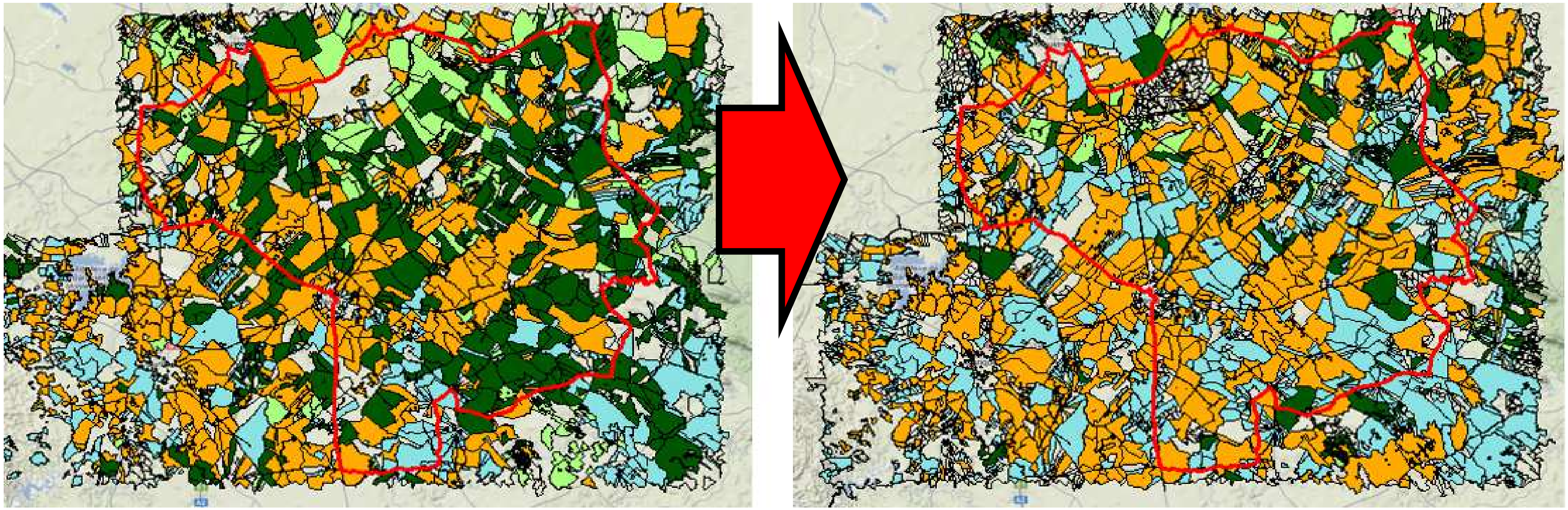
TPSD – Theories & Practices of Sustainable Development

3rd lecture

13 march 2020

The farming-system approach to biodiversity, ecosystem services and sustainability



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Farming systems – concept

Farming system analysis is a way to integrate, in a synthetic way, many aspects of land management that are relevant to understand environmental problems.

A farming system is a particular way of:

- combining certain amounts of different inputs, e.g. land of a specific type, human labour, machines, fertilizers,
- to produce a specific mix of outputs, e.g. milk, apples …
- which is <u>common to a set of farms</u>.

(Claude Reboul, with adaptations)

It is the same "recipe" used by these farmers, including (1) the ingredients, (2) their relative amounts and (3) the step-by-step protocol used to combine them to get (4) the final combination of dishes.

Farming systems – concept

What defines a farming system is the **proportions**, e.g.:

- % of pastures in total farmland area in the farm;
- ton of maize produced per hectare;
- amount of water used per hectare of irrigated land;
- % of milk in the Total Revenue of the farm;
- number of heads of livestock per hectare.

… not indicators of physical or economic **dimension**, e.g.:

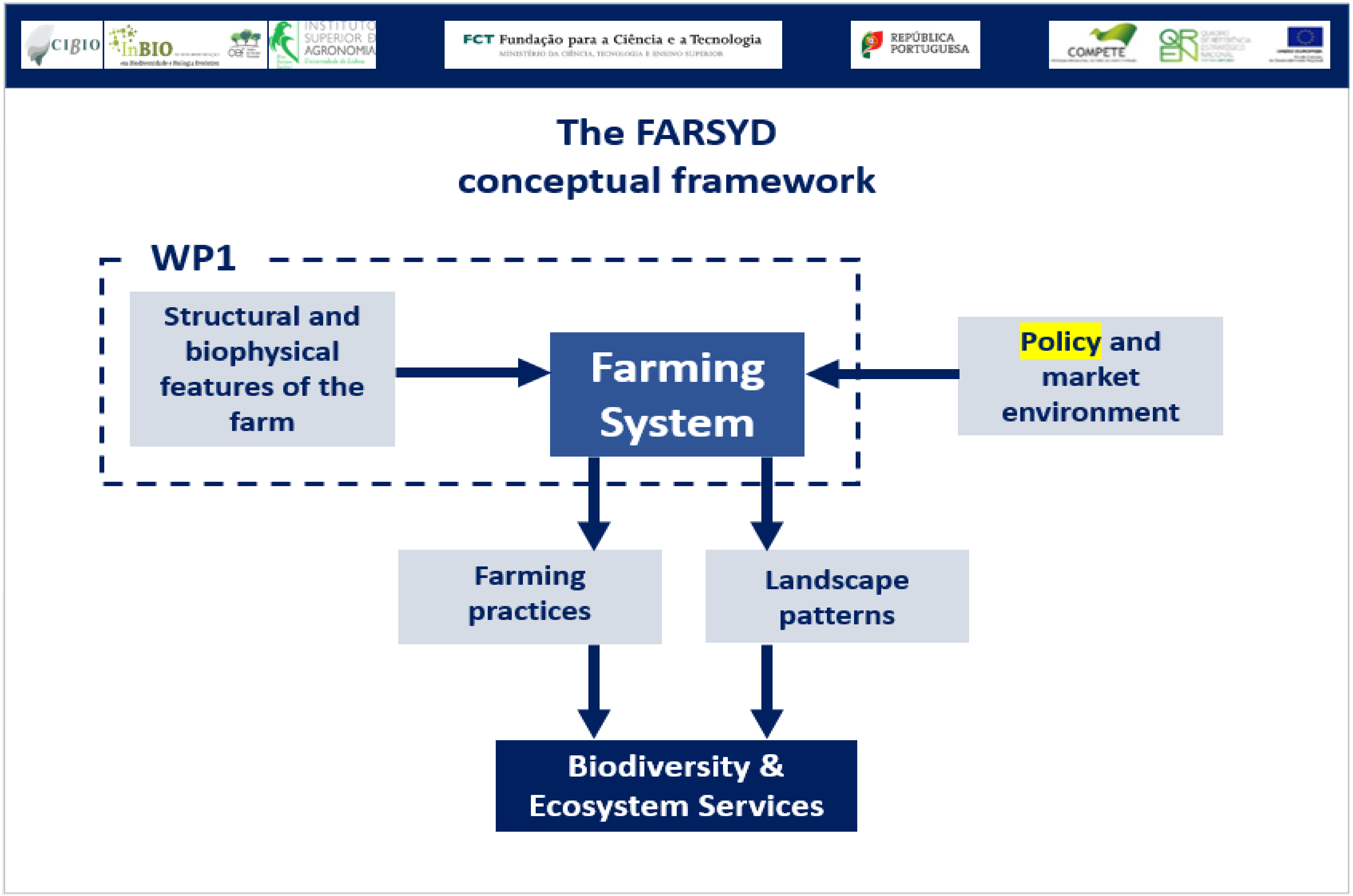
- total area of land in use (in hectares);
- total yearly revenue (in Euros);
- total livestock in the farm (in Standard Head Units).

Farming system – dimensions

A farming system can be described according to:

- Output intensity, in ton of output per hectare or Euros of Revenue per hectare;
- Input intensity, in cubic meters of water per hectare, Kg of fertilizer per hectare or overall Intermediate Consumption in Euros per hectare;
- Specialization level - according to the % of the most relevant output in Total Revenue or Income, farms are either specialized or polyculture farming;
- Specialization pattern, i.e. the main outputs and their proportions;
- Capital to labour ratio, mechanization level or other general indicators of technology.

Farming system choice – drivers



Farming systems – typology

The farming system concept has been used to classify the farms within a particular region; an example:

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Agriculture, Ecosystems and Environment

journal homepage: www.elsevier.com/locate/agee

Modelling farming system dynamics in High Nature Value Farmland under policy change

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ABSTRACT

Understanding the factors driving changes in farm management is needed for designing policies and subsidy schemes to protect High Nature Value Farmland (HNVF). We describe farming system dynamics

Farming systems – typology

Used variables (built based on data from IFAP/CAP paying agency)

Cereals	**Proportion of dryland cereals in Utilized Agricultural Area (UAA)**
Fallow land	**Proportion of fallows in UAA**
Pastures	**Proportion of pastures and forages in UAA**
Other annual crops	**Proportion of other (more intensive) annual crops in UAA**
Permanent crops	**Proportion of permanent crops (olive groves) in UAA**
Stocking rate (livestock intensity)	**Number of standardized Livestock units (LU) per hectare of land with pastures and forages**
% Bovines	**Proportion of bovine LU in total livestock (also in LU)**

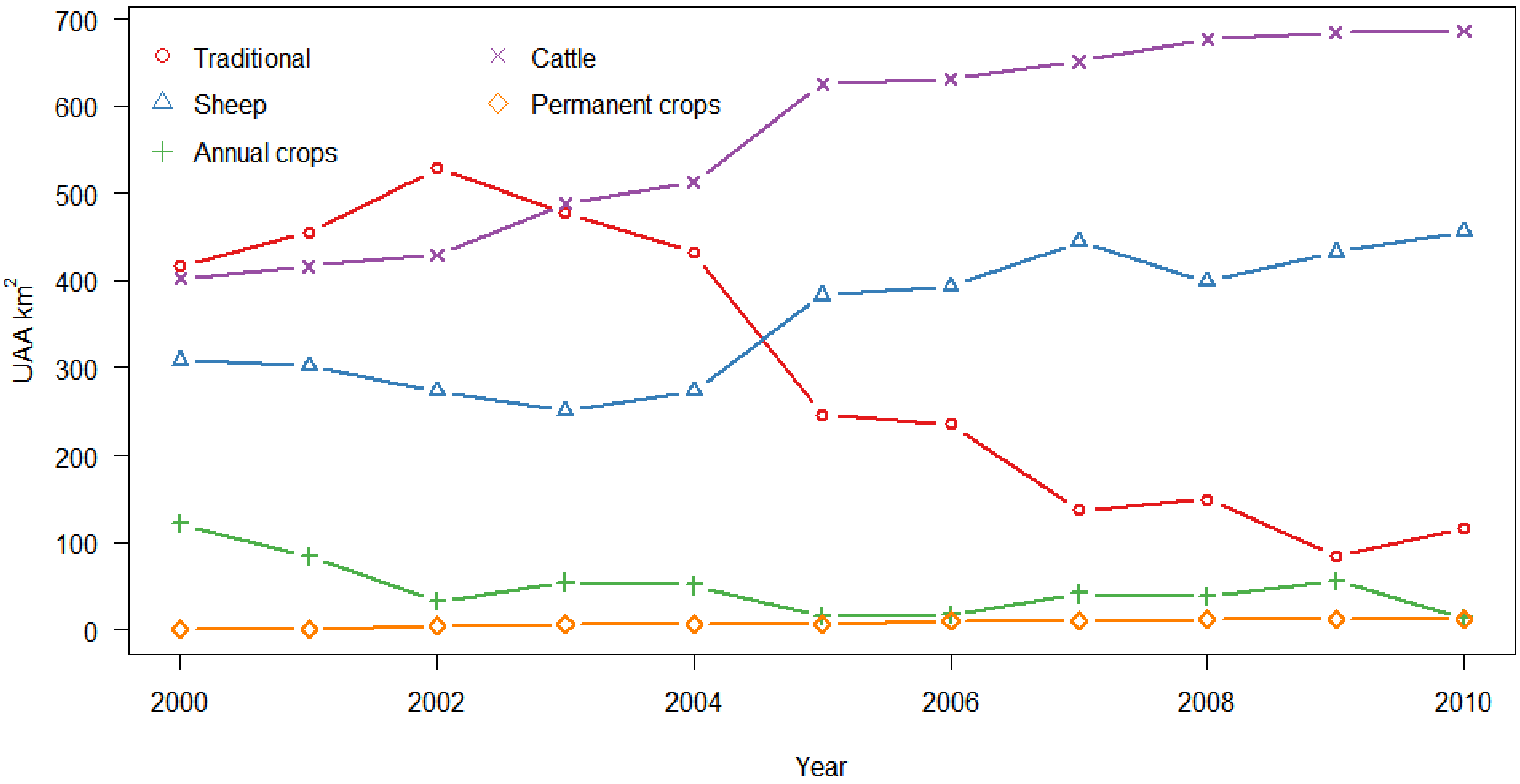
Clustering method: PAM *(partition around medoids – carried out in R software)*

Farming systems – typology

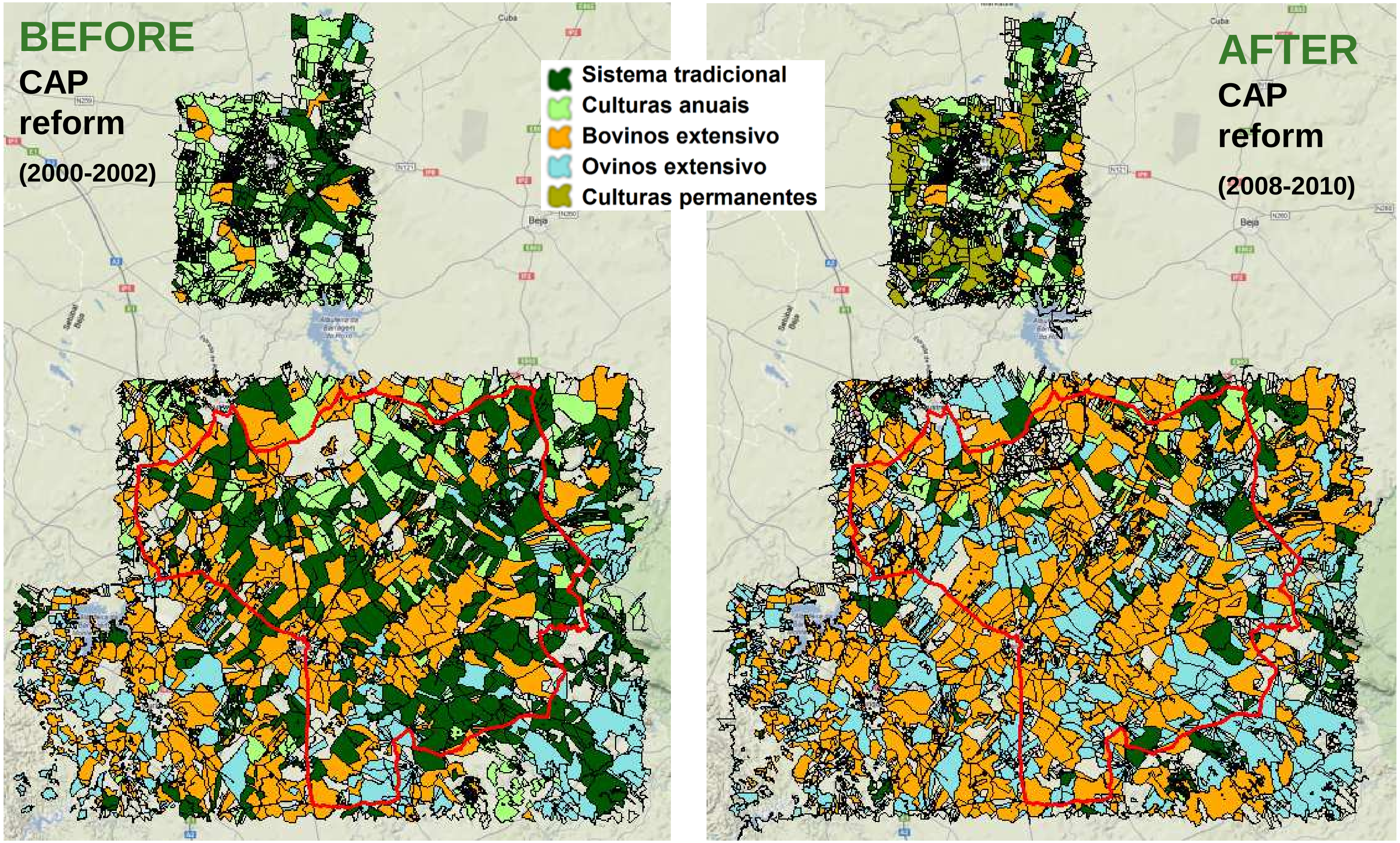
The result:

