



Landscape Patterns and Ecosystems Processes in Agricultural Landscapes: Causes and Consequences

Jacques Baudry, Françoise Burel

► To cite this version:

Jacques Baudry, Françoise Burel. Landscape Patterns and Ecosystems Processes in Agricultural Landscapes: Causes and Consequences. Landscape patterns and processes in the Armorique LTER, University of Colorado. Institute of Arctic and Alpine Research, Boulder, USA., Feb 2011, Boulder, United States. 36 p. hal-02810181

HAL Id: hal-02810181

<https://hal.inrae.fr/hal-02810181>

Submitted on 6 Jun 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

University of Colorado, Boulder
INSTARR (Institute of Arctic and Alpine Research)
Seminar February, 2011

Landscape Patterns and Ecosystems Processes in Agricultural Landscapes: Causes and Consequences

Jacques Baudry

National Institute for Agronomic Research
Armorique LTER
jbaudry@rennes.inra.fr

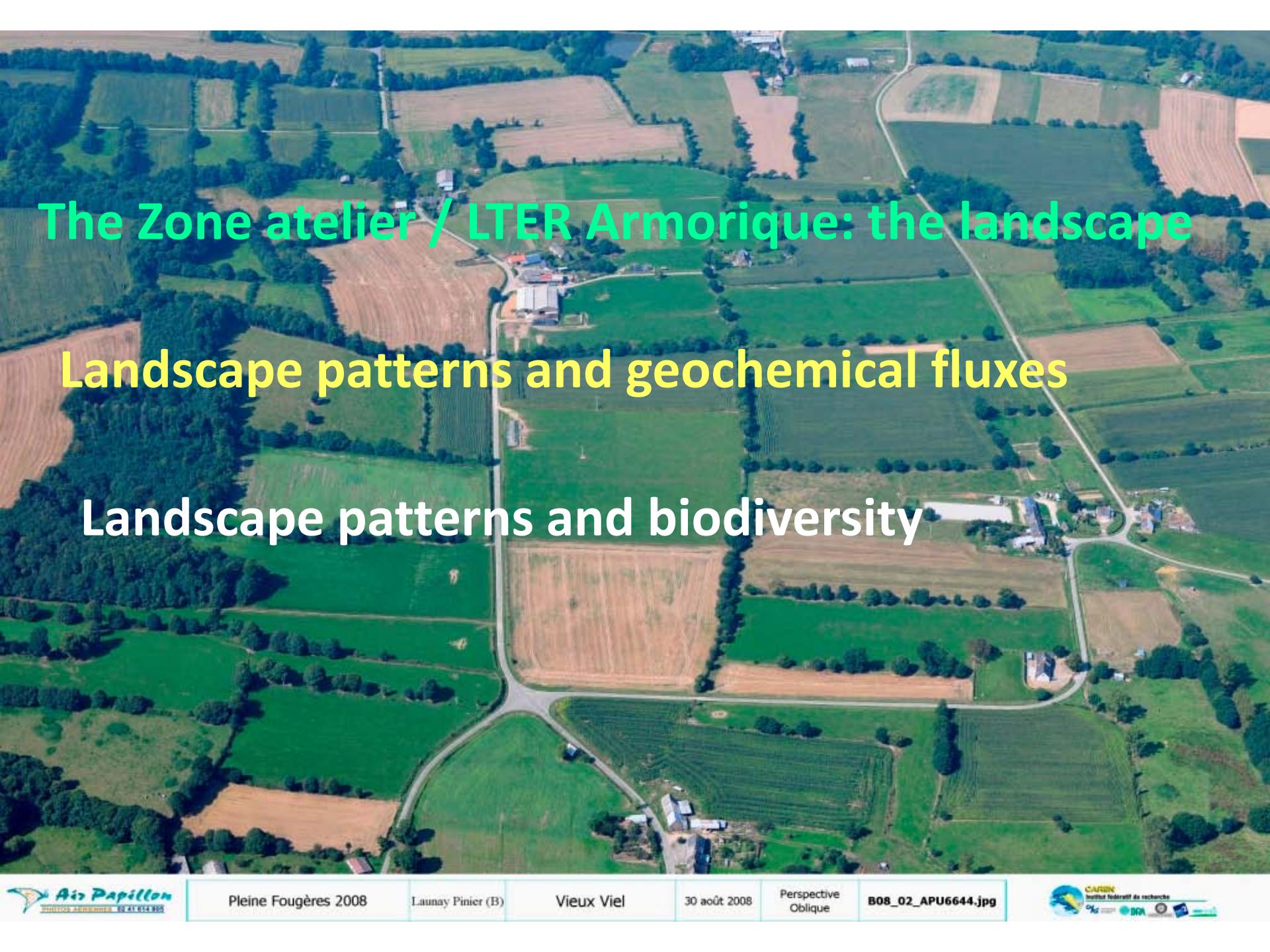
Françoise Burel
CNRS, (National Center for Scientific
Research Ecobio

Francoise.burel@univ-rennes1.fr



An aerial photograph of a rural landscape. In the foreground, there's a large green field with some darker, possibly harvested or fallow areas. A dense cluster of green trees is visible in the lower center. In the middle ground, a road or path cuts through the fields, leading towards a small cluster of houses and buildings that form a village. The background shows more fields extending to the horizon under a clear sky.

How an agricultural landscape has been designed over millennia to control ecological processes, therefore to provide services to the society.
How changes in landscape patterns induce changes in ecological processes.



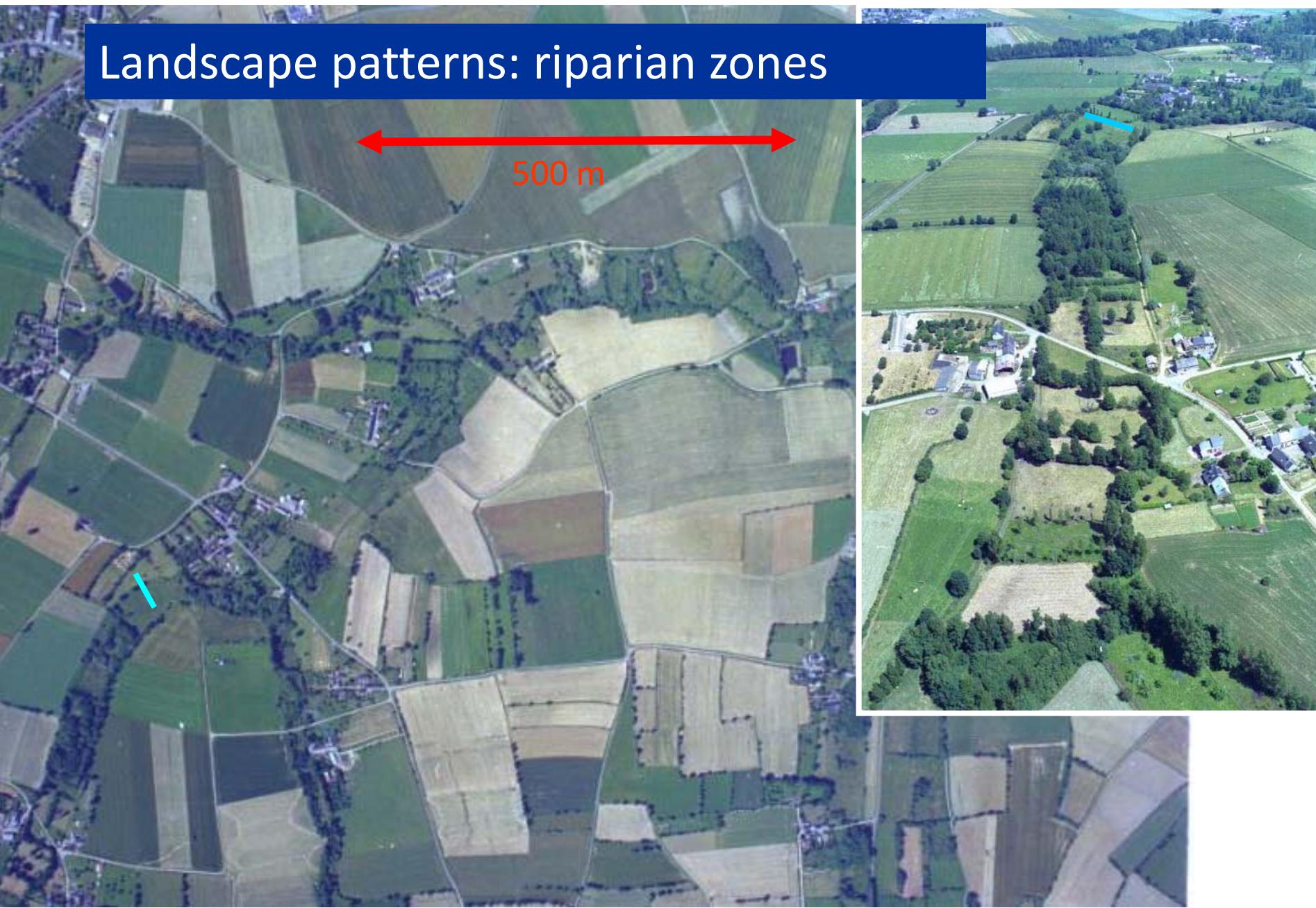
The Zone atelier / LTER Armorique: the landscape

Landscape patterns and geochemical fluxes

Landscape patterns and biodiversity

The Zone atelier / LTER Armorique: A man made landscape

Landscape patterns: riparian zones



Gradient of hedgerow density/ land use



Paysage Fougeres 2008 Le Grand Moulin (E) Trans 27 juillet 2008 Perspective oblique AGRI_01_AP01564.jpg



Paysage Fougeres 2008 Lezay-Poussy Vieux Val 30 juillet 2008 Perspective oblique AGRI_01_AP01601.jpg



Paysage Fougeres 2008 La Pile IC Paysage Fougeres 01 août 2008 Perspective oblique C01_01_AP01624.jpg

The function of hedgerows

Firewood, timber
Fence
Etc.

