, Meijide, García-Torres, L, Vallejo, A. 2010. Combination of drip irrigation and organic fertilizer for mitigating emissions of nitrogen oxides in semiarid climate.