	Traditional System (polyculture, low-intensity)	Specialized Annual Crops (more intensive)	Specialized Cattle low-intensity	Specialized Sheep low-intensity	Specialized Olive groves (intensive)
Cereals	**0.28**	**0.58**	0.14	0.10	0.00
Fallow land	**0.25**	0.10	0.06	0.00	0.00
Pastures	**0.42**	0.00	**0.77**	**0.88**	0.00
Other annual crops	0.04	**0.31**	0.00	0.00	0.00
Permanent crops	0.00	0.02	0.03	0.02	**1.00**
Stocking rate (livestock intensity)	**0.15**	**0.00**	**0.46**	**0.23**	0.00
% Bovines	**0.00**	0.00	**0.85**	**0.00**	0.00

Farming system change



Mapping Farming system change



Farming system change (Transition matrix)

		2008-2010				
		Sistema tradicional	**Culturas anuais**	**Bovinos extensivo**	**Ovinos extensivo**	**Culturas permanentes**
2000-2002	**Sistema tradicional**	15.8	4.4	36.4	40.9	0.9
	Culturas anuais	23.1	36.1	15.7	9.8	14.0
	Bovinos extensivo	0.7	1.5	85.3	9.7	2.1
	Ovinos extensivo	2.4	0.9	20.6	73.5	0.0
	Culturas permanentes	0.0	0.0	0.0	0.0	100.0

Farming system change
- the drivers

	Tradicional	Annual crops	Cattle	sheep	Olive groves
Traditional		Soil quality, Montado	Size	Soil quality, Size	-
Annual crops	Montado	Soil quality	Soil quality	Soil quality	Soil quality
Cattle	-	-		ZPE Size Soil quality	-

Farming system change (discussion)

CAP reform and emerging market opportunities have been identified as major drivers for:

- the substitution of a polycultural, low-intensity traditional farming system, which is often associated with the high biodiversity value of the region, by specialized cattle and sheep rearing systems (also low-intensity);
- the substitution of a specialized, intensive annual-crops system by an also specialized, super-intensive olive-groves system.

The traditional system was not significantly affected by intensification towards intensive annual crops or intensive olive production;

It has mostly been affected by specialization towards specialized livestock systems.

Farming system change (discussion)

Some specific characteristics of farms promoted particular farming system transitions:

- Fertile soils tend to promote the persistence of the specialized annual crops system, the transition from traditional to annual crops and the transition from annual to permanent crops;
- Poorer soils tend to promote the transition from the traditional to specialized sheep system, or the transition from annual crops to the specialized livestock systems (either cattle or sheep);
- Larger farm size tends to promote the transition from the traditional to the specialized cattle system;
- Small farm size tends to promote the transition from the traditional and cattle to the specialized sheep system.

Drivers of farming system choice and policy analysis

In this study, drivers of farmers' choice of farming system were analysed and used in policy analysis.

Ecological Economics 145 (2018) 331–338

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Ecological Economics

journal homepage: www.elsevier.com/locate/ecolecon

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Analysis

A Spatially Explicit Choice Model to Assess the Impact of Conservation Policy on High Nature Value Farming Systems

Check for updates

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Drivers of farming system choice and policy analysis

Study’s goals:

1. Identify main drivers affecting the choice of farming system by the farmer;
2. Model the farmer’s choice of farming system;
3. Use the estimated choice model to assess the effect of different policy options on farmers’ choices of farming system (FS)
4. … and then on environmental variables depending on FS.

Drivers of farming system choice and policy analysis

Method:

1. Farms in the study area were classified by farming system in each year between 2000 and 2010;

2. The values of biophysical, structural, market and policy variables (drivers) were assessed for each farm in each year between 2000 and 2010;

3. Logistic regression was used to model the choice of farming system in each year

Drivers of farming system choice and policy analysis

Choice model (Logit) specification

Dependent variable (categorical):

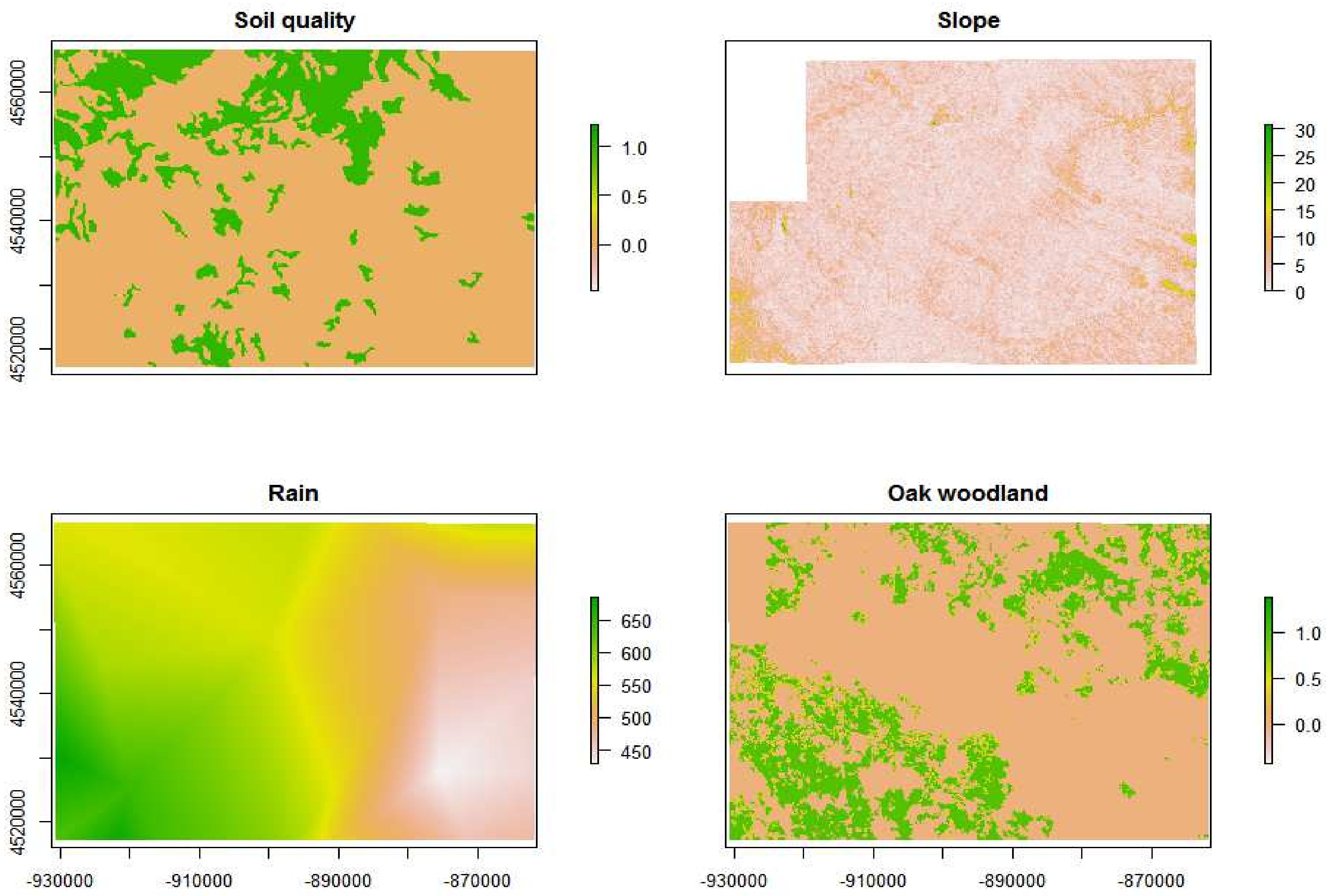
- Farming system

Independent variables (drivers):

- Biophysical (soil, rain, slope)
- Structural (Farm size, Oak, Janus)
- Policy (SPA in/out)
- Economic (GIR, GIRdif)
- Inertia (FSlag)

Drivers of farming system choice and policy analysis

Biophysical drivers mapping:



Drivers of farming system choice and policy analysis

Results: Estimated choice model (dep. variable = 1 when traditional FS chosen; else = 0)

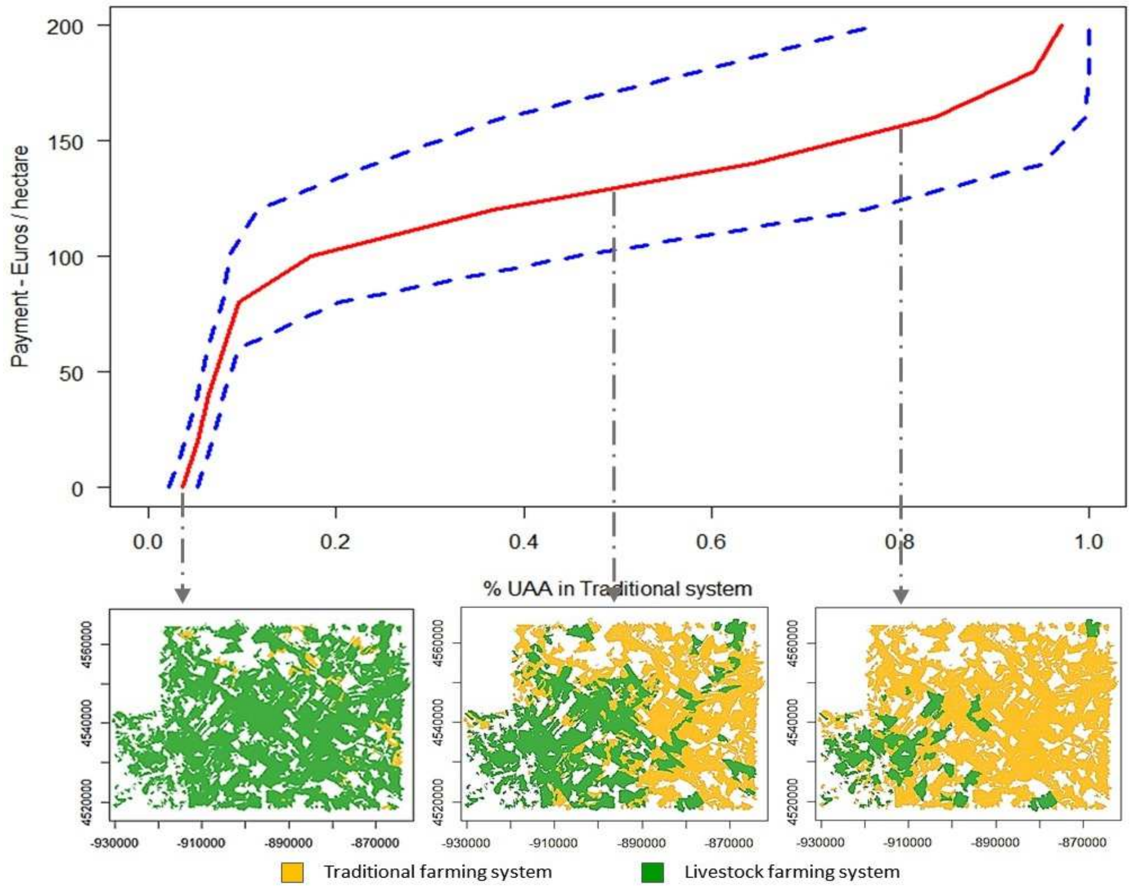
	Coefficient (B)	Std. error	z value	Pr(>|z|)
Intercept	-1.187	0.950	-1.250	0.211
GIR	6.140	0.703	8.739	<0.001***
GIRdif	4.093	1.033	3.962	<0.001***
FSlag	2.498	0.170	14.704	<0.001***
SOIL	1.629	0.294	5.538	<0.001***
RAIN	-9.525	1.530	-6.225	<0.001***
UAA	-0.130	0.041	-3.136	0.002**
JANUS	-0.884	0.383	-2.305	0.021*

Significance codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05

Model fit: Log-likelihood = -531.95 (df = 8); AIC = 1079.9; BIC = 1123.2

Drivers of farming system choice and policy analysis

Results: spatially-explicit supply function for biodiversity conservation (if this linked to the traditional FS)



•Payment:	0 €/ha	•Payment:	132 €/ha	•Payment:	157 €/ha
•P_RFS (median):	3.6%	•P_RFS (median):	50.0%	•P_RFS (median):	80.0%
•P_RFS (mean):	3.9%	•P_RFS (mean):	52.5%	•P_RFS (mean):	83.7%
•GIR:	0.71	•GIR:	1.23	•GIR:	1.32
•MPA:	50.3 ha	•MPA:	263.4 ha	•MPA:	513,6 ha
•NPATCH:	91	•NPATCH:	235	•NPATCH:	192
•LU/ha:	0.46	•LU/ha:	0.34	•LU/ha:	0.26
•CEH:	56.9%	•CEH:	43.4%	•CEH:	34.8%

- **P_RFP** - % of area under the traditional FS
- **GIR** – gross income ratio
- **MPA** – Mean patch area
- **NPATCH** – Number of patches
- **LU/ha** – Livestock density
- **CEH** – Early harvest (% of cropland harvested before the 31st May)

Farming systems' effects on the landscape

In a different study, we compared landscape variables across the different farming systems in the area.

Landscape Ecol (2016) 31:791–803
DOI 10.1007/s10980-015-0287-0

CrossMark

RESEARCH ARTICLE

Landscape makers and landscape takers: links between farming systems and landscape patterns along an intensification gradient

Paulo F. Ribeiro · José L. Santos · Joana Santana · Luís Reino · Pedro J. Leitão · Pedro Beja · Francisco Moreira

Received: 22 February 2015 / Accepted: 28 September 2015 / Published online: 13 October 2015

Farming systems' effects on the landscape

Method:

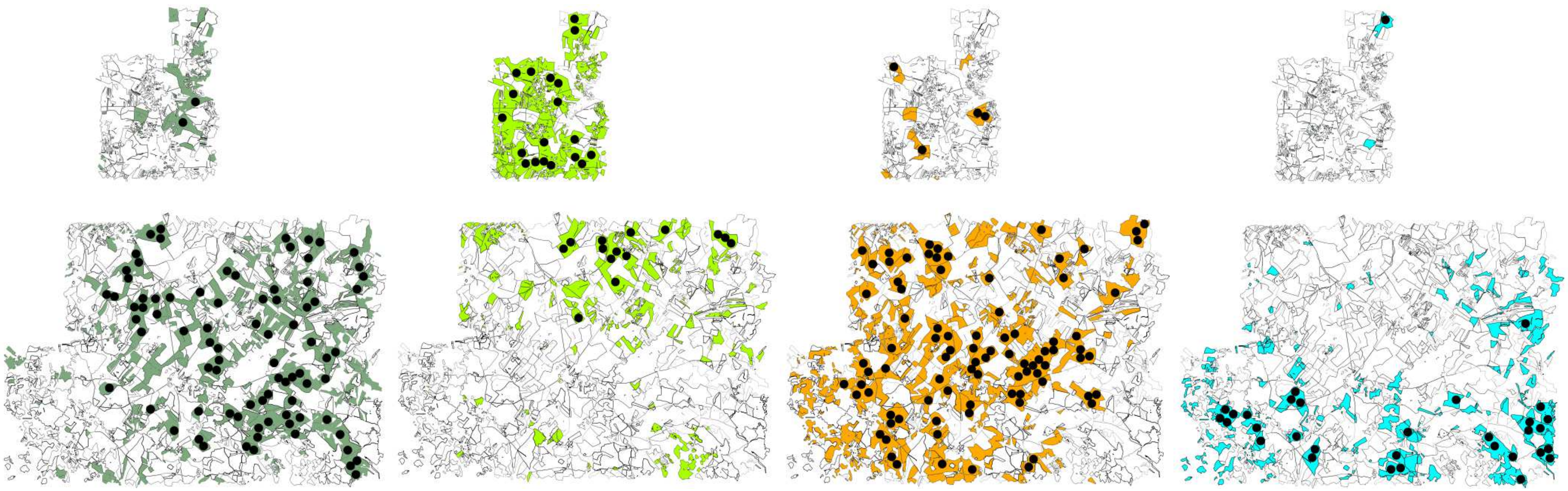
Comparing values of several landscape metrics across different farming systems.