Planted on a bank
along a ditch

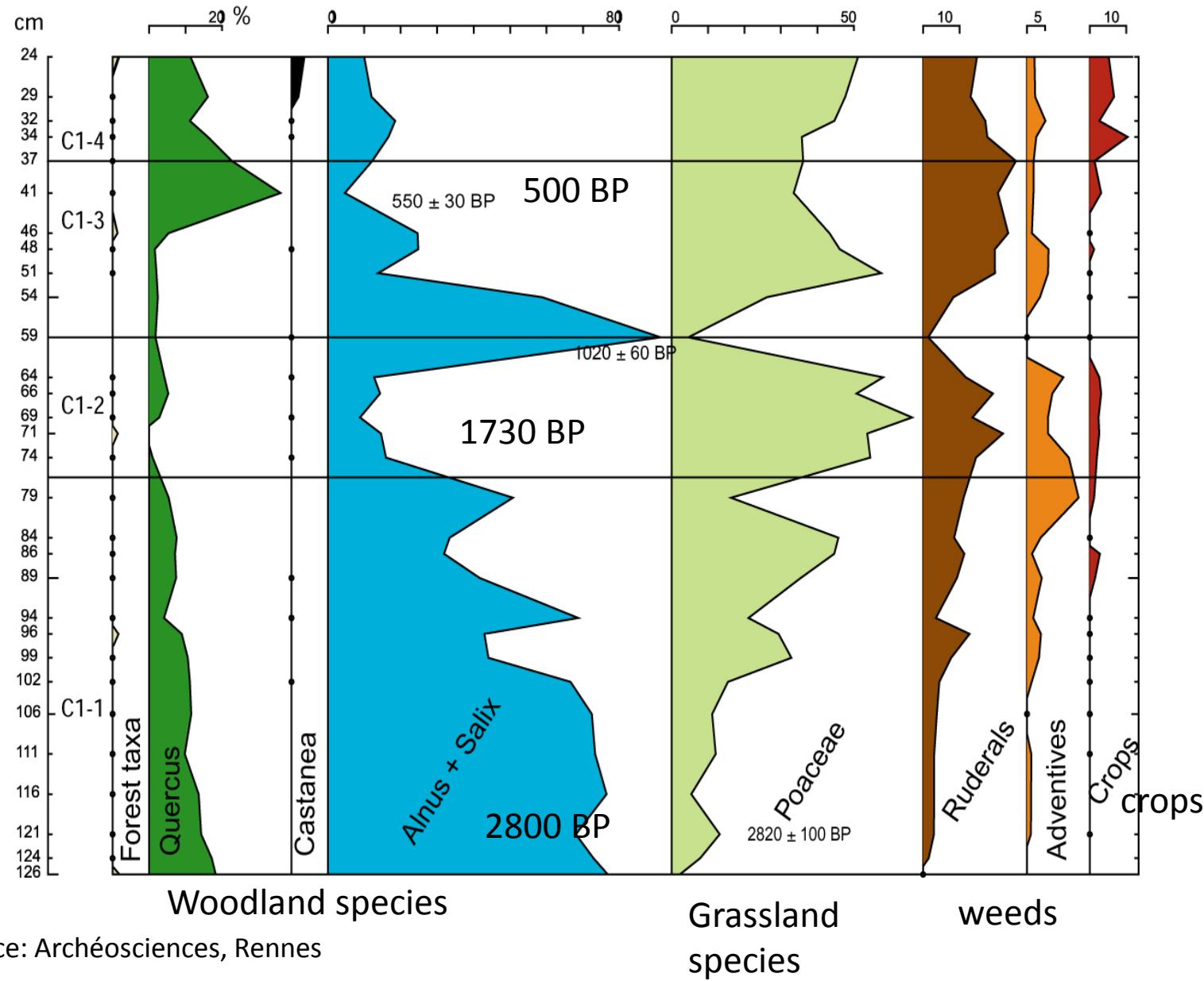
Control of water flow



Erosion control

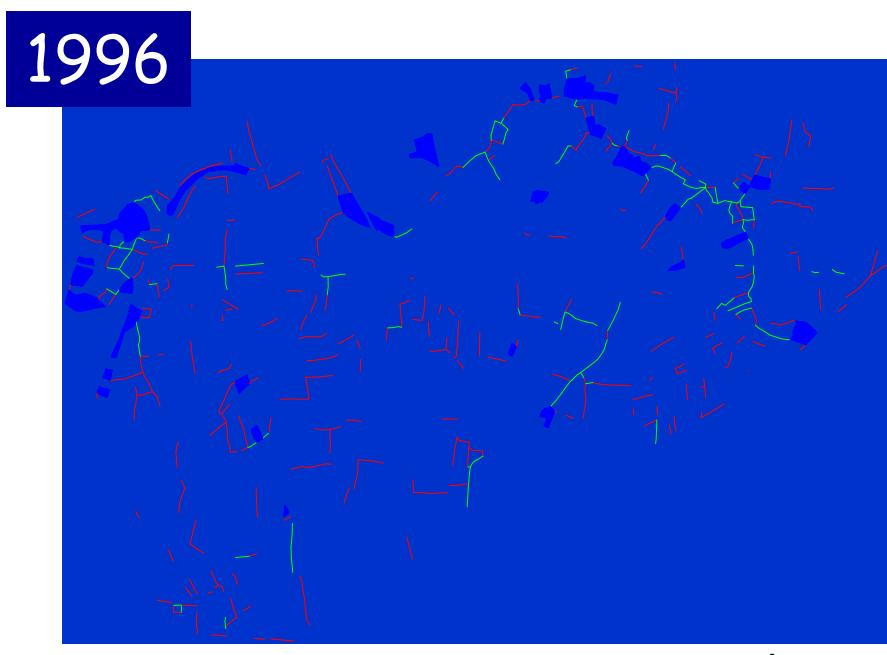
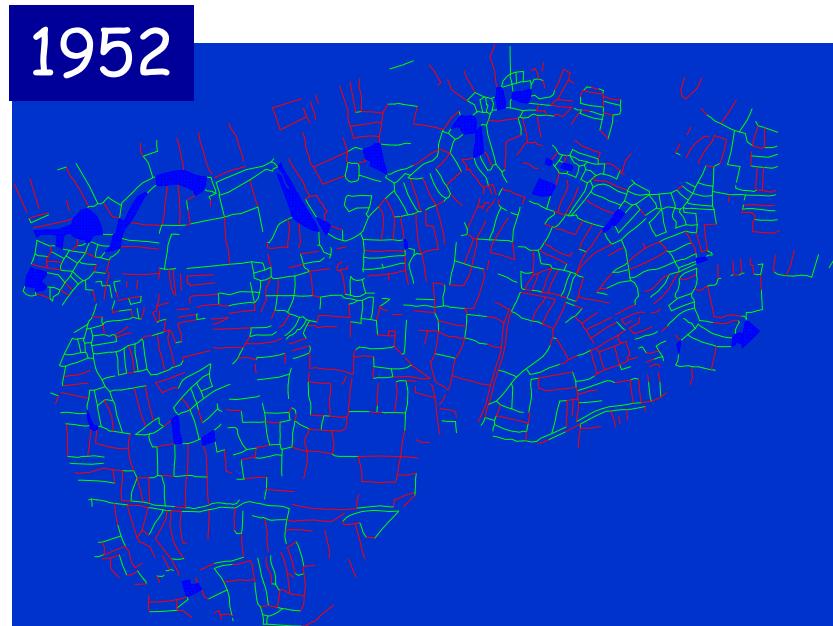


The Zone atelier / LTER Armorique: a landscape with a long history



Source: Archéosciences, Rennes

The Zone atelier / LTER Armorique: A fast changing landscape



North



Hedgerows with continuous tree cover



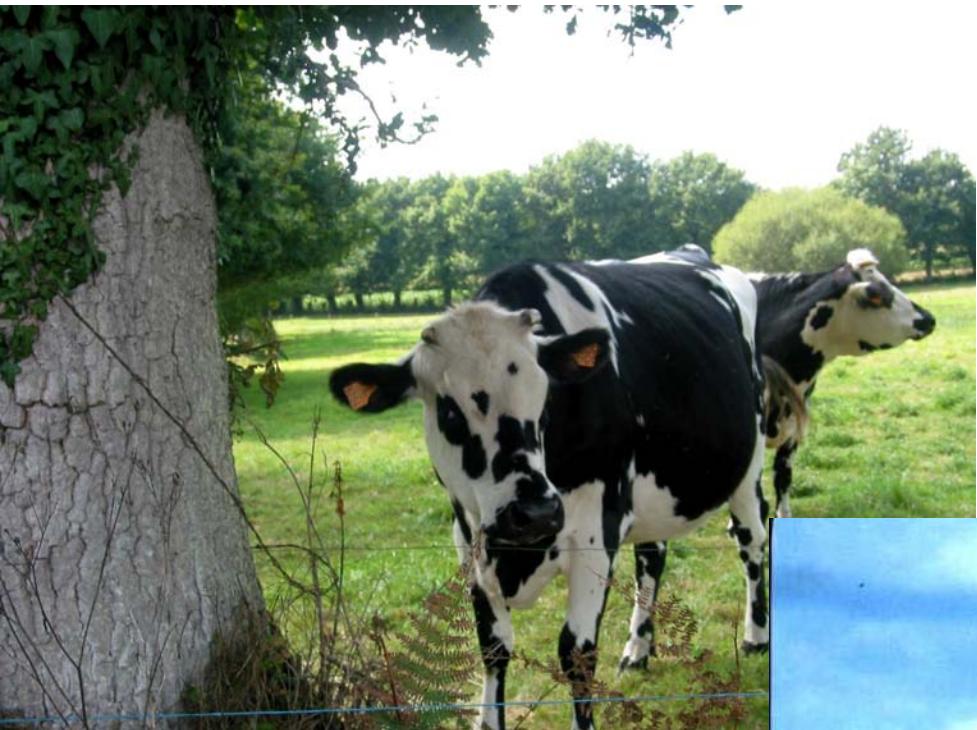
Hedgerows with non-continuous tree cover

■ Woodland (ha)

1952	1966	1982	1990	1996
61,50	35,75	18,50	12,00	7,00
58,00	52,25	31,00	27,50	19,50
15,25	15,50	19,50	15,25	18,25

