From Land Cover to Farm Types

Adrian Leip & Renate Köble

EC JRC – Institute for Environment and Sustainability, Climate Change Unit, Ispra, Italy

Markus Kempen, Thomas Heckelei, Wolfgang Britz