Sample:

- Random circles with 1 sq. Km
- Totally included in a single Farming system (FS)
- No overlap among sampling circles
- Minimum of 30 circles per FS

Farming systems' effects on the landscape

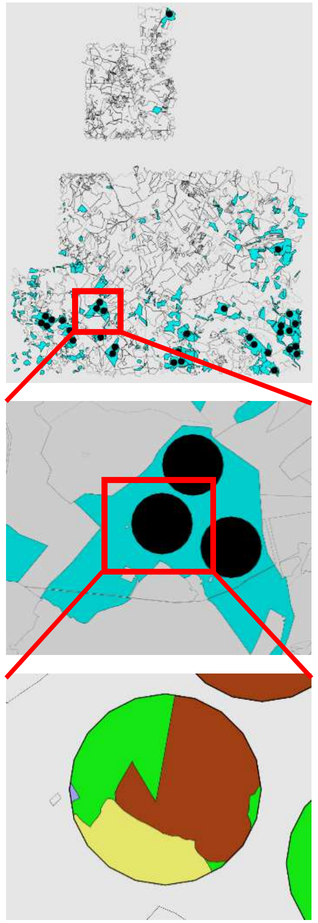
Sampling landscape circles in Farming system maps



Traditional (n=85) | **Annual crops** (n=33) | **Cattle** (n=91) | **Sheep** (n=32)

Farming systems' effects on the landscape

Landscape metrics



VARIABLE	DESCRIPTION	Mean ± SD (Min-Max)
Landscape configuration variables:		
NPATCH	Number of patches in each plot	6.05 ± 3.36 (1 – 20)
TEDG	Total edges (plot boundary excluded) in each plot (meters)	63.74 ± 35.01 (0-185.09)
PSCOV	Patch size coefficient of variance (patch size standard deviation divided by the mean patch size)	111.22 ± 46.79 (0-285.92)
AWMSI	Area weighted mean shape index (area weighted sum of each patches perimeter divided by the square root of patch area for all patches and adjusted for the plot, divided by the number of patches)	1.44 ± 0.27 (1 – 2.49)
Landscape composition variables:		
NUSES	Number of different land uses/covers (LUC) in each plot	3.90 ± 1.29 (1 – 8)
SDI	Shannon diversity index on LUC in each plot	0.87 ± 0.35 (0 – 1.73)
CEREAL	proportion of cereal crops in each plot	0.27 ± 0.23 (0 - 0.99)
FALLOW	proportion of fallows in each plot	0.16 ± 0.19 (0 - 0.91)
BSOIL	proportion of bare soil in each plot	0.01 ± 0.06 (0 - 0.75)
PASTURE	proportion of permanent pastures in each plot	0.38 ± 0.31 (0 - 1.00)
SHRUB	proportion of shrublands in each plot	0.02 ± 0.06 (0 - 0.40)
LEGUM	proportion of leguminous crops in each plot	0.01 ± 0.05 (0 - 0.37)
FORAGE	proportion of forage crops and temporary pastures in each plot	0.01 ± 0.04 (0 - 0.34)
FOREST	proportion of forest in each plot	0.05 ± 0.14 (0 - 0.89)
PERMCROP	proportion of permanent crops (olive groves) in each plot	0.01 ± 0.04 (0 - 0.42)
OTHACROP	proportion of other annual crops in each plot	0.06 ± 0.15 (0 - 0.90)
SOCIAL	proportion of social areas (roads, buildings) in each plot	0.00 ± 0.01 (0 - 0.13)

Farming systems' effects on the landscape

Principal Component Analysis

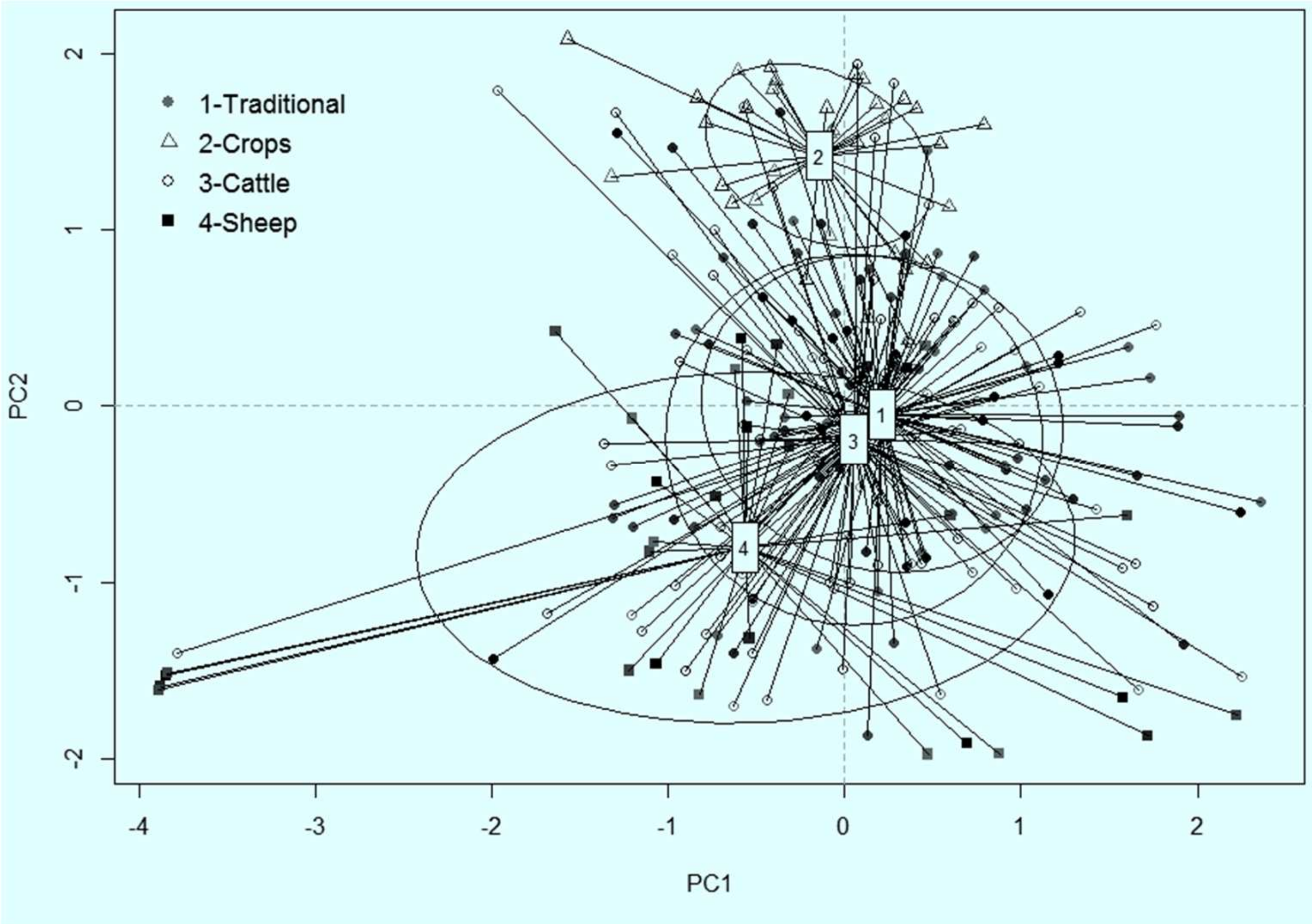
(using varimax of the 7 PC with eigenv. > 1)

Variable loadings

	PC1	PC2	PC3	PC6	PC4	PC7	PC5
	(Heter.)	(Special.)	(P. crops)	(Forage)	(Social)	(Fallows)	(Legum.)
Explained var. (%)	0.24	0.11	0.08	0.07	0.07	0.06	0.06
Cumulative var. (%)	0.24	0.35	0.43	0.50	0.56	0.63	0.69
NPATCH	**0.91**	0.02	0.07	0.09	-0.01	-0.04	0.01
TEDG	**0.91**	0.23	0.07	0.02	-0.05	-0.11	0.01
NUSES	**0.78**	0.08	0.27	0.31	0.15	-0.01	0.06
AWMSI	**0.75**	0.01	0.01	-0.35	0.00	-0.02	0.05
SDI	**0.73**	0.31	0.20	0.13	-0.04	-0.25	0.04
PSCOV	**0.72**	0.04	-0.04	0.13	-0.03	0.12	-0.03
PASTURE	-0.28	**-0.79**	-0.27	0.01	0.22	0.10	0.19
CEREAL	0.08	**0.78**	-0.16	-0.01	-0.01	0.07	0.27
OTHACROP	0.06	**0.53**	0.13	-0.03	0.15	0.00	-0.11
PERMCROP	0.06	0.09	**0.77**	-0.18	0.22	-0.01	0.11
WETLAND	0.12	0.08	**0.72**	0.10	-0.02	0.05	0.05
FORAGE	0.26	-0.11	-0.07	**0.72**	0.05	0.00	0.05
SHRUB	0.53	-0.37	-0.11	**-0.55**	-0.08	0.11	-0.03
SOCIAL	0.18	0.10	0.17	0.19	**0.75**	0.14	-0.05
MONTADO	-0.30	-0.18	0.06	-0.07	**0.54**	-0.17	-0.25
FOREST	0.08	-0.28	0.39	0.34	-0.46	0.11	-0.39
FALLOW	0.23	0.23	-0.05	-0.06	-0.12	**-0.71**	-0.34
BSOIL	0.05	0.15	0.03	-0.07	-0.07	**0.71**	-0.28
LEGUM	0.08	-0.04	0.17	0.05	-0.14	-0.05	**0.78**

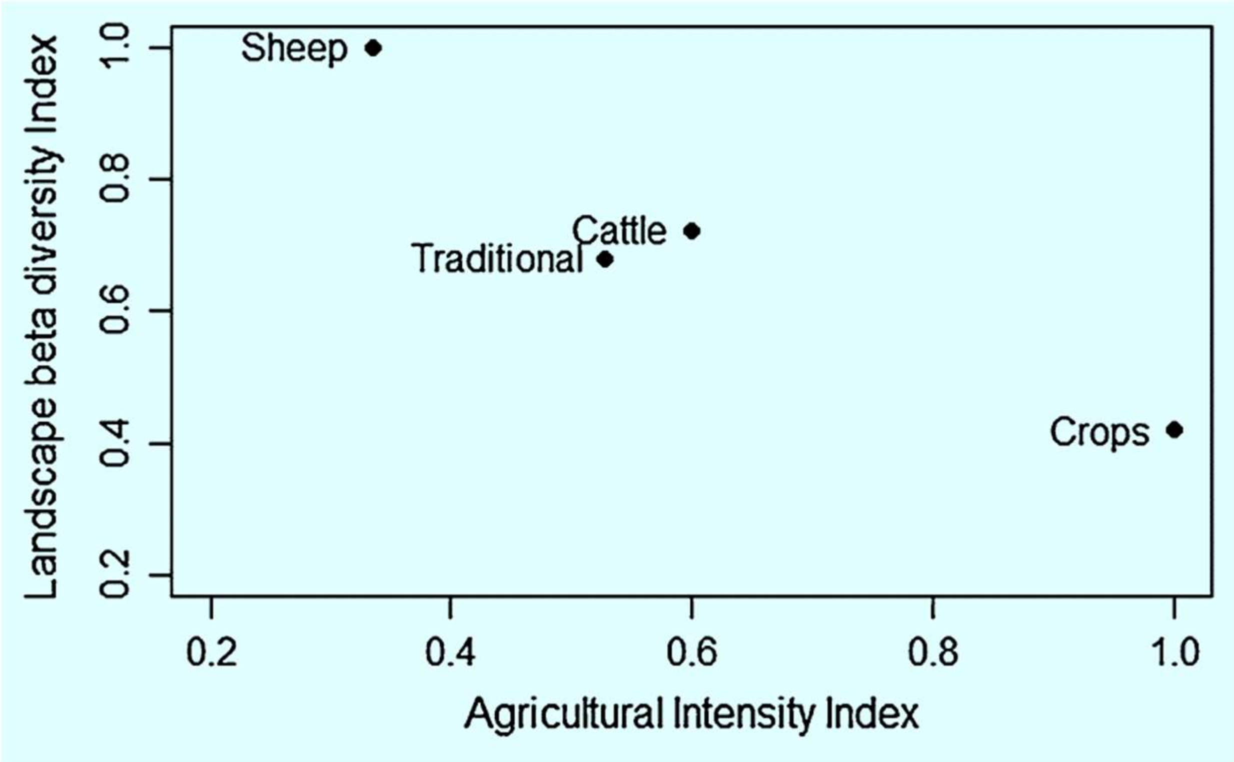
Farming systems' effects on the landscape

Scatterplot of the 241 observations on the 2 first PCs



Farming systems' effects on the landscape

Relationship between "*landscape flexibility*" and the intensity level of the Farming system



Landscape Flexibility Index - Average Euclidean distance to group centroids (standardized by the highest value)

Agricultural Intensity Index – Weighted average of unitary gross margins of the different crops and activities in each farming system (standardized by the highest value)

Farming systems' effects on the landscape

Synthesizing…

Farming system

- High intensity → < Landscape flexib. → "LANDSCAPE MAKERS"
- Low intensity → > Landscape flexib. → "LANDSCAPE TAKERS"

Farming systems' effects on biodiversity conservation

In another study, we compared the different farming systems from a biodiversity conservation perspective.