Source: P. Morand

From small “self-sufficient” farms

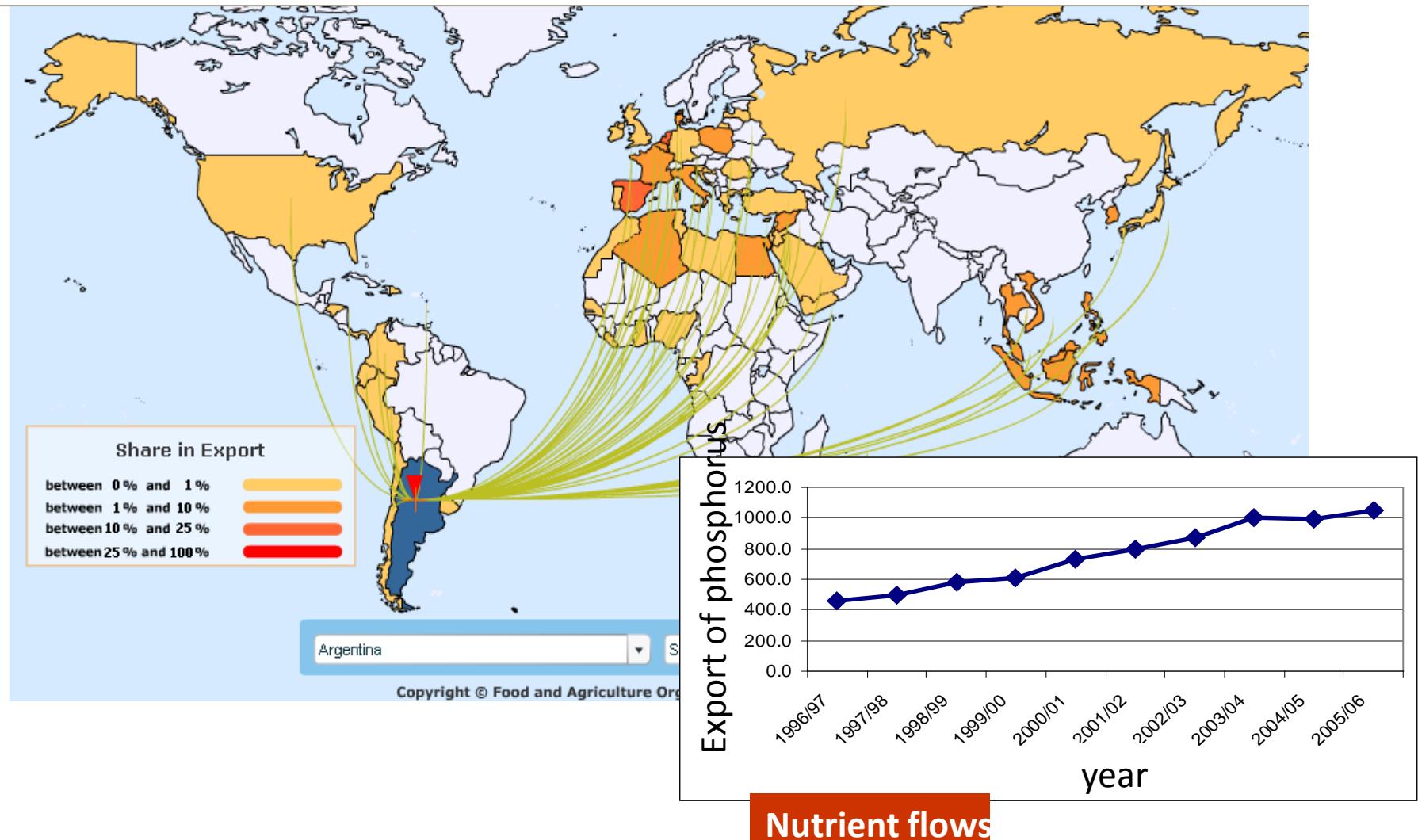


To highly productive
industrial farms
embedded in the global
food market

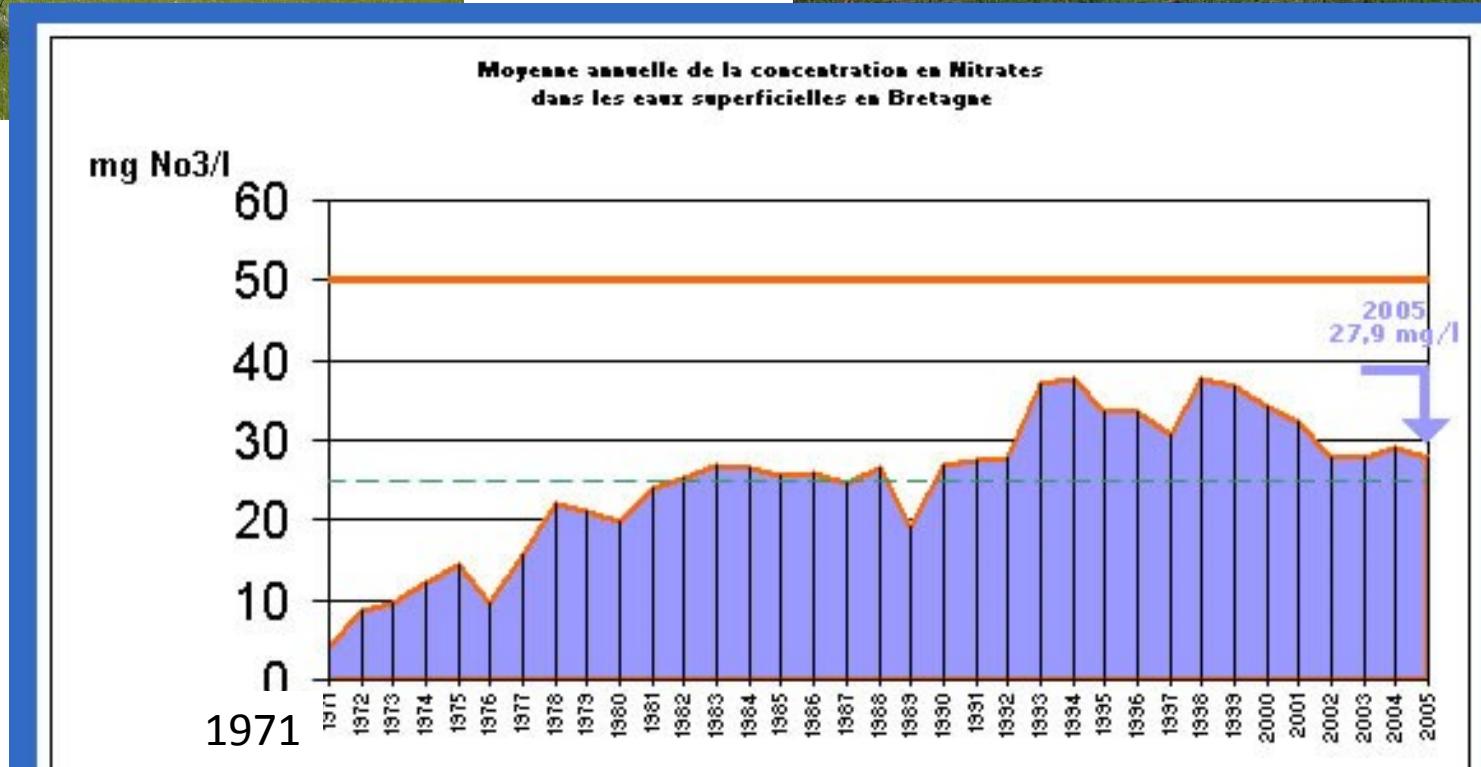


The Zone atelier / LTER Armorique: A landscape connected to the world

World trade: Export of soybean from Argentina



Nutrient flows



Annual average level in Brittany (from DIREN and Agence de l'eau)

The Armorique LTER: hydrology, nutrient fluxes as related to landscape patterns

Do some elements have a specific role in the control of biogeochemical fluxes?

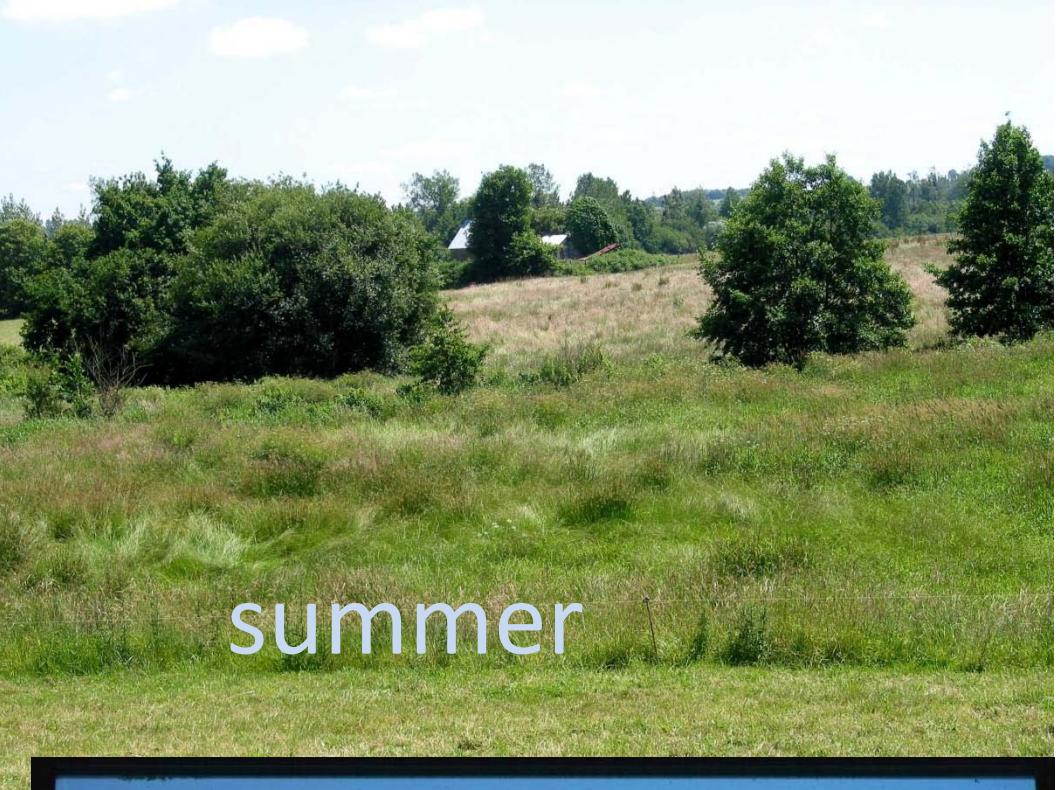
Riparian zone
Hedgerow

Does that translate at the landscape level?

Watershed



(1) Riparian zone

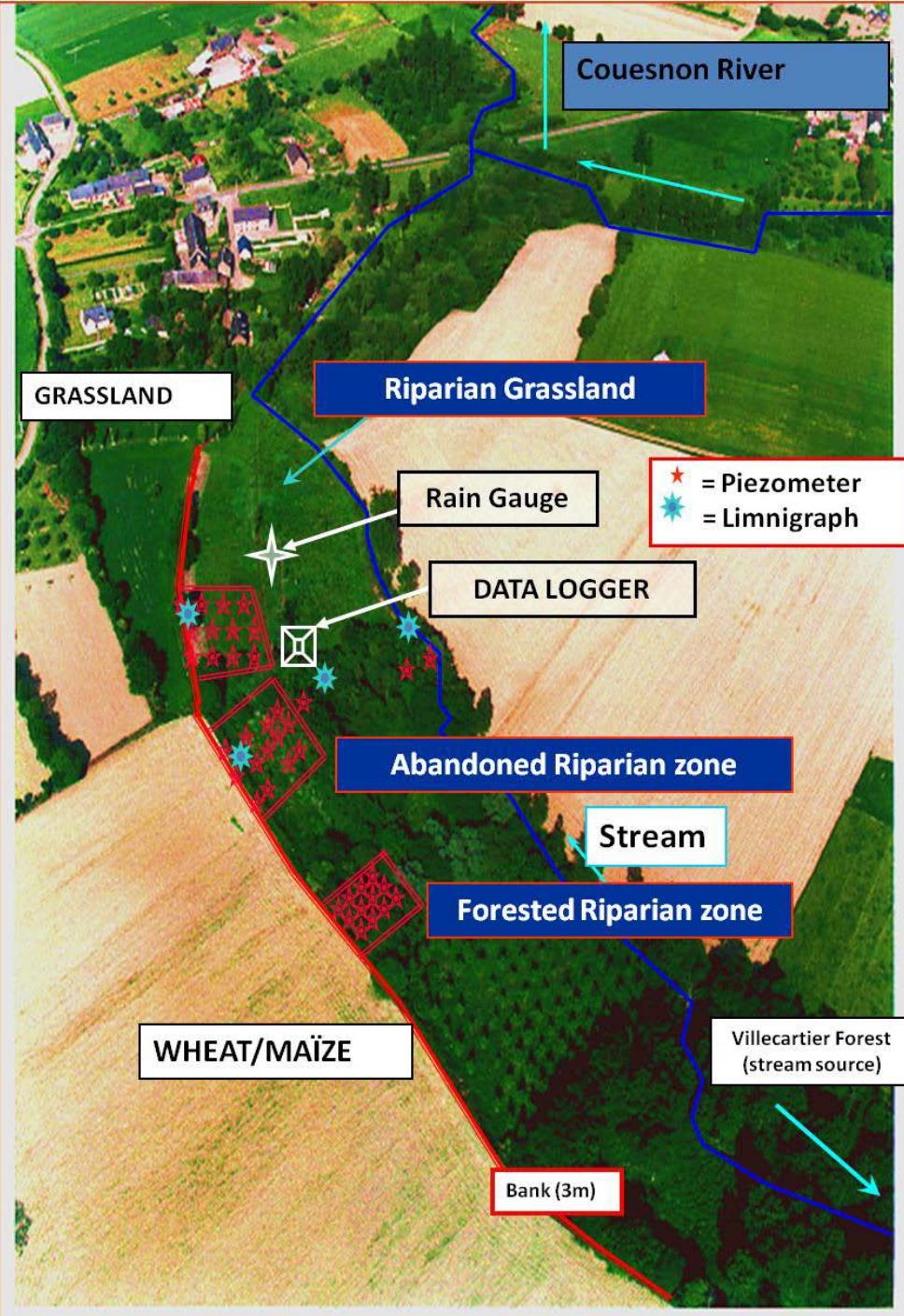


summer



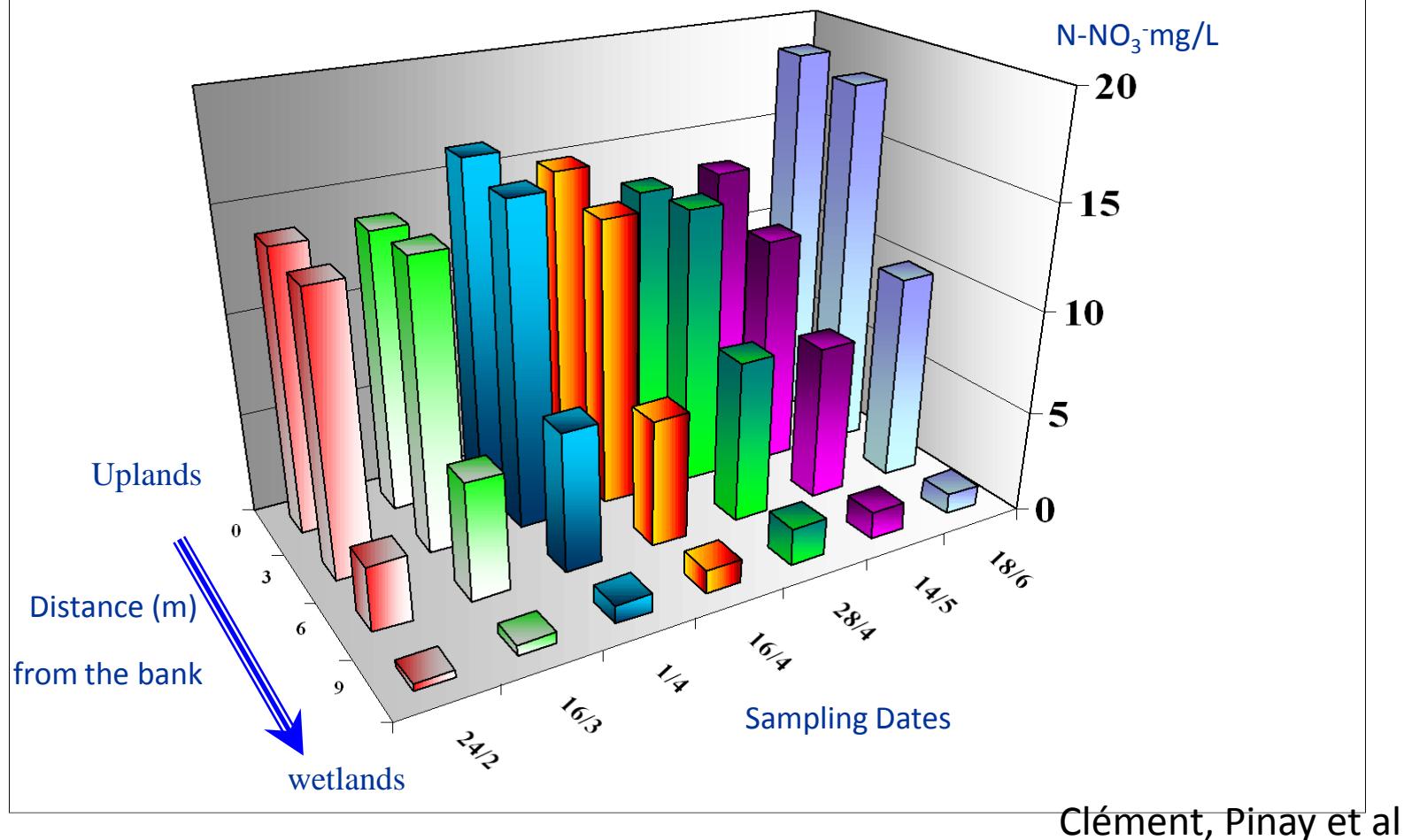
winter

Denitrification ?

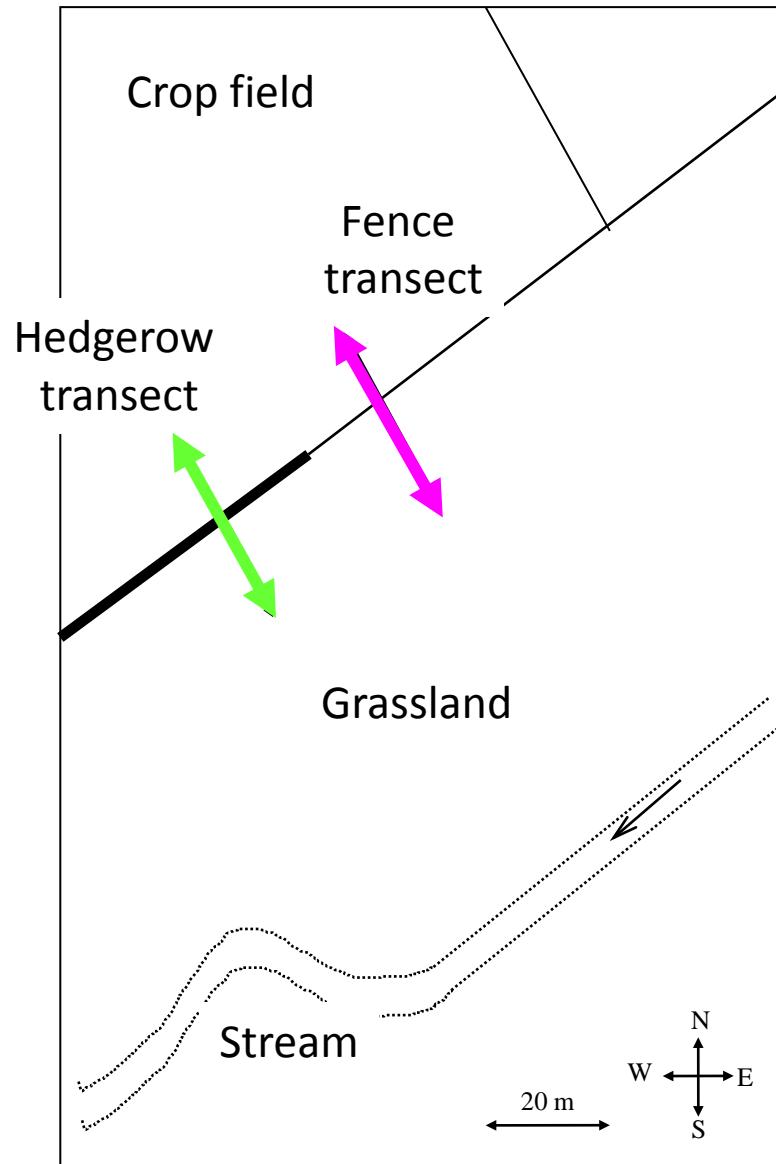
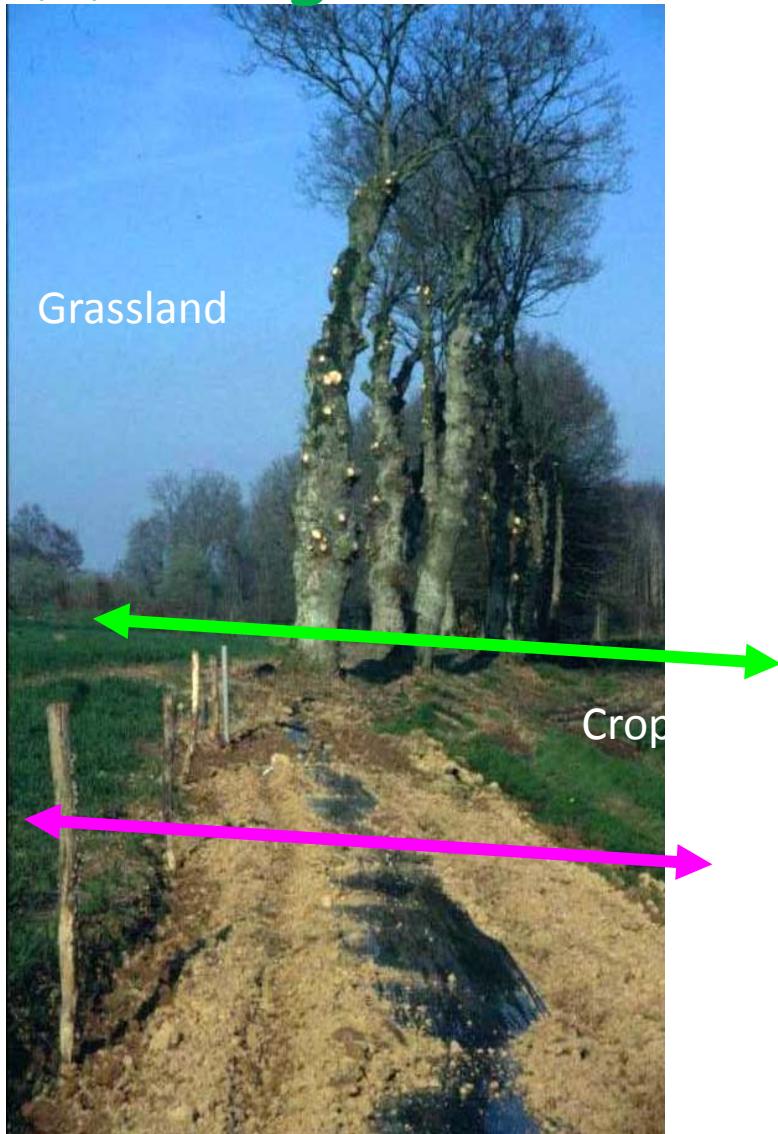