Land Use Policy 58 (2016) 165–172

Contents lists available at ScienceDirect

Land Use Policy

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An applied farming systems approach to infer conservation-relevant agricultural practices for agri-environment policy design

CrossMark

Paulo Flores Ribeiro [a,*], José Lima Santos [a], Joana Santana [b,c], Luís Reino [b,c], Pedro Beja [b,c], Francisco Moreira [b,c,d]

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[d] REN Biodiversity Chair

Farming systems' effects on biodiversity conservation

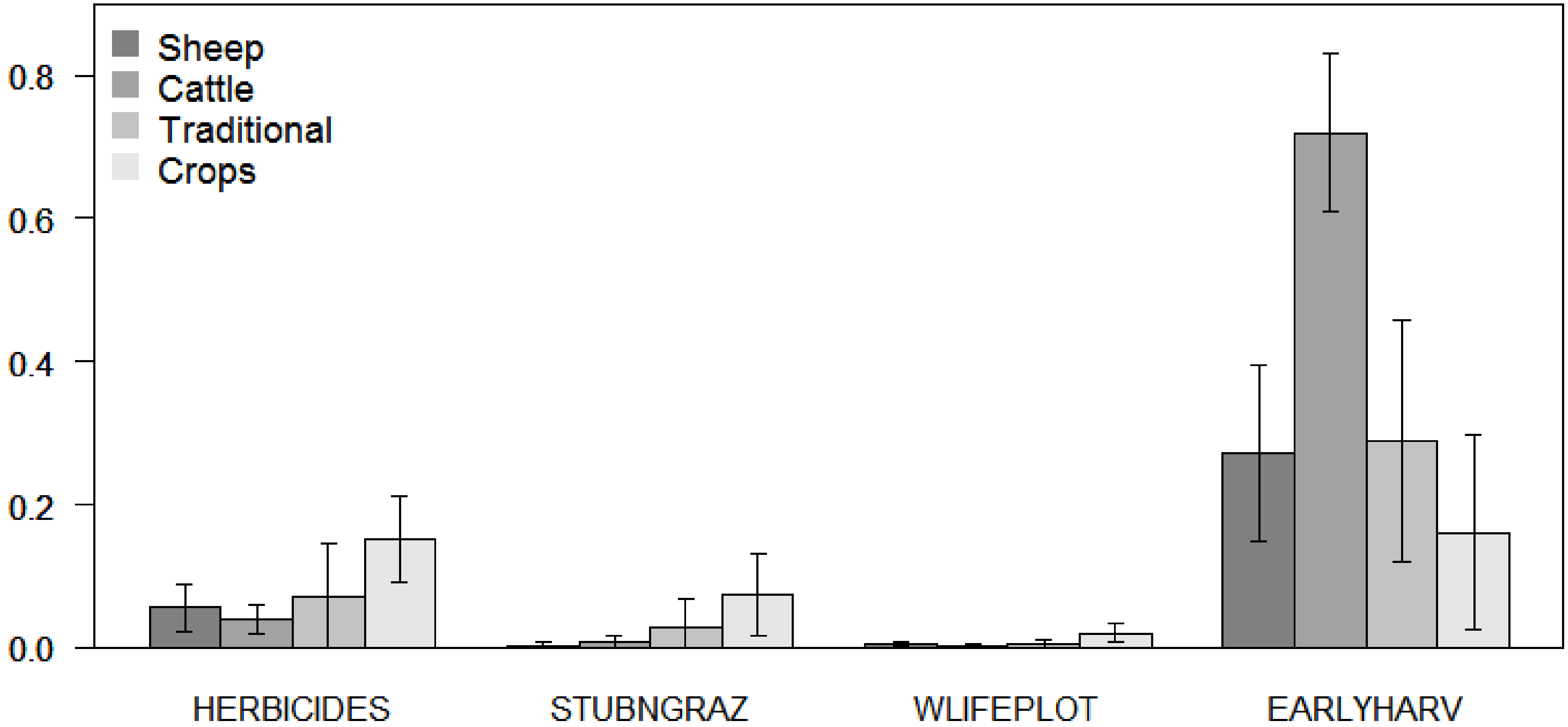
Methodological approach:

1. Conservation-relevant farming practices were first identified based on a literature review;
2. 200 farms in the study area were then surveyed and asked about conservation-relevant farming practices
3. Sampled farms were classified into farming systems using cluster analysis
4. Differences in conservation-relevant farming practices were eventually analysed across farming systems.

Farming systems' effects on biodiversity conservation

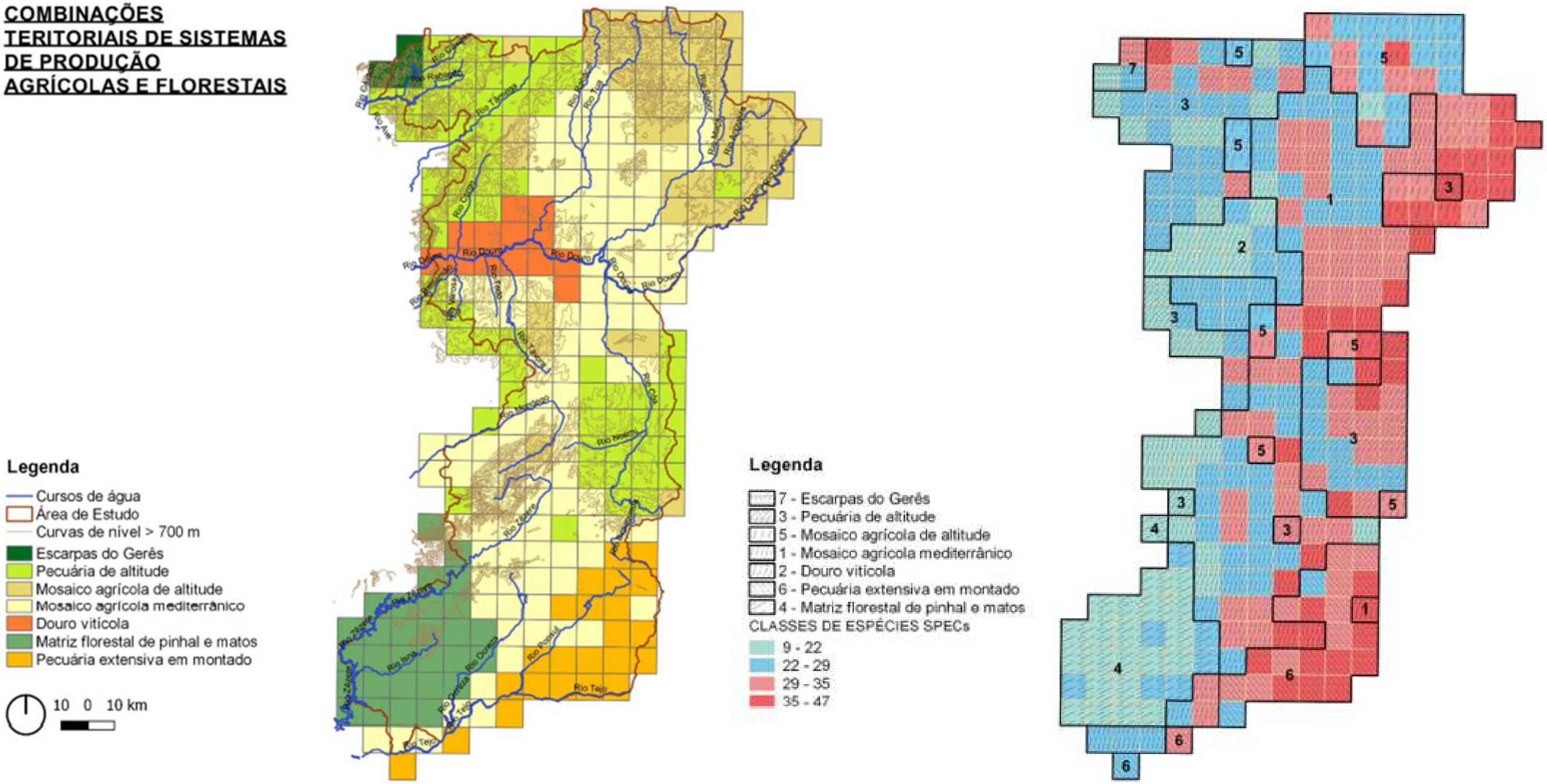
Variable	Code	Description	Mean ± SD (Min-Max)
Farm characterization variables:			
Dry cereals	CEREAL	% UAA with dry cereals	19.9 ± 16.9 (0-100)
Other annual crops	OTHCROP	% UAA with other annual crops	1.0 ± 4.4 (0-55.6)
Permanent crops	PCROP	%UAA with permanent crops	0.8 ± 3.0 (0-20.0)
Fallows	FALLOW	% UAA with fallows	64.4 ± 26.1 (0-100)
Pastures	PPAST	% UAA with pastures	13.9 ± 25.1 (0-100)
Cattle ratio	CRATIO	% of cattle LU in total LU	31.5 ± 43.1 (0-100)
Livestock density	STOCKDENS	LU per hectare of fodder area	0.37 ± 0.44 (0-2)
Farming practices variables:			
Fertilizers	FERTILIZERS	% UAA fertilized	21.4 ± 17.7 (0-100)
Herbicides	HERBICIDES	% UAA treated with herbicides	6.6 ± 13.9 (0-82.6)
Direct drill	DIRCTDRILL	% UAA under direct drill	0.6 ± 5.6 (0-70.8)
Plough	PLOUGH	% UAA ploughed or disked	18.9 ± 18.4 (0-100)
Mechanical operations	N_MECOP	Number of mechanical operations in arable land (typical year)	3.48 ± 1.31 (0-7)
Irrigation	IRRIGAT	% UAA irrigated	1.1 ± 8.4 (0-100)
Stubs not grazed	STUBNGRAZ	% UAA with ungrazed stubbles	3.2 ± 12.4 (0-100)
Improved pastures	PASTPLUS	% UAA with improved pastures	6.4 ± 17.0 (0-100)
Wildlife plots	WLIFEPLOT	% UAA with wildlife food plots	0.8 ± 2.1 (0-17.8)
Conservation buffers	CONSBUFF	% UAA with conservation buffers	7.1 ± 14.6 (0-100)
Stockpiled forages	STOCKFOR	% UAA with stockpiled forages	8.7 ± 13.1 (0-69.6)
Crop rotation	ROTYEARS	Duration of crop rotation (years)	1.82 ± 2.09 (0-5.00)
Early harvest	EARLYHARV	% of the cereal area that is harvested before 31th May	42.0 ± 49.1 (0-100)
Wire fences	WIREFENCE	Meters of wire fences per hectare	31.3 ± 71.6 (0-593.1)

Farming systems' effects on biodiversity conservation



Farming systems' effects on biodiversity conservation

In another study, we more directly compared levels of biodiversity across farming systems.



Brief summary of study carried out at the EU level

Feasibility study on the economic valuation of Public Goods and Externalities (PGaE) of EU

Building an empirically-based framework to value PGaE of agriculture at broad supranational scales

European Commission

JRC SCIENTIFIC AND POLICY REPORTS

Feasibility Study on the Valuation of Public Goods and Externalities in EU Agriculture

Authors:
Livia Madureira, José Lima Santos, Ana Ferreira, Helena Guimarães

Land Use Policy 53 (2016) 56–70

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Building an empirically-based framework to value multiple public goods of agriculture at broad supranational scales

José Lima Santos[a,*], Lívia Madureira[b], Ana C Ferreira[b], Maria Espinosa[c], Sergio Gomez y Paloma[c]

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Challenges in developing a framework to value changes in multiple Ecosystem Services (PGaE of agriculture) at a macro-regional scale

- To address this policy demand, the required valuation framework needs to:
  - focus on available policy options at this broad, supranational scale (to be empirically robust from a supply-side perspective);
  - be understandable by the general public of many involved countries (demand-side requirement);
  - provide context-rich valuation scenarios, leading people to engage in actual economic trade-offs as opposed to symbolic reactions (demand-side requirement).

Macro-Regional Agri-Environmental Problems (MRAEP) –the core concept

A MRAEP involves four dimensions:

1) the particular farming systems and agricultural landscape(s) prevailing in a specific macro-region (MR);
2) the bundle of PGaEs currently delivered by that agro-ecological infrastructure;
3) an expected direction of future change in land use, e.g. farmland abandonment or agricultural intensification; and
4) the expected effects of such change on the delivery of PGaE in that MR.

A typology of MRAEPs

Building a typology of MRAEPs requires four sequential steps:

1. identifying and describing the MRs;
2. identifying the current PGaE bundle in each MR
3. identifying the core land-use dynamic trend in each MR
4. selecting the core PGaE to be valued in each MRAEP

Identifying Macro-Regions (MR)

Landscape variables:

- Land Cover (agriculture, forest, natural and artificial classes);
- Agricultural Land Use (arable, permanent crop and grassland in UAA);
- Core versus Marginal Areas – percentage of UAA in different LFA classes;
- Biogeographic regions; *

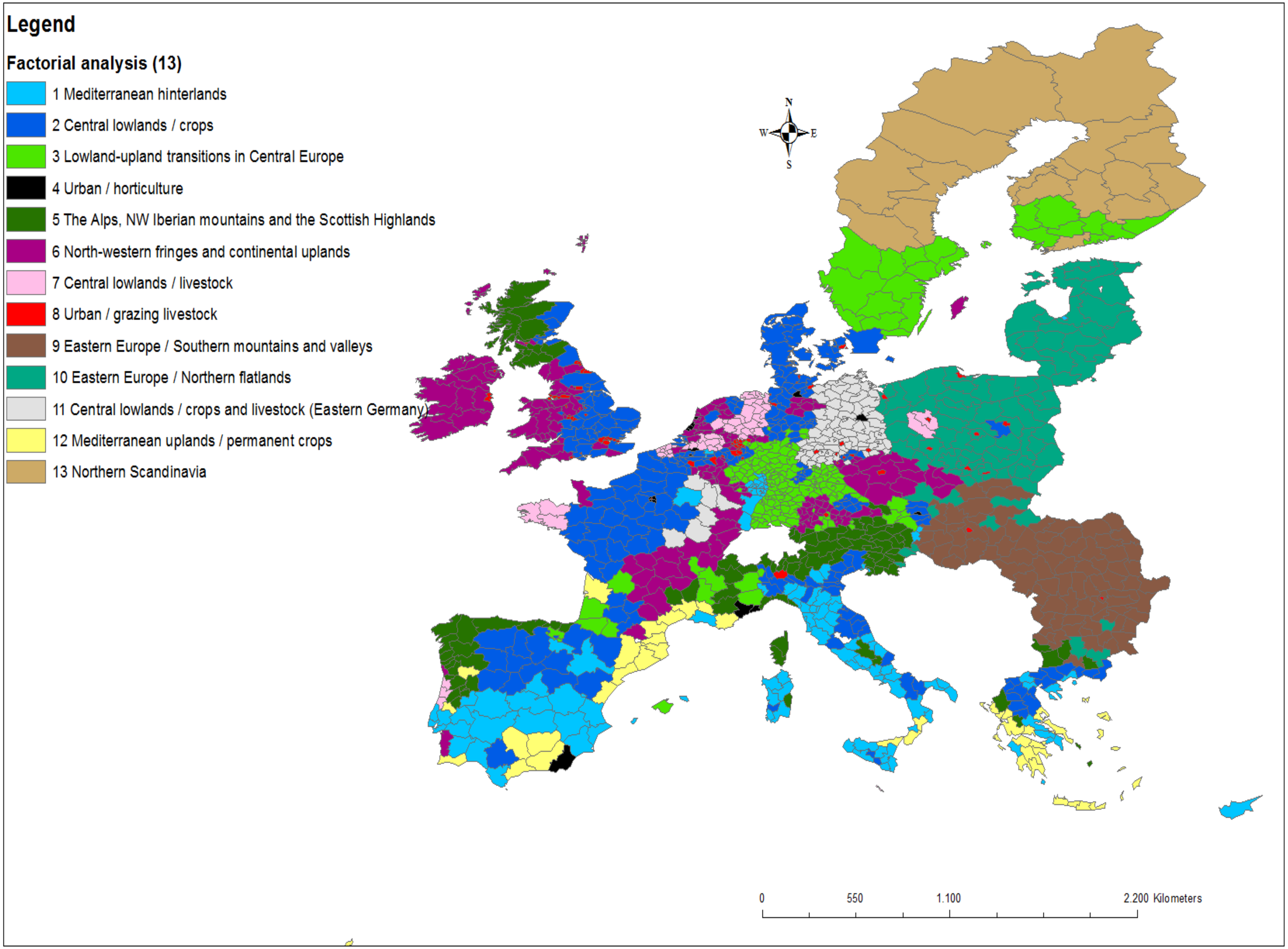
Farming-system variables:

- Specialization Pattern – distribution of farms;
- Economic Intensity of Farming - average Gross Margin per hectare;
- Relevance of Irrigation - percentage of irrigated area in the UAA; *
- Stocking Rates –Livestock Standard Units per hectare of UAA.
- Average (physical) Farm Size in hectares; *
- Distribution of Farms per Size Class;
- Average Economic Farm Size, in ESU.*

Identifying Macro-Regions (MR)

- Factor analysis run on EU-wide data including these variables at the NUT3-level

  (aims: dimension reduction and avoid overweighting dimensions with more variables)
- Hierarchical cluster analysis run on the first 9 factors from the PCA (eigenvalue criterion).
- Resulting 13 clusters (MR) profiled using centroids and mapped using the ArcGis.



Legend
Factorial analysis (13)
1 Mediterranean hinterlands
2 Central lowlands / crops
3 Lowland-upland transitions in Central Europe
4 Urban / horticulture
5 The Alps, NW Iberian mountains and the Scottish Highlands
6 North-western fringes and continental uplands
7 Central lowlands / livestock
8 Urban / grazing livestock
9 Eastern Europe / Southern mountains and valleys
10 Eastern Europe / Northern flatlands
11 Central lowlands / crops and livestock (Eastern Germany)
12 Mediterranean uplands / permanent crops
13 Northern Scandinavia
N
W
E
S
0
550
1.100
2.200 Kilometers

	The Alps, NW Iberian mountains and Scottish Highlands	Central lowlands/ livestock
Overall landscape	Balanced mosaic of fores (40%), and natural (31%) with scarce farmland (25%).	Strongly dominated by farmland (68%) with some artificial (16%).
Use of the UAA	Strongly dominated by grasslands (68%).	Strongly dominated by arable (72%).
Specialization	Specialist grazing livestock (50%), mixed farming (23%) and permanent crops (12%).	Specialist grazing livestock (39%), mixed farming (28%) granivores (11%) and horticulture (4%).
Core vs marginal areas	Largely mountain LFA (70%).	Mostly non-LFA (72%)
Economic intensity of farming	Low (750-1300 Euros/ha).	High (2500-3500 Euros/ha).
% of irrigated UAA	Some (2.5-7.5%).	Medium (7.5-15.0%)
Stocking rates (LSU/UAA)	Medium (1.00-1.25)	Very High (> 4.00)
Average farm size (ha)	Medium (30-40 ha).	Medium/small (20-30 ha).
Average economic size of farms (ESU)	Small (10-25 ESU).	Large (50-100 ESU).

Used PGaE indicators:

Landscape (cultural services)

- Recreation potential index (Maes et al. 2011);
- Cultural heritage (Paracchini, Unpublished);

Biodiversity

- High Nature Value Farmland (HNVF) – (Paracchini et al. 2008);

Water quality and availability

- Infiltration (mm) – (Maes et al., 2011);
- Irrigated UAA – in percentage of UAA (EC, 2011);
- Total nitrogen input – (Liep et al., 2011);

Soil quality

- Soil erosion – PESERA model (EC, 2011).
- Soil carbon content. – Low values indicate soil quality problems; (Maes et al., 2011);

Air quality

- Total NH3 emissions; (Liep et al., 2011);

Used PGaE indicators (Cont.):

Climate stability

- Soil carbon content – High values indicate contribution to carbon storage; (Maes et al., (2011);
- Total N2O emissions (Liep et al., 2011).

Resilience to flooding

- Flooding risk (model LISFLOOD; Wimmer (CESR/ UK).

Resilience to fire

- Fire risk – average yearly burnt (JRC).

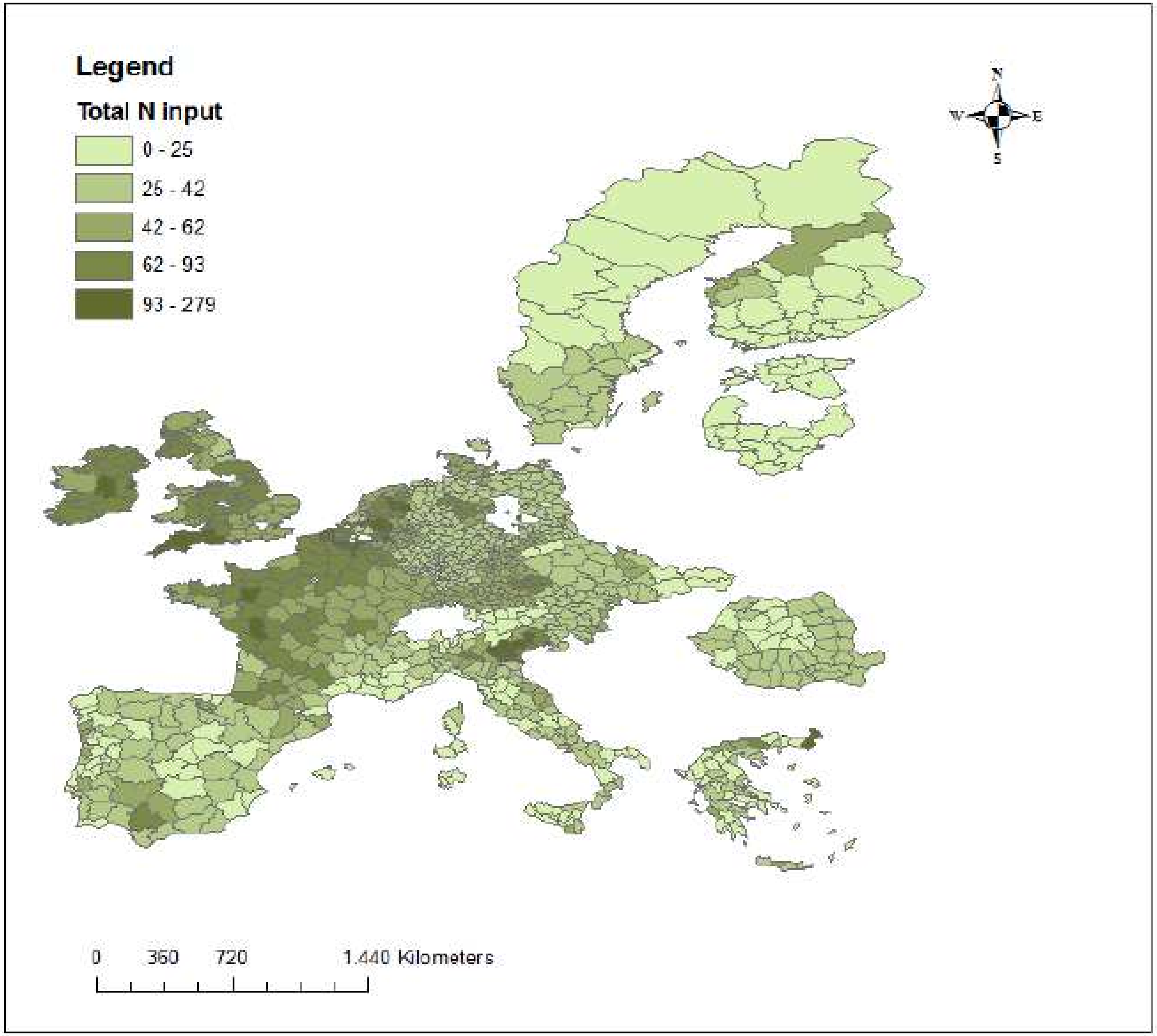


Figure 46 - Distribution of total N input in UE (Kg.yr-1.Km-2)
(in Liep *et al*., 2011)

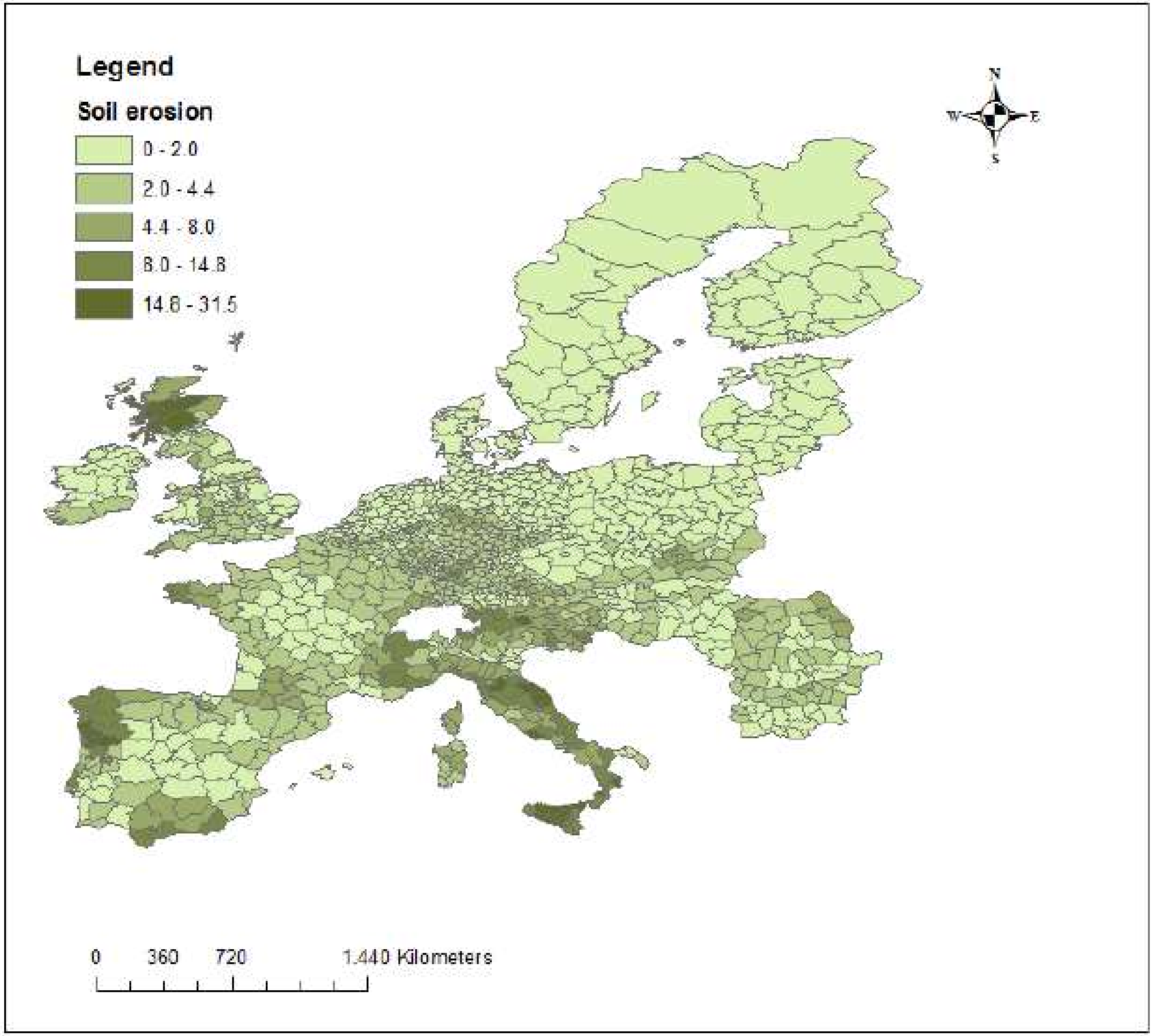
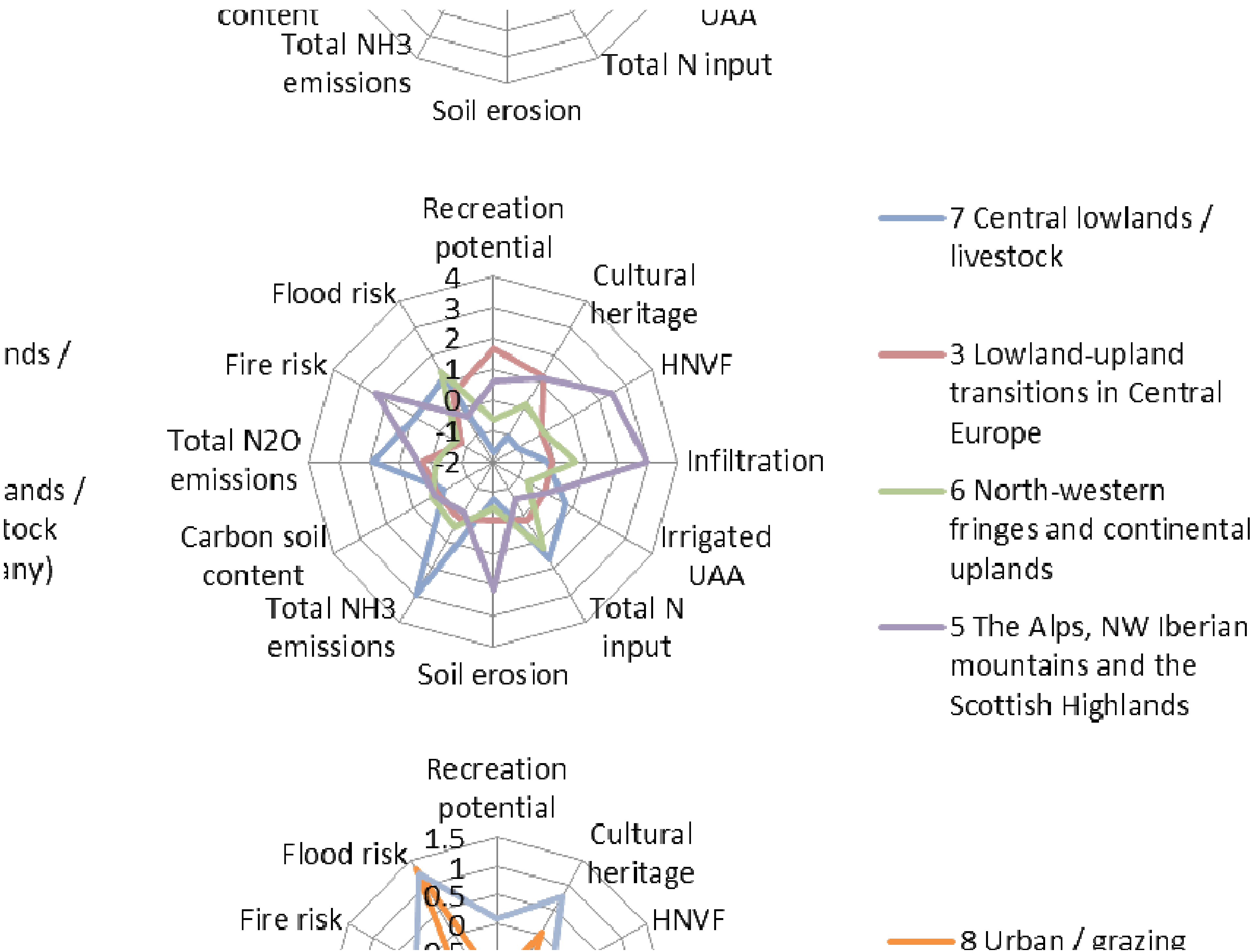


Figure 47 - Distribution of soil erosion in UE (Ton.ha-1.yr-1)
(retrieved from the data sets included in the Rural Development Report 2011)

Profiling MR according to their typical PGaE bundle

MR examples:

- The Alps, NW Iberian mountains and the Scottish Highlands;
- Central lowlands/livestock
- Mediterranean hinterlands and uplands
- Central lowlands/crops



content
Total NH3 emissions
Soil erosion
Total N input
UAA
nds /
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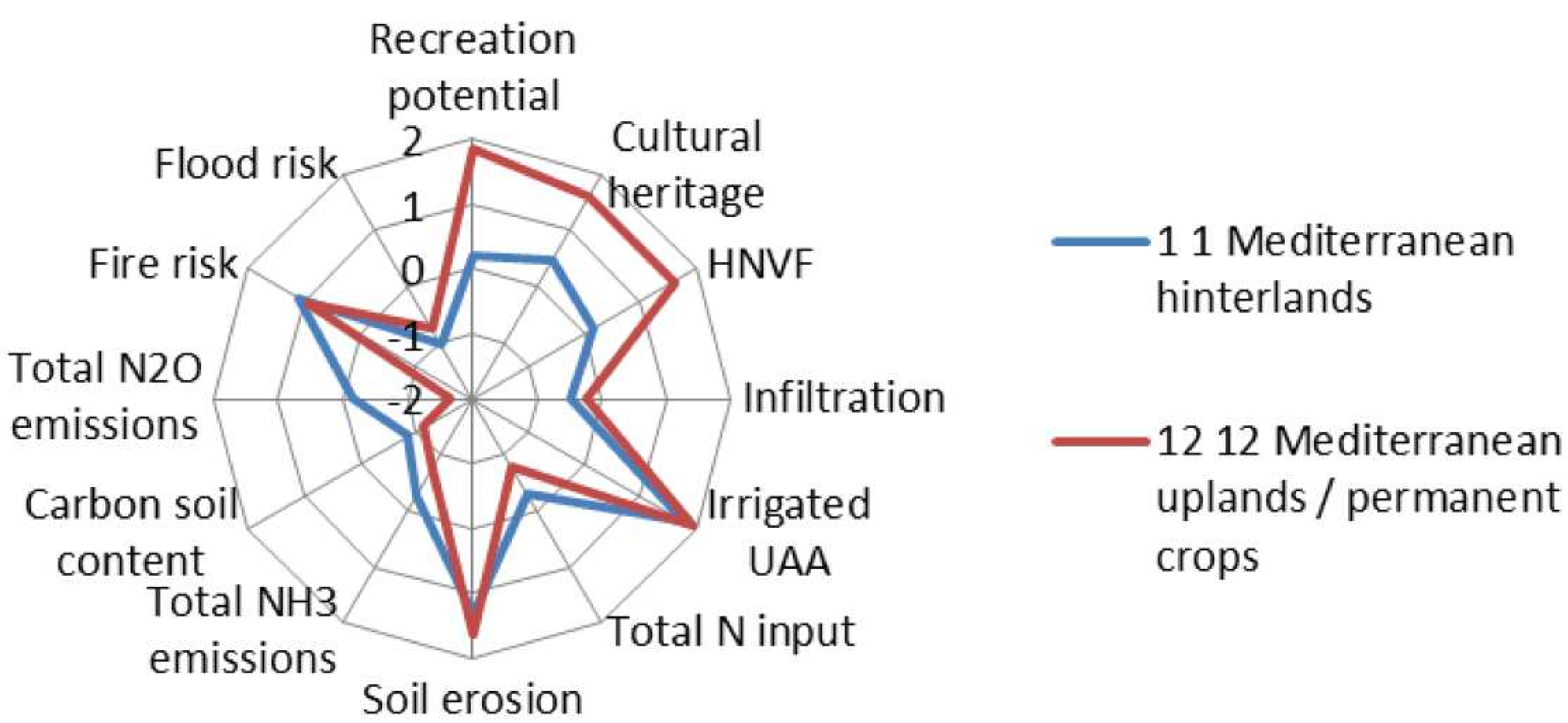
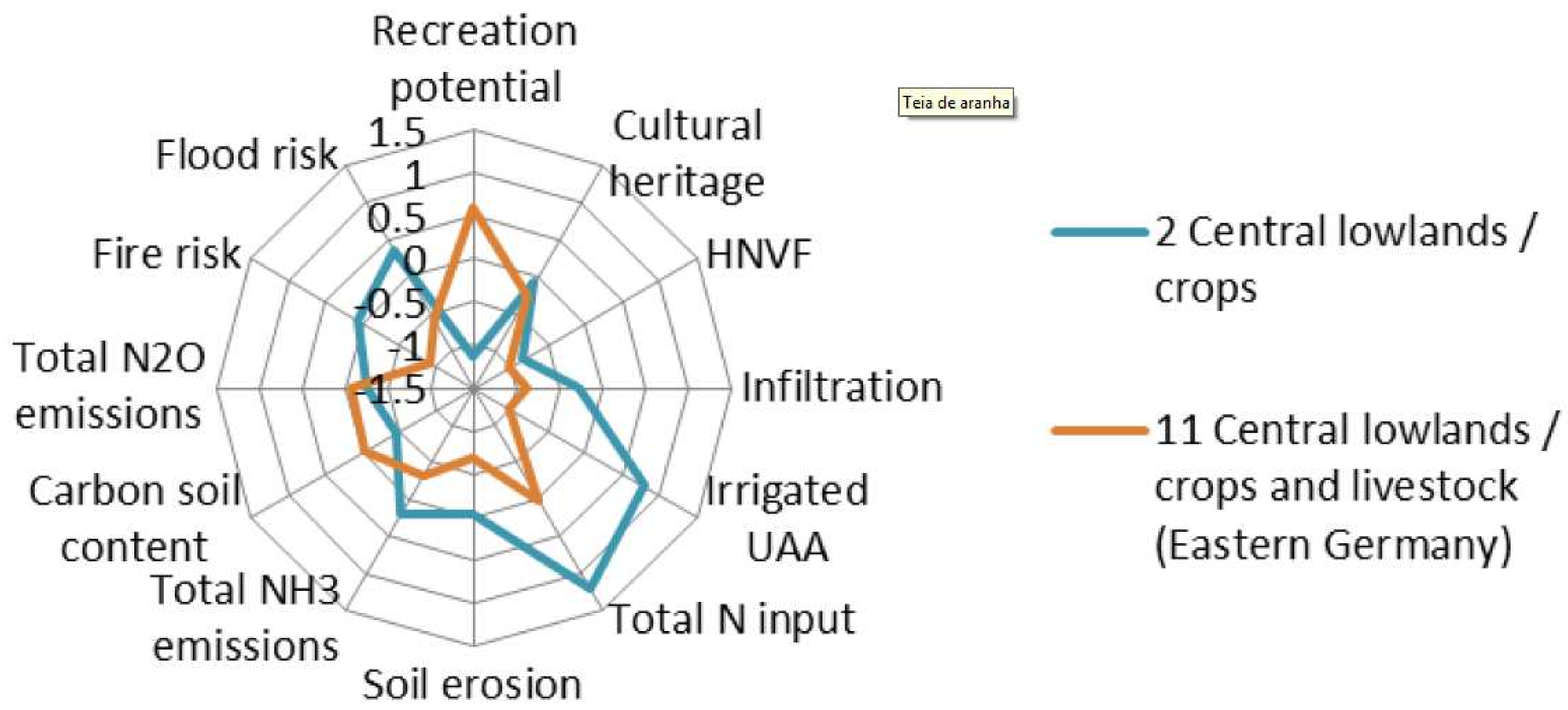
tock
any)
Recreation potential
Cultural heritage
HNVF
Infiltration
Irrigated UAA
Total N input
Soil erosion
Total NH3 emissions
Carbon soil content
Total N2O emissions
Fire risk
Flood risk
4
3
2
1
0
-1
-2
7 Central lowlands / livestock
3 Lowland-upland transitions in Central Europe
6 North-western fringes and continental uplands
5 The Alps, NW Iberian mountains and the Scottish Highlands
Recreation potential
Cultural heritage
HNVF
Fire risk
Flood risk
1.5
1
0.5
0
8 Urban / grazing


Recreation potential
Cultural heritage
HNVF
Infiltration
Irrigated UAA
Total N input
Soil erosion
Total NH3 emissions
Carbon soil content
Total N2O emissions
Fire risk
Flood risk
2
1
0
-1
-2
1 1 Mediterranean hinterlands
12 12 Mediterranean uplands / permanent crops


Recreation potential
Cultural heritage
HNVF
Infiltration
Irrigated UAA
Total N input
Soil erosion
Total NH3 emissions
Carbon soil content
Total N2O emissions
Fire risk
Flood risk
1.5
1
0.5
0
-0.5
-1
-1.5
2 Central lowlands / crops
11 Central lowlands / crops and livestock (Eastern Germany)
Teia de aranha

Recreation...

Selecting core PGaE to be valued in each MRAEP

When the current value of the PGaE indicator presents a level from medium-high to very high, or low to very-low, it was considered for selection when:

- the dynamic trend is expected to significantly worsen the condition of the PGaE, and there is a policy option able to counteract this worsening;
- the current status is negative, the dynamic trend is expected not to improve it, and there is a policy option able to improve that negative current status.

- Survey design for the MRAEP “farmland abandonment in Mediterranean Upland”

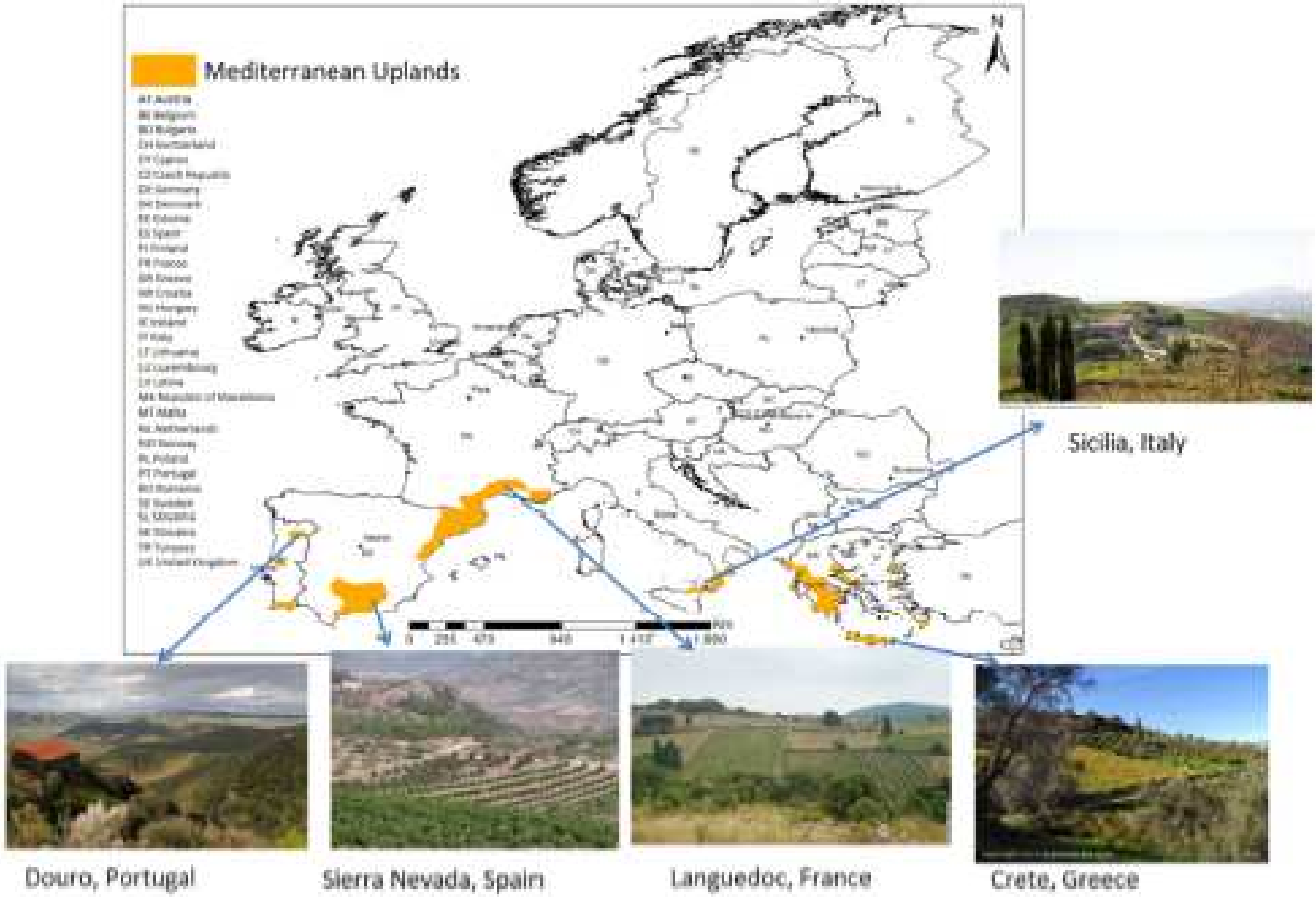
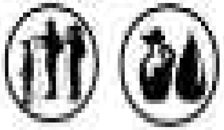


Figure 4 – Delimitation of Mediterranean Upland macro-region including views of sites in this MR

- Non-monetary attributes: selection and description – “farmland in Mediterranean Upland and its benefits to the common-citizen”

- Non-monetary attributes: selection and description – "farmland abandonment in Mediterranean Upland and its losses to the common-citizen"

- Non-monetary attributes: selection and description – PG programmes

Attribute	Farmers' commitment:	Society's benefits:
Landscape Conservation  	Maintain production of traditional crops Practice an environmental friendly agriculture	Safeguard the cultural heritage Enjoy high quality and tasty products Enjoy the traditional countryside for recreation and leisure
Erosion Control 	Keep terraces on steep sloped terrain Keep the soil covered with vegetation and avoid ploughing	Ensure soil fertility Ensure the soil's ability to support landscape and biodiversity
Biodiversity Conservation 	Maintain the habitats for endangered fauna and flora Practice an environmental friendly agriculture	Preserve animal and plant species from extinction Enjoy nature for recreation and leisure
Fire risk reduction 	Bushes' removal Keep crops as barriers to the progression of fires	Ensuring the integrity of people and goods Avoid air pollution and emissions of greenhouse gases

- Choice set: number of alternatives (baseline and reference levels) – MRAEP “farmland abandonment in Mediterranean Upland”

  - Example of choice set

Programme providing services ...	No application	Option A	Option B
 **Landscape conservation**	0 %	0 %	100 %
 **Biodiversity conservation**	0 %	100 %	0 %
 **Soil erosion control**	0 %	50 %	50 %
 **Fire risk reduction**	0 %	100 %	0 %
Increase in taxes payments (annually for 5 years)	0 €	3 €	21 €

- Test at pilot level of the questionnaire for–Samples
  MRAEP “farmland abandonment in Mediterranean Upland”

Three samples for 300 valid interviews each have been selected

a) Face-to-face interviews with CAPI (computer assisted personal interviews), carry out in the Metropolitan area of Lisbon (PT)

b) Panel web-base (one-line) administrated for national population of Portugal

c) Panel web-base (one-line) administrated for national population of Germany

Criteria for sampling selection:

1. Stratified samples have been selected

a) Age, gender

b) & c) Age, Gender, NUTS2

2. Individual with 18 years old in charge of household expenses

- Estimates for the attributes WTP (based on estimates for MNL and RPL specifications), values are in €

PGaE	PT_F2F		PT_WEB		DE_WEB	
	MNL	RPL	MNL	RPL	MNL	RPL
Landscape	23	29	29	36	27	37
IC-upper bond	29	38	38	49	36	50
IC-lower bound	16	21	21	23	19	23
Farmland Biodiversity	26	29	47	54	45	59
IC-upper bond	32	38	58	69	56	78
IC-lower bound	19	19	36	38	34	40
Erosion control	25	28	23	23	17	19
IC-upper bond	32	38	31	33	24	30
IC-lower bound	18	19	16	13	10	9
Fire risk reduction	42	51	36	51	20	23
IC-upper bond	50	62	45	65	28	35
IC-lower bound	33	39	27	36	13	13

Note: Confidence Intervals (95% confidence level)

Assessing the proposed valuation framework

- The design of context-rich valuation scenarios is always a challenging aspect of the design and implementation of stated-preference valuation methods,
- it is even more challenging when we move to a supra-national scale.
- A multi-country valuation framework for multiple PGaE for entire cross-country MRs, such as the ones discussed in this paper has never been built before, as far as we know.

Assessing the proposed valuation framework

- Potential usefulness of the proposed framework: deliver information on the value for ordinary people of changes in multiple PGaE of agriculture at broad cross-country scales.
- Useful for the evaluation of the implications of CAP reforms.
- Or for a better integration of (environmental or social) non-trade issues into a full cost-benefit assessment of multi-lateral trade agreements.