Clément, Pinay et al

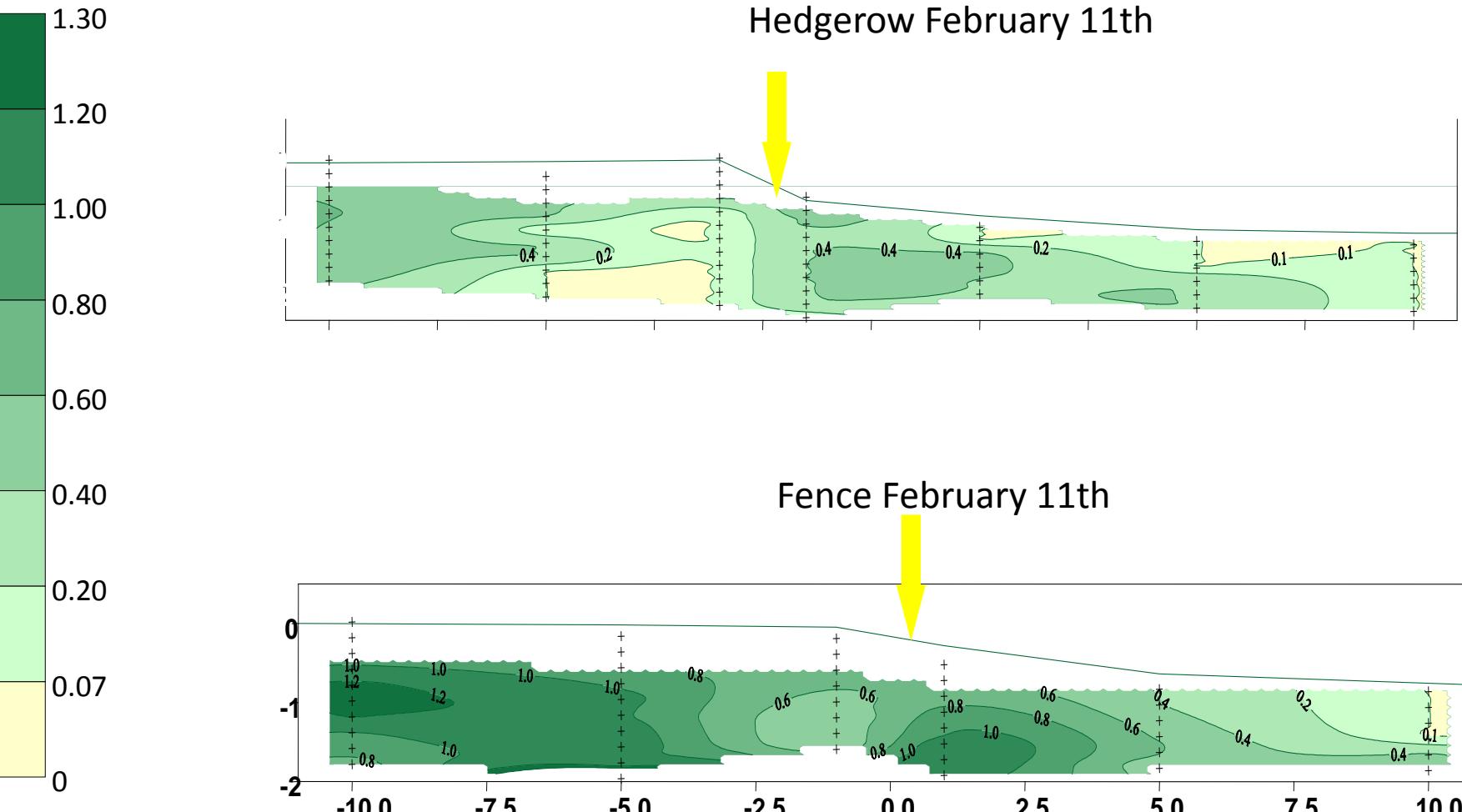
N-NO₃- concentrations along the riparian flowpath



(1) hedgerow



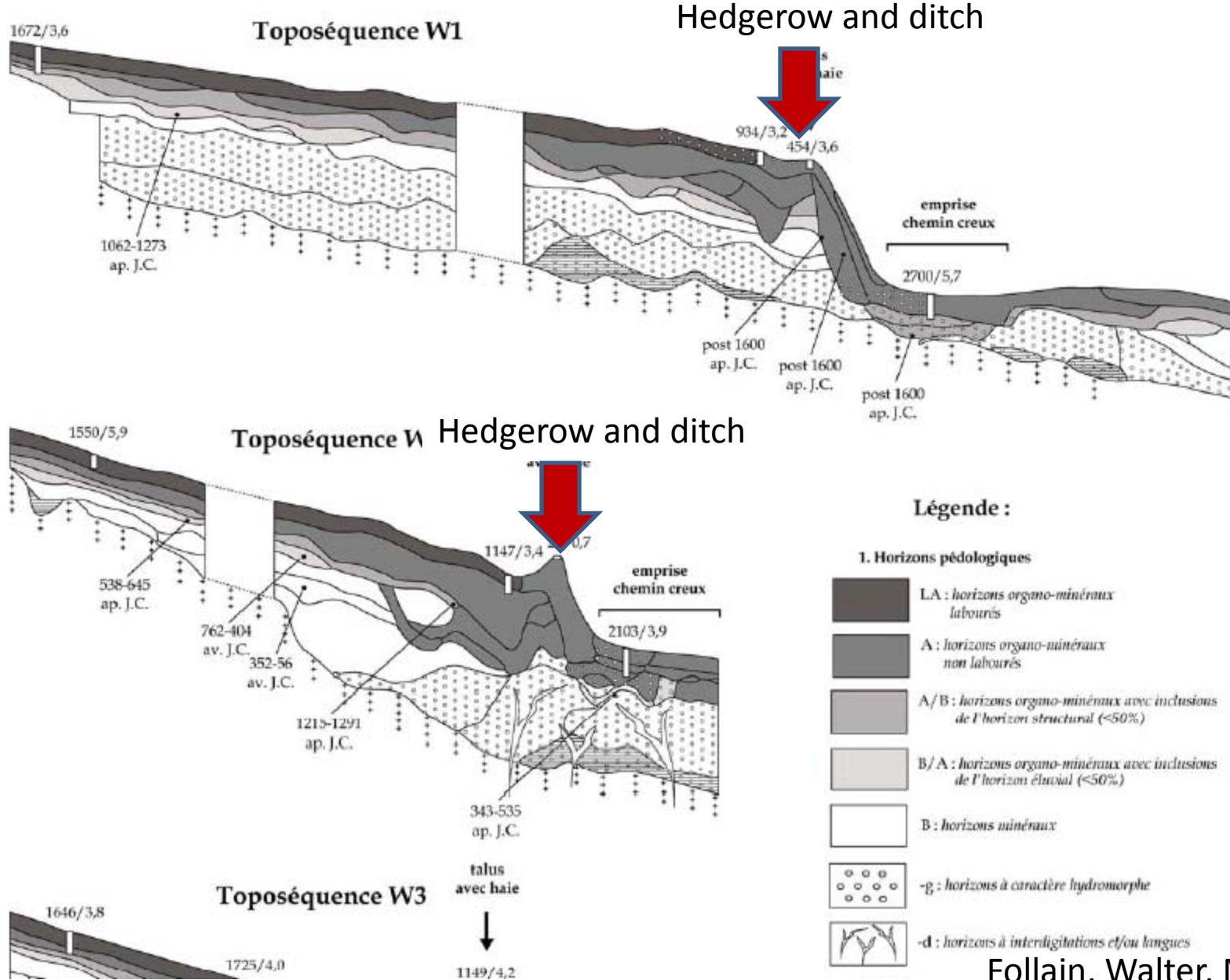
Hedgerow as a buffer



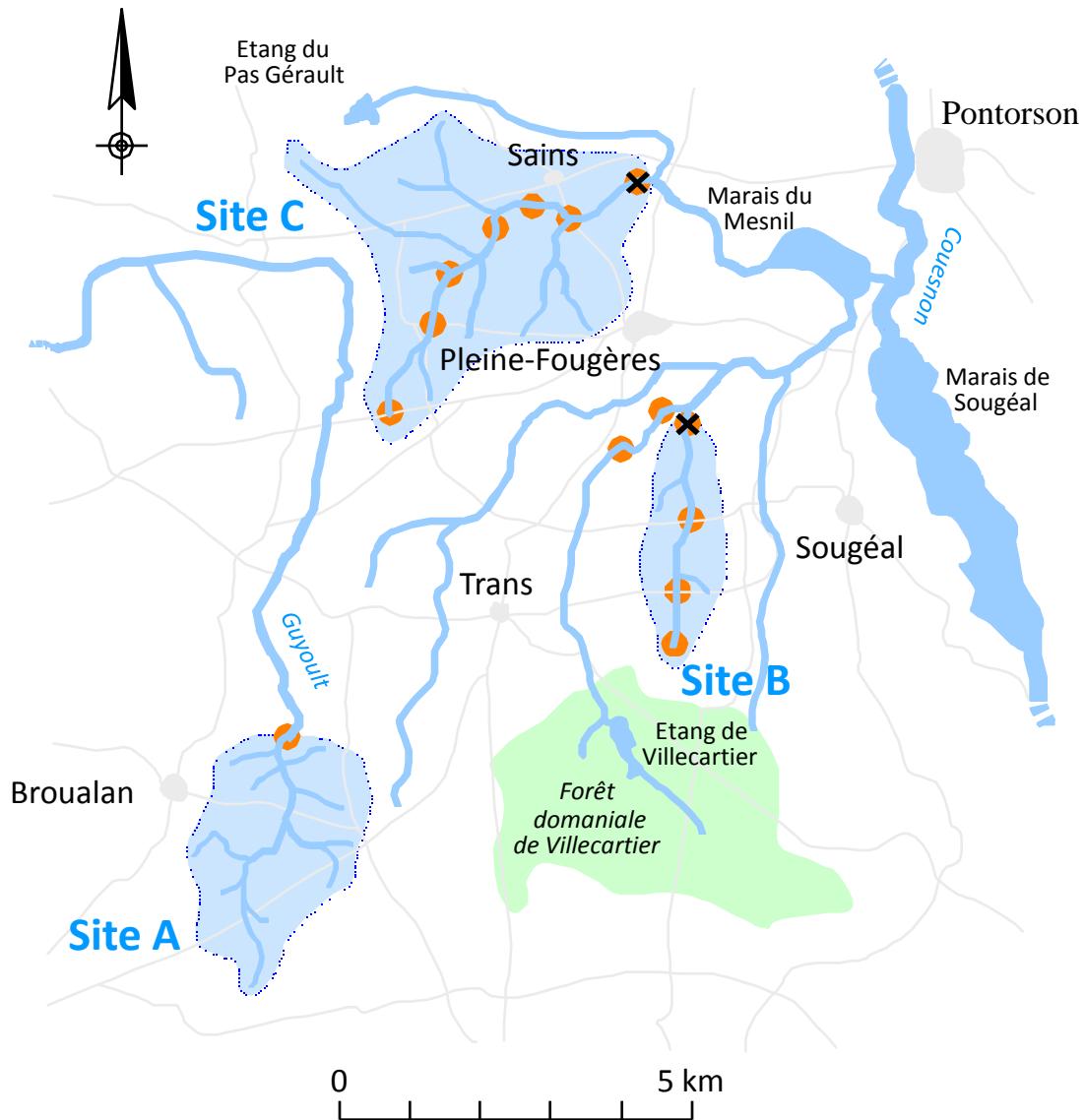
1 millimole NO₃ = 62 mg/l

Caubel, Mérot, Grimaldi

Accumulation of organic matter



At the watershed scale



Site A:

granit
area = 647 ha
Beven = 17,5%

Site B:

Shale and silt
area = 227 ha
Beven = 20,7%

Site C:

Shale and silt
area = 1082 ha
Beven = 20,5%

● Suivis bi-mensuels

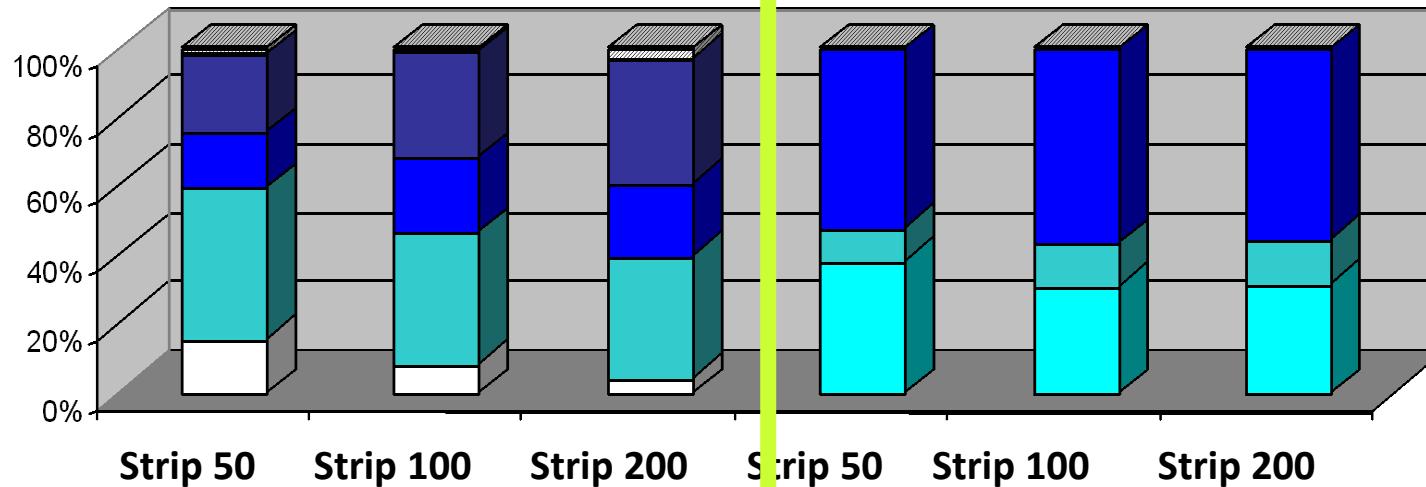
✖ Suivis asservis aux régimes
d'écoulement

Heterogeneity of fertilization level

Maize

Zone Outlet

Zone Headwater



Grassland

Strip 50

Strip 100

Strip 200

Legend:
N ferti. in
kg/ha

■ Missing data

— > 300

■ 150-200

■ 100-150

■ 50-100

■ 0-50

■ 0

Strip 50 Strip 100 Strip 200

N fertilization, by land cover, and distance from a stream

Estimated nitrogen input

At the watershed scale

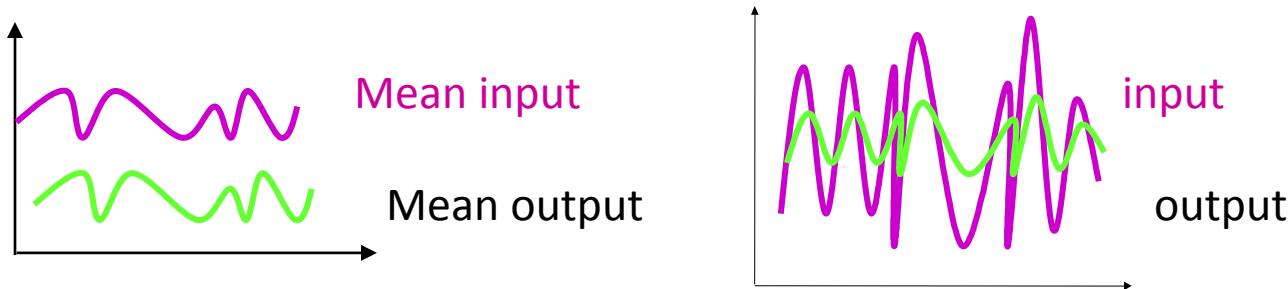


Catchments	A	B	C	D	N
Area (km²)	6.37	2.09	4.61	2.91	4.95
Bedrock	granite	schist	schist	schist	schist
Hedgerows (m.ha⁻¹)	100	103	66	47	37
Bottom wetlands (km²)	1.75	0.37	0.40	0.52*	0.40**
Land-use (%)					
Cultures and rotational grasslands	52	66	78	75	88
Permanent grasslands	41	29	18	20	5
Other land-use	7	5	4	5	7
Nitrogen input (kg N. ha⁻¹)	190***	230***	232***	201****	350****

Viaud,
Mérot,
Baudry

concentration of NO₃ in streams

Buffer effects



Measured nitrogen output (concentration) NO₃⁻

Catchment	NO ₃ ⁻	
	Mean	Standard-deviation
A	12.3	3.5
B	31.3	3.1
C	33.7	6.8
D	35.9	6.0
N	68.5	12.9

1

5.5

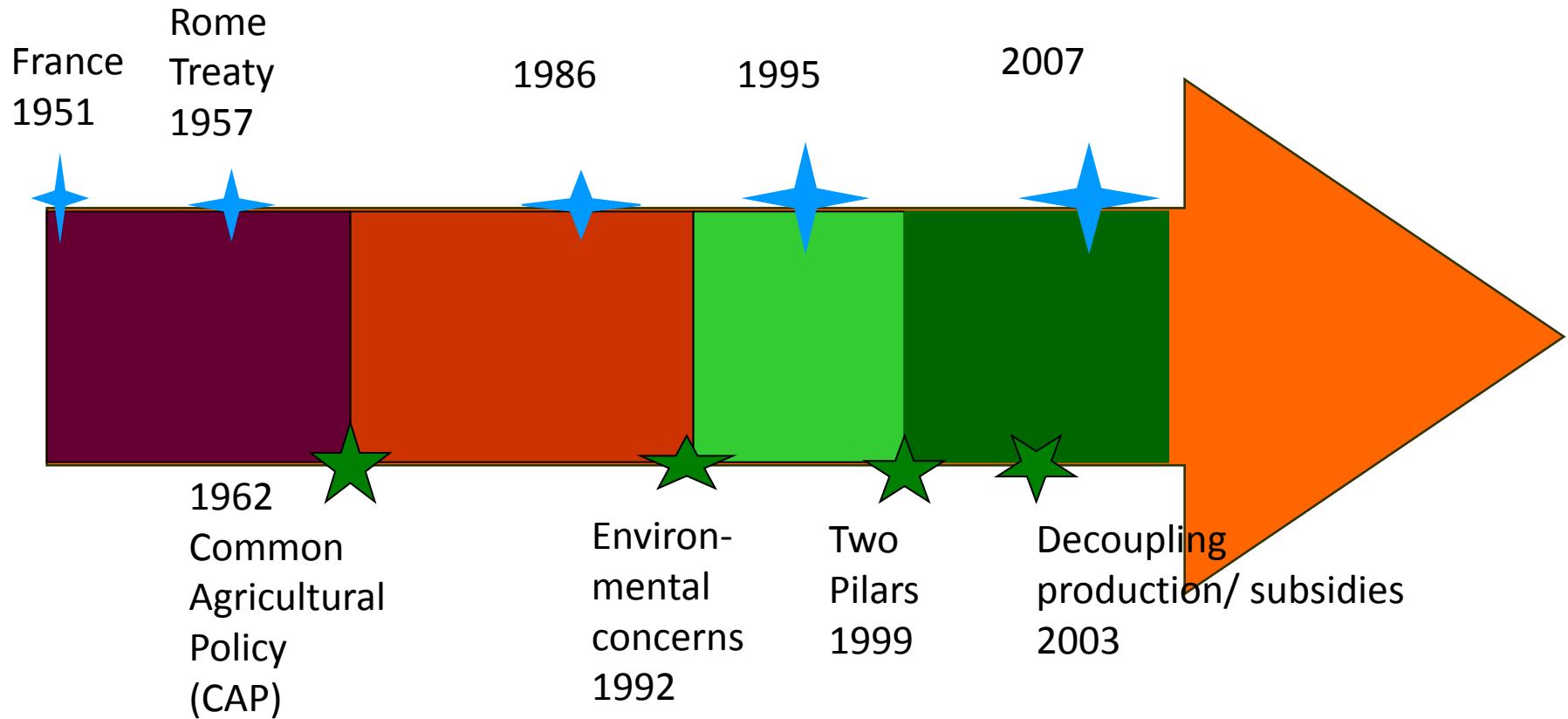
Hedgerow density or hedgerow network patterns?