Assessing the proposed valuation framework

- Relevant PG from a supply-side perspective were found also to be understandable and relevant for respondents (demand-side), at least in the tested MR
- CM was revealed to be a good option for delivering value estimates for each PGaE
- Our approach was able to provide value estimates for different PGaE in a well-defined context, thus ensuring content validity
- Multi-country preferences were gathered for PGaE provided at a supranational scale

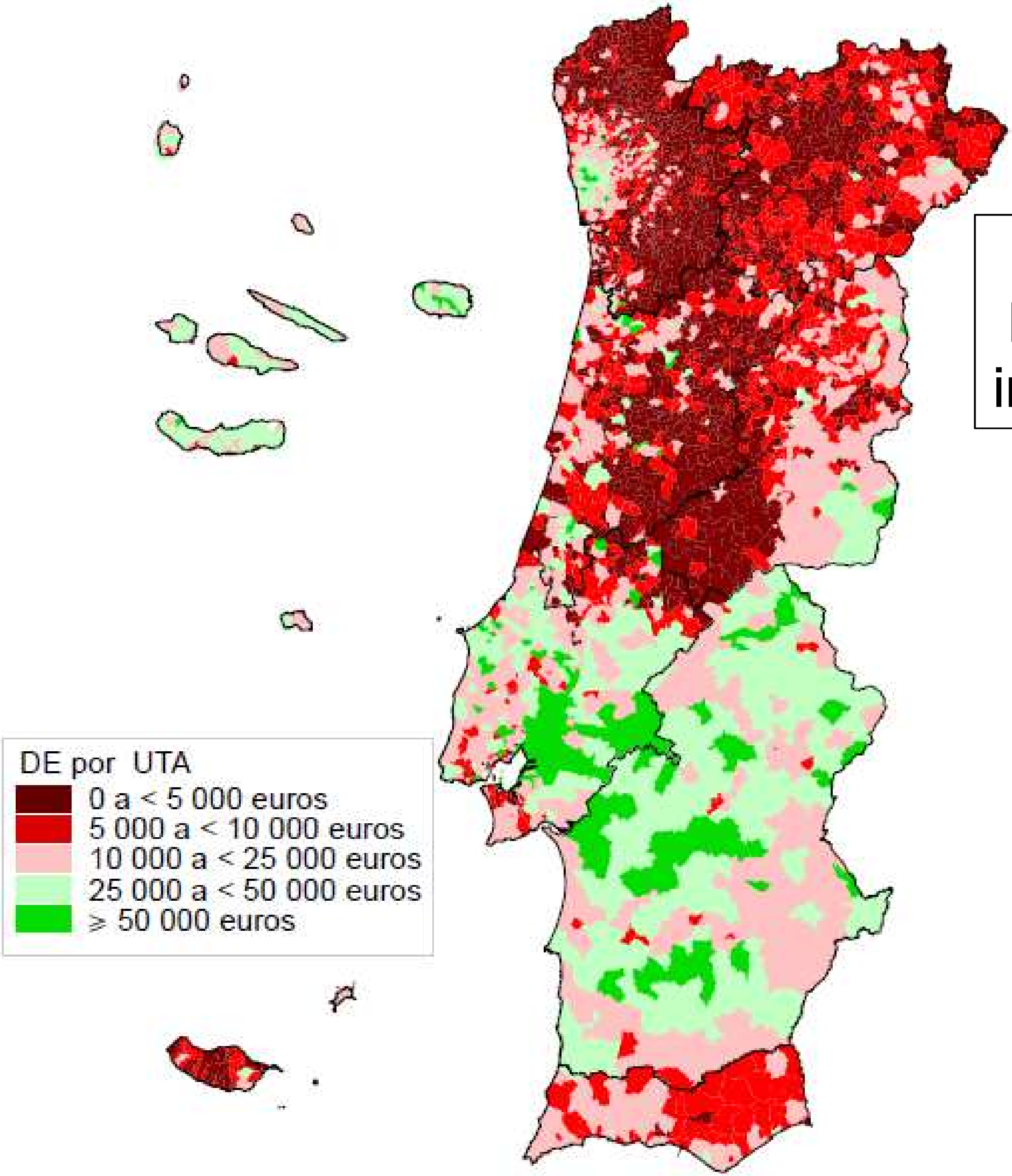
A first idea: land use and land cover (LULC) and LULC change are key to understand major sustainability challenges

Labour productivity in agriculture (the driver)

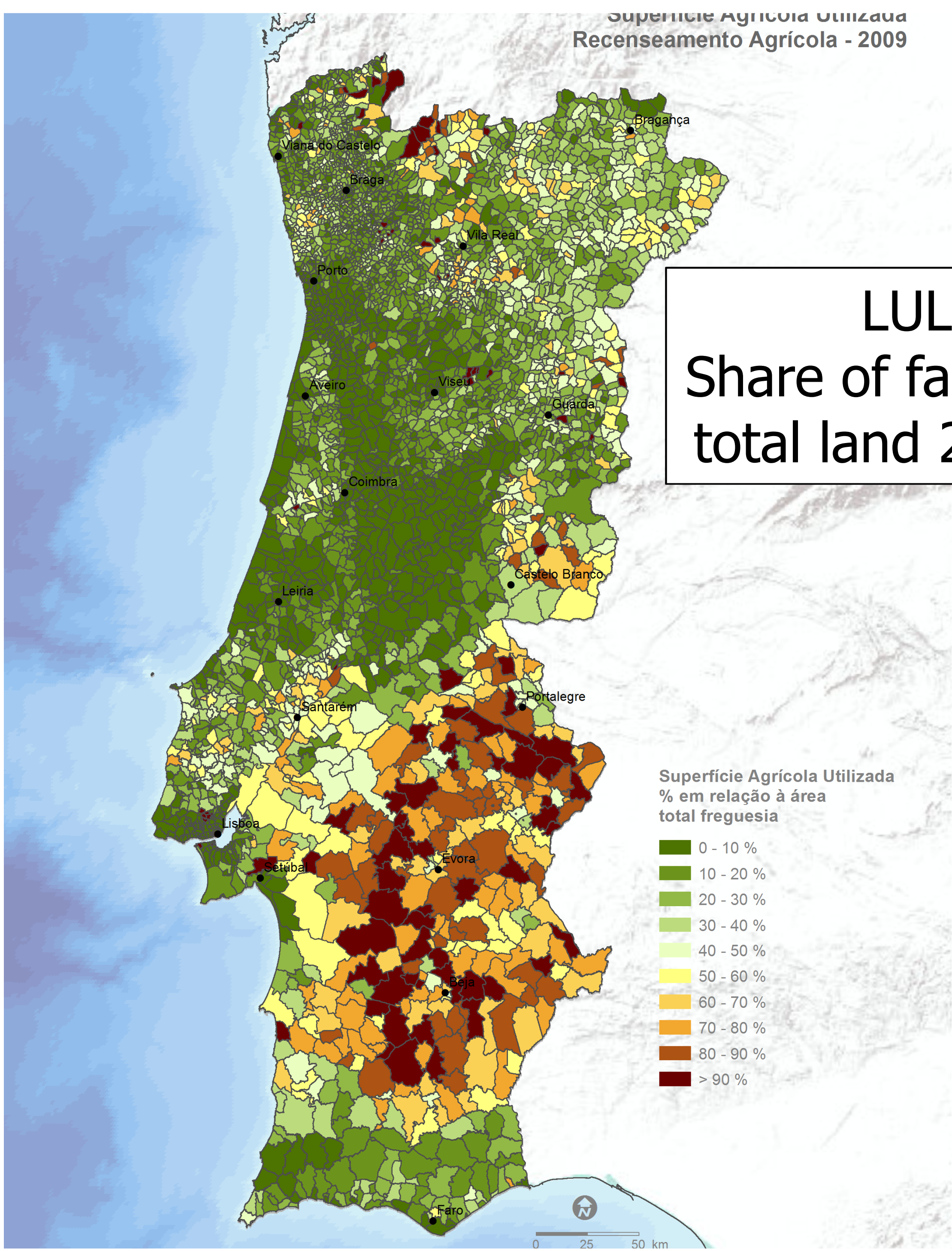
Share of farmland in total land (LULC)

Wildfire hazard (the consequence)

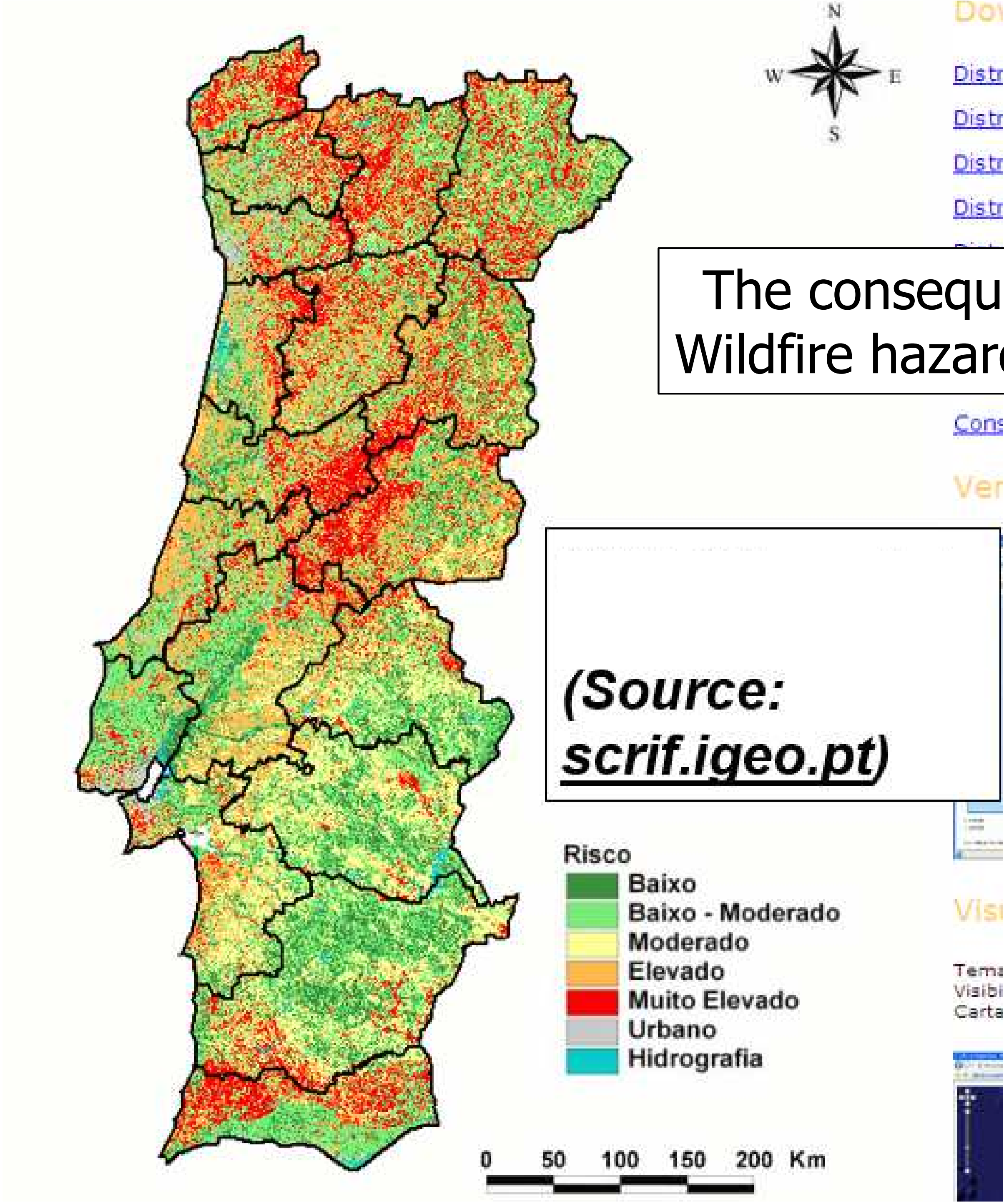
Driver: Labour productivity in agriculture (2009)



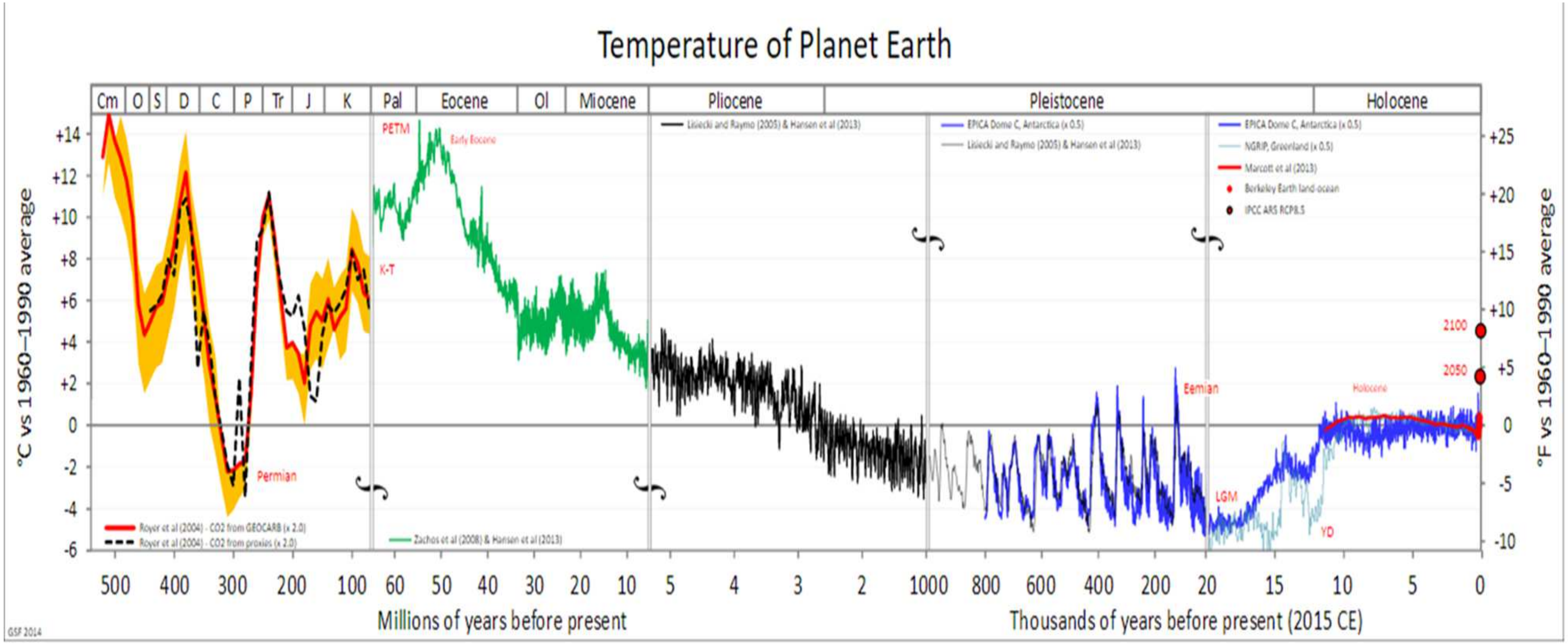
LULC: Share of farmland in total land 2009 (%)



The consequence: Wildfire hazard 2009



(Source: scrif.igeo.pt)

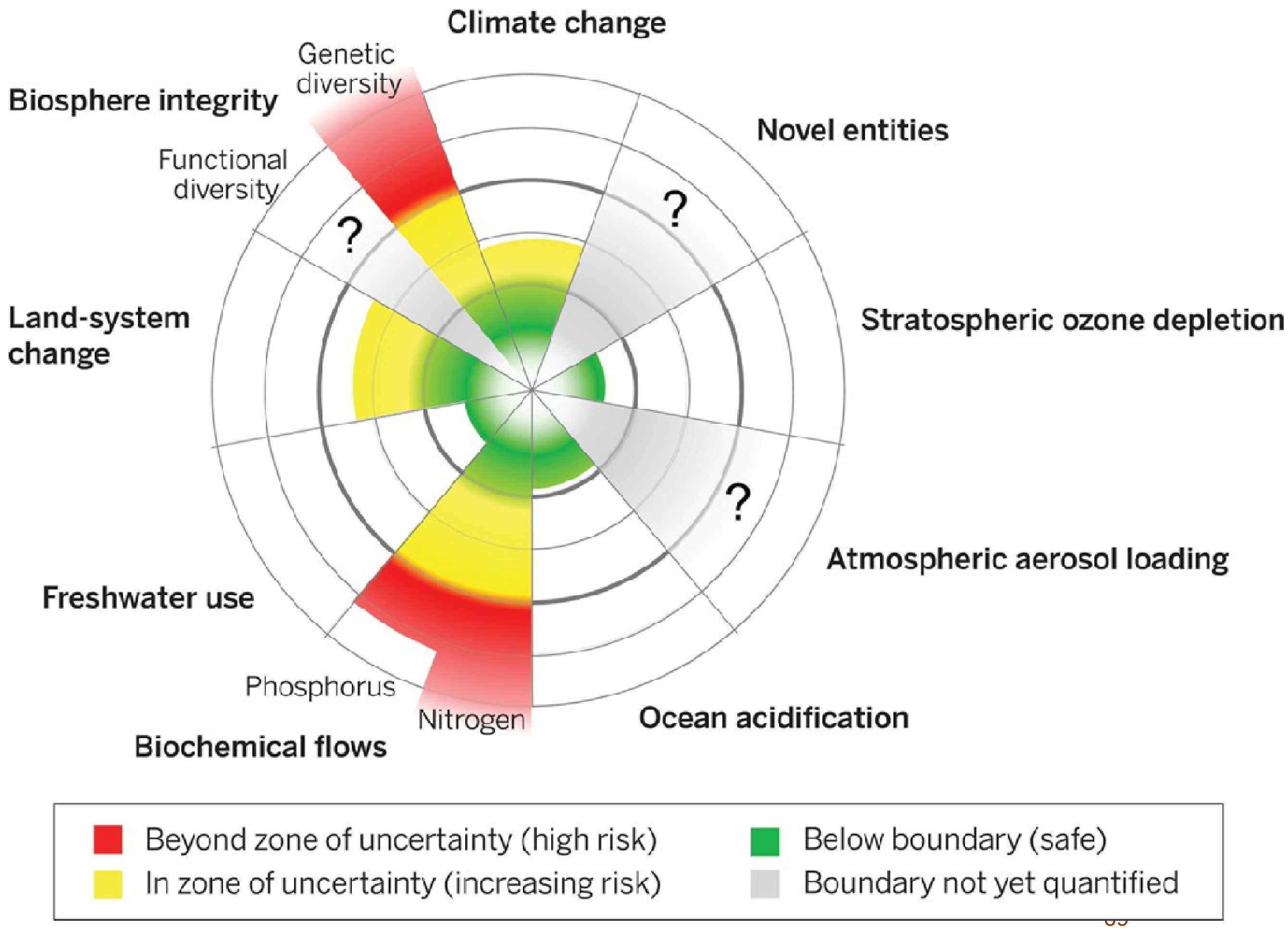


Source: http://gergs.net/2015/06/updating-the-geological-temperature-plot/all_palaeotemps/

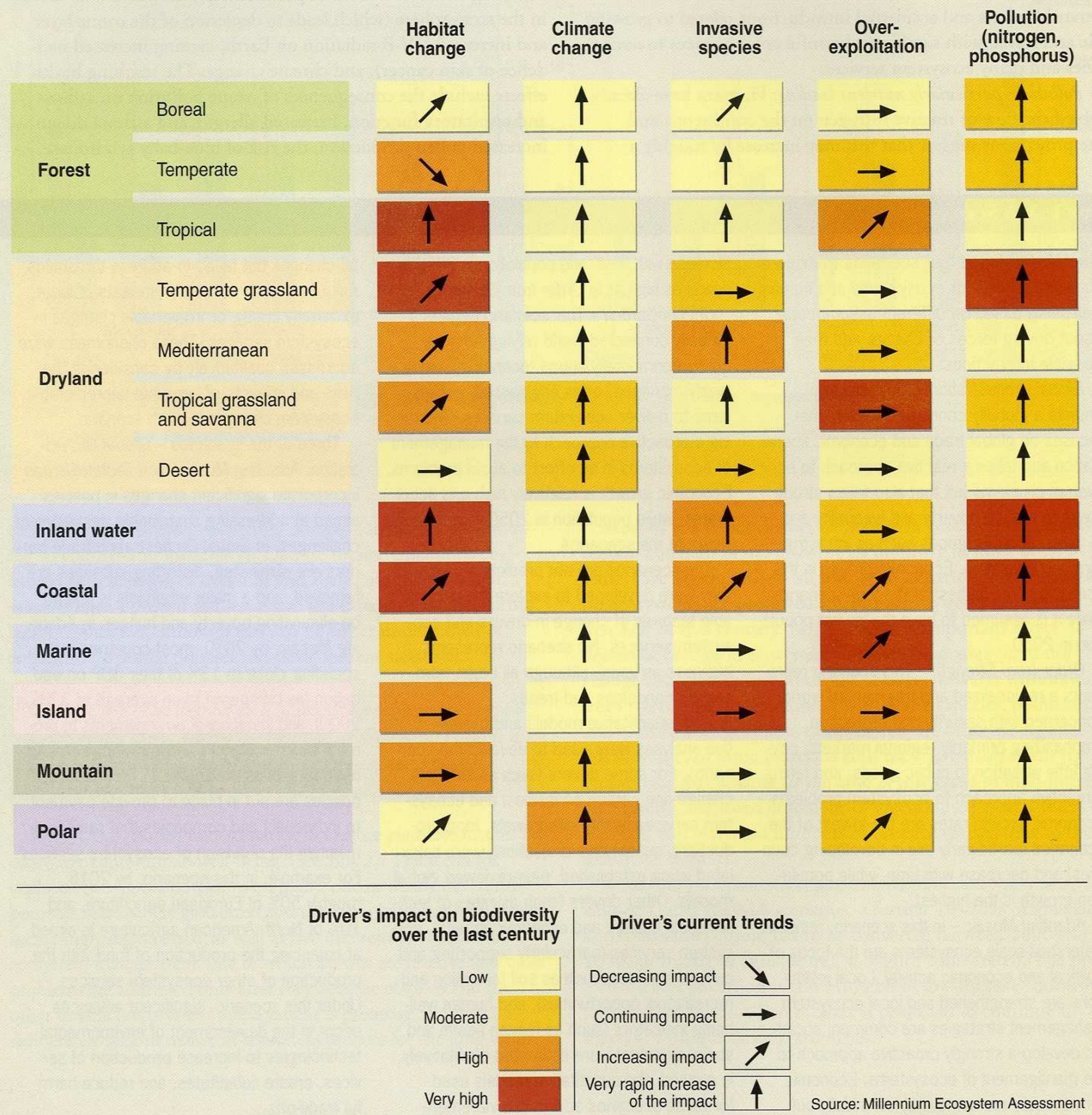
First, most important contributor: Burning of fossil fuels

Second: LULC change

Current status of the control variables for seven of the planetary boundaries. The green zone is the safe operating space, the yellow represents the zone of uncertainty (increasing risk), and the red is a high-risk zone.



Will Steffen et al. Science 2015;347:1259855

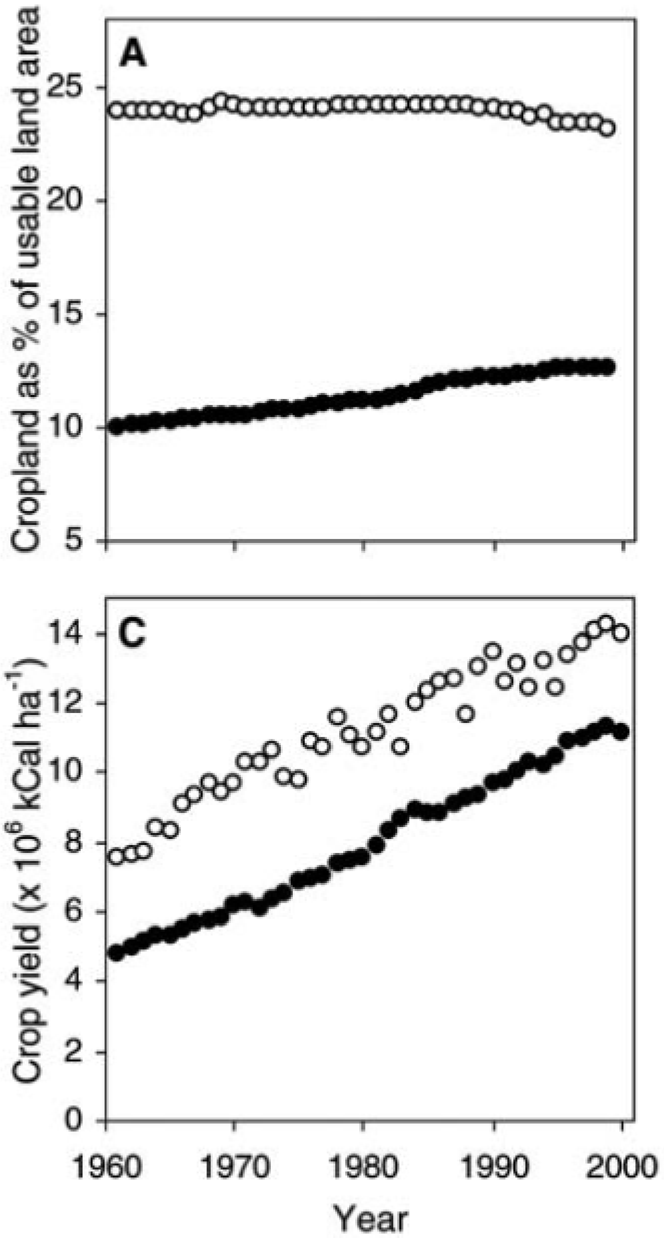


Source: Millennium Ecosystem Assessment

Farming and the Fate of Wild Nature

Rhys E. Green,[1,2]* Stephen J. Cornell,[1,3] Jörn P. W. Scharlemann,[1,2] Andrew Balmford[1,4]

World food demand is expected to more than double by 2050. Decisions about how to meet this challenge will have profound effects on wild species and habitats. We show that farming is already the greatest extinction threat to birds (the best known taxon), and its adverse impacts look set to increase, especially in developing countries. Two competing solutions have been proposed: wildlife-friendly farming (which boosts densities of wild populations on farmland but may decrease agricultural yields) and land sparing (which minimizes demand for farmland by increasing yield). We present a model that identifies how to resolve the trade-off between these approaches.



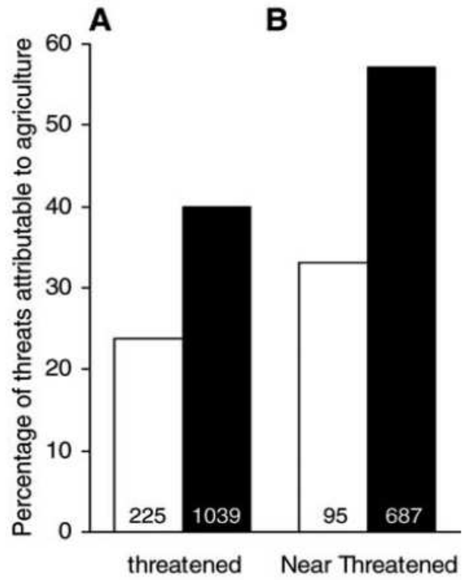
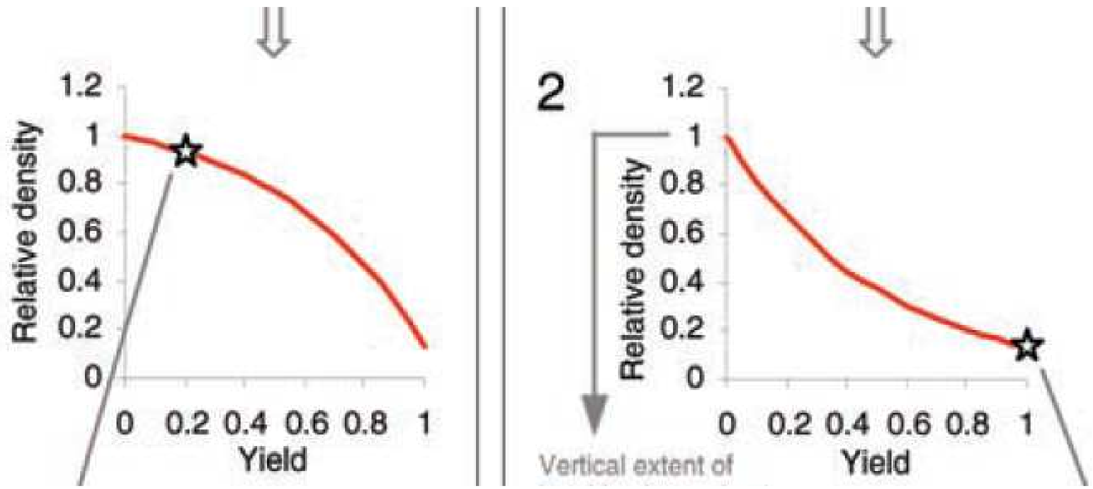
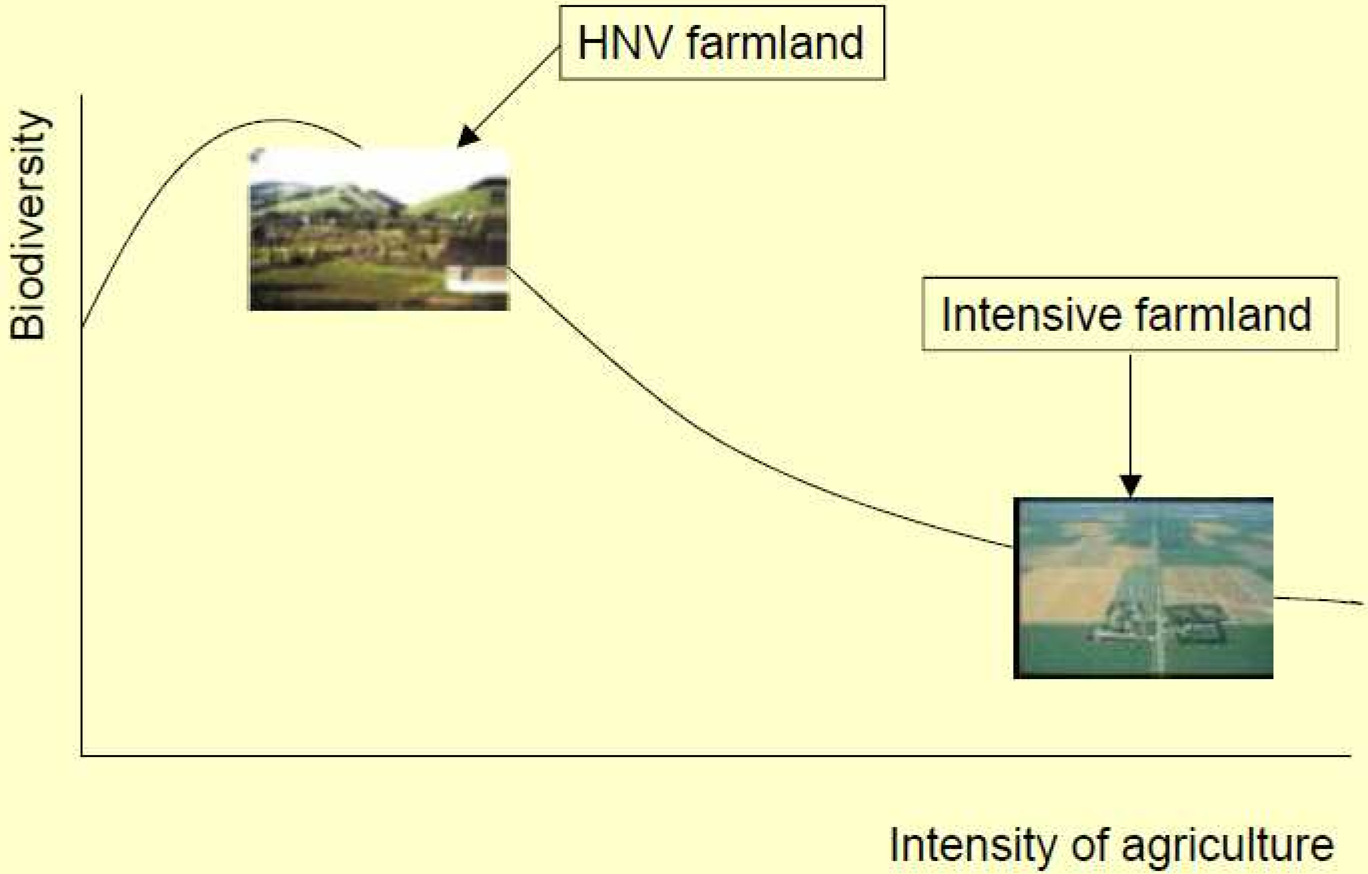


Fig. 2. The mean proportion of a species' listed threats that are attributable to agriculture plotted for threatened (A) and Near-Threatened (B) birds from the developed (white) and developing (black) world (*3*).



Sist. agr. extensivos: High Nature Value farmland



Fonte: EEA (2004: 5)

Not only LULC change: other aspects of land management are also key drivers of environmental change

- Fertilizer use
- Pesticide use
- Stocking rates
- Water use

… many of these are related to use intensity rather than LULC class

… and <u>not</u> included in most LULC analyses.