The position of hedgerows: parallel or perpendicular to the slope is a key factor

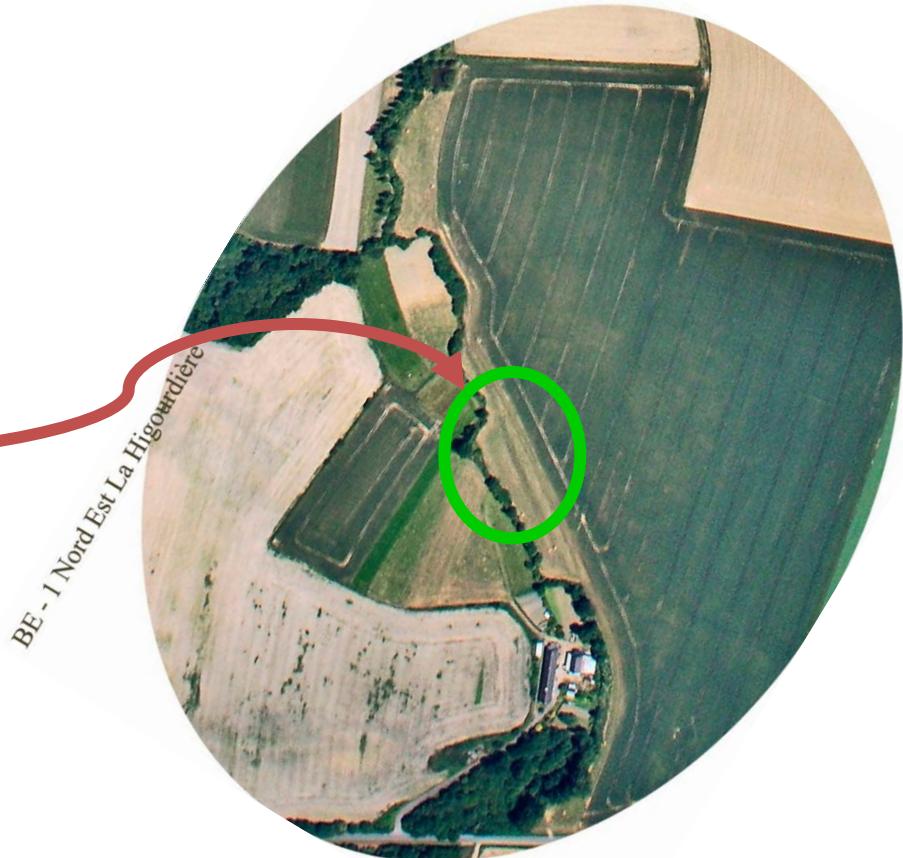
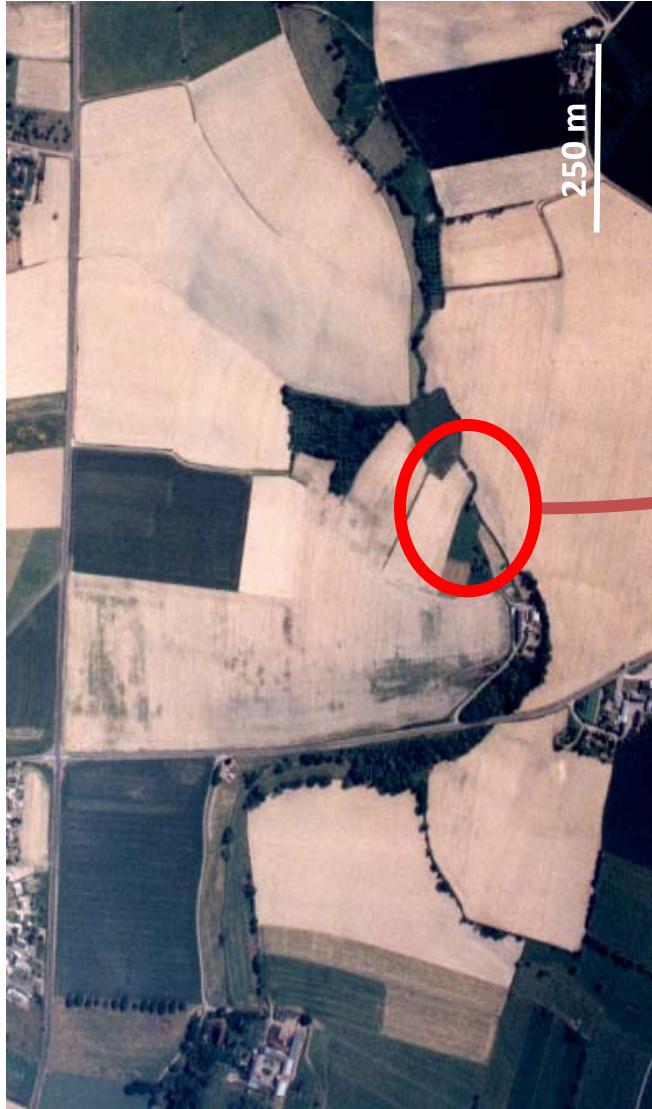


Regional drivers/ responses - EU

EU: the Common Agricultural Policy



RESPONSE for water quality



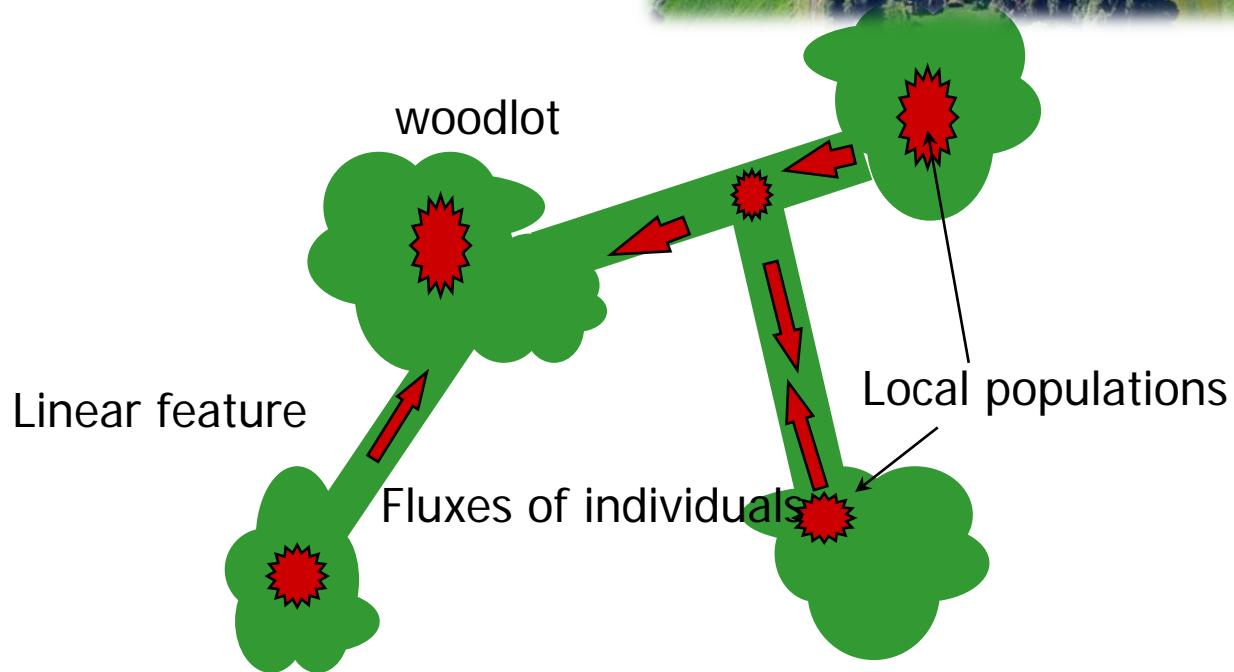
Implementation of grassy strips: nitrate directive, cross-compliance

The Armorique LTER: biodiversity

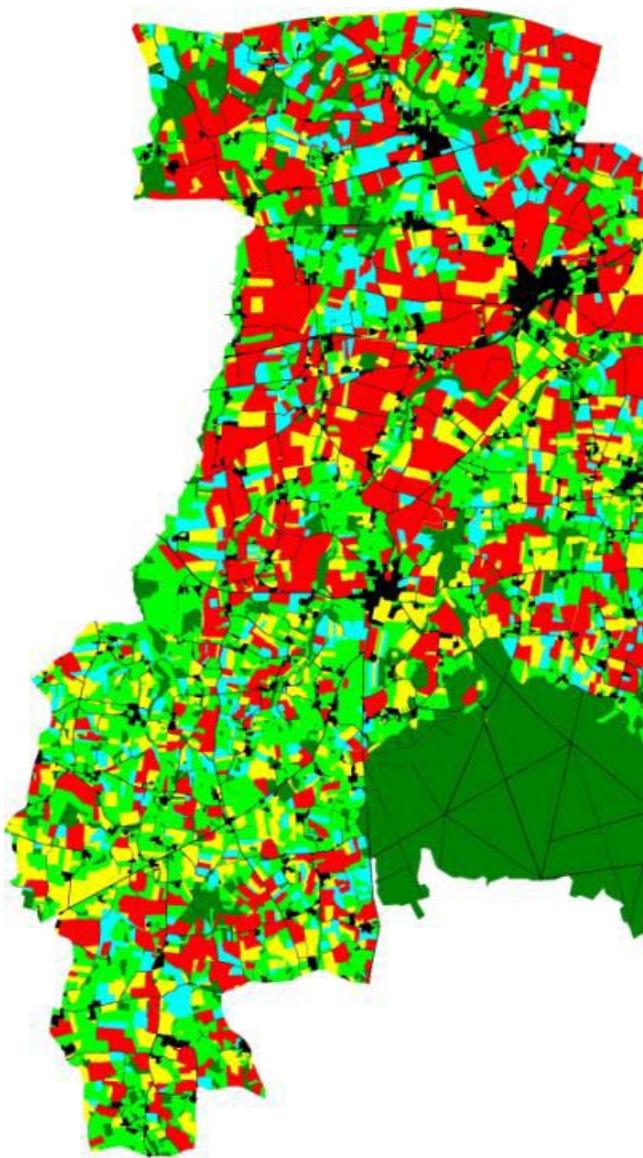
How the landscape patterns that control biogeochemical flows affect biodiversity patterns?



Hedgerows act as corridors for forest carabid beetles



Crop succession 2002-2006



Corridor efficiency of hedgerows
depends on their surroundings

They must be surrounded by
permanent grasslands and woodlots

- woodland
- Permanent grassland
- 50% grassland
- Few grassland
- No grassland
- Buildings & roads



The effects of landscape structure and composition on wild bees

Many agricultural crops and natural plant populations are dependent on **pollination by insects**.

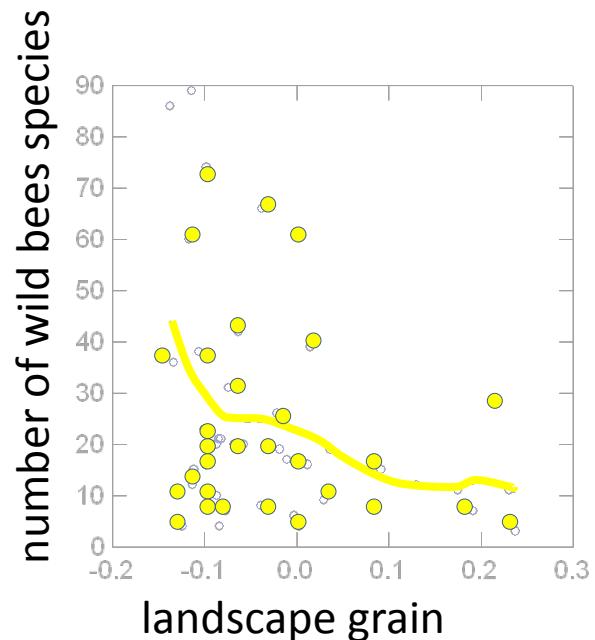
Alarming **declines in wild bee populations** have been reported for various countries all around the world.

Principal causes are linked to destruction and fragmentation of habitats through agricultural intensification

- decrease of **floral resources** (abundance and diversity)
- rarefaction of suitable **nesting sites** and **larval food**
- potential direct impact of **pesticides**
- effects of **climate changes**



Landscape structure and wild bees diversity



fine

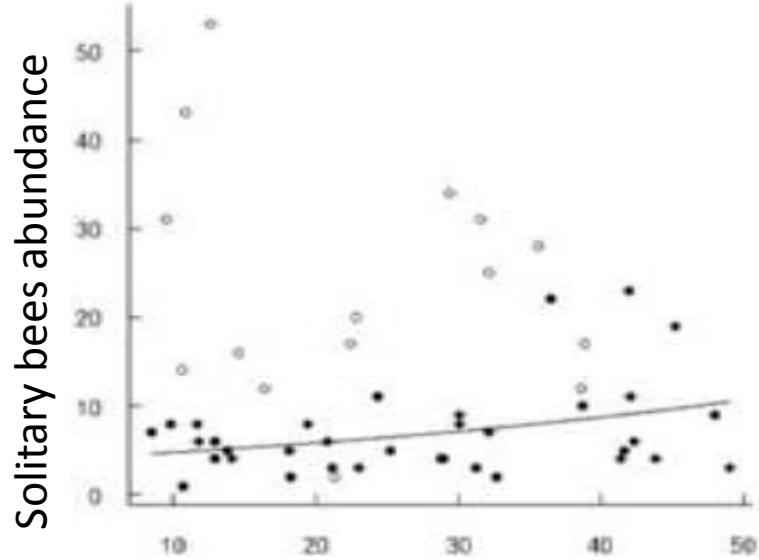
coarse



Fine grain landscape

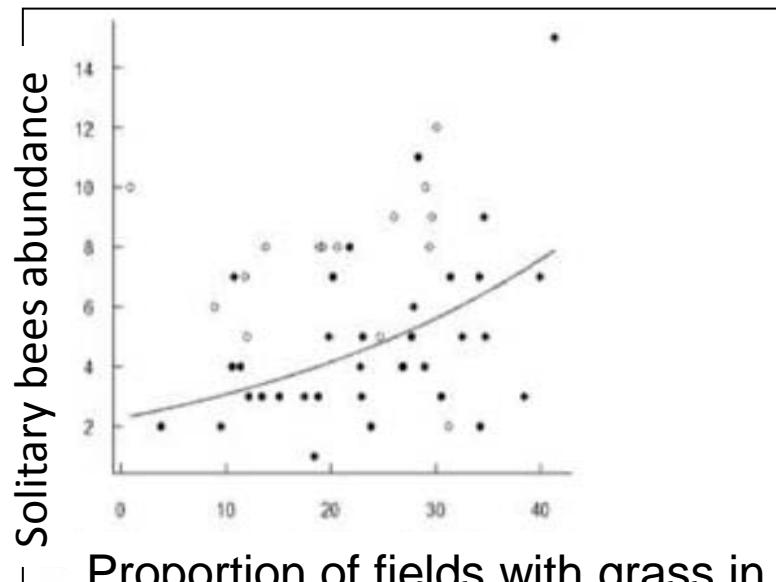


Coarse grain landscape

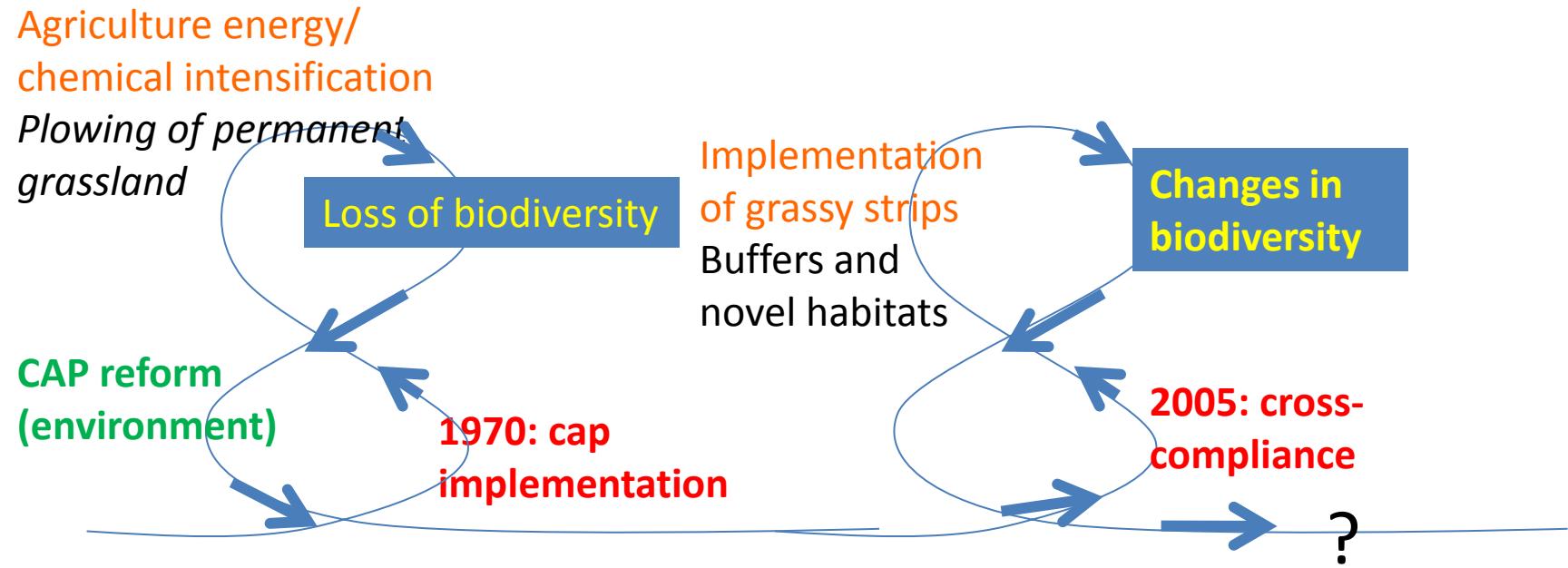


Both hedgerows, as nesting sites, and crops/ grass, as food resource play a role

Proportion of permanent grassland in 1200m windows



The adaptative cycle of the resilience of biodiversity management to agricultural intensification



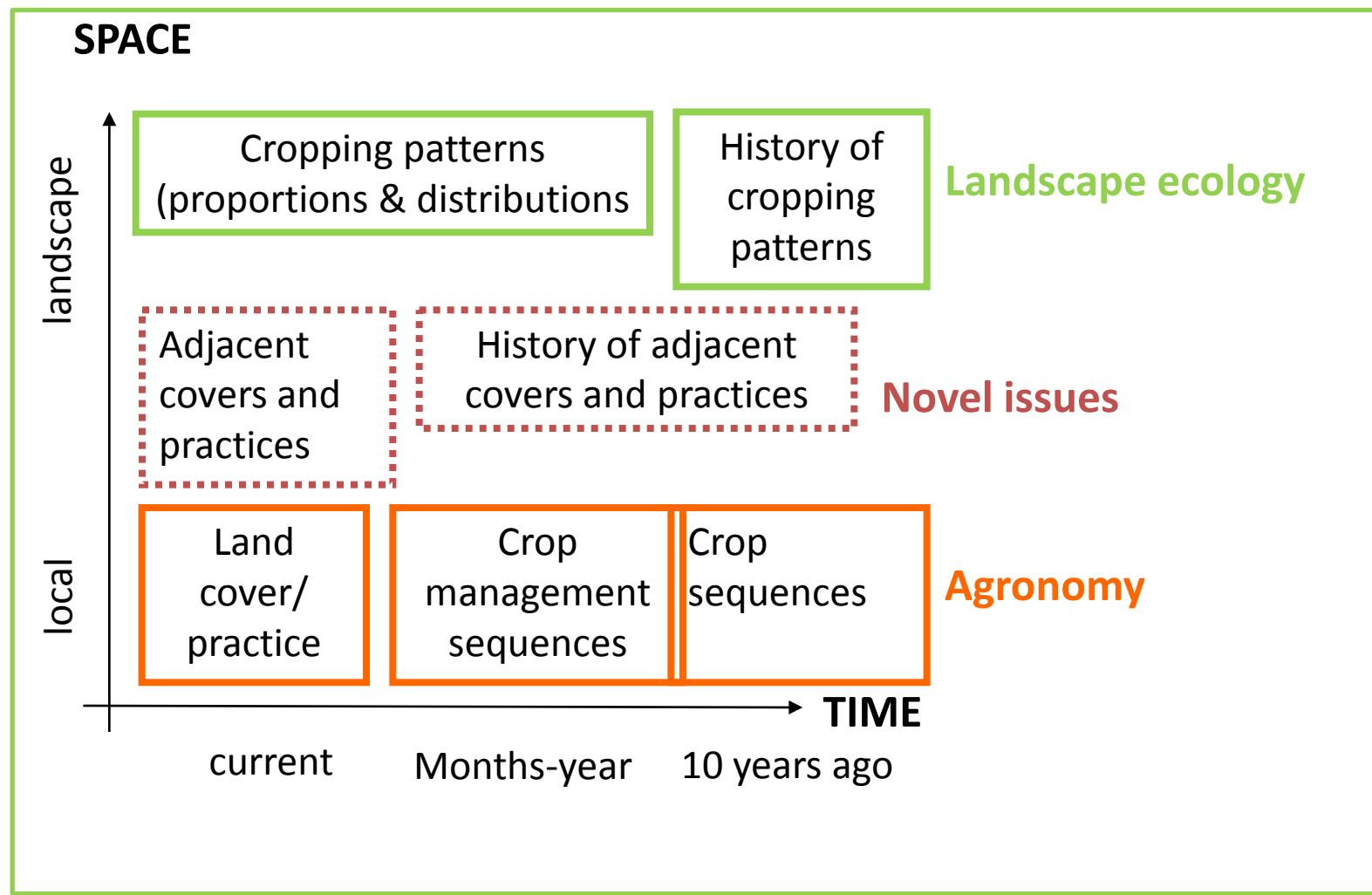
Hedgerows have a profound effect on fluxes, those fluxes change landscape patterns

Hedgerow removal led to the rise of many disservices, which was a cause of changes in policies

Biodiversity, and the services it provides depends on landscape patterns

The paradigm that prevailed in agronomy that every thing can be control by management at field scale is no more acceptable

At stake: a framework to further analyze resilience in agricultural landscapes



A black and white cow with a long, flowing white mane is grazing behind a barbed wire fence. The cow is surrounded by dense green foliage, including large leaves and branches in the foreground and background. The scene is set outdoors in a rural or farm environment.

Thank you for your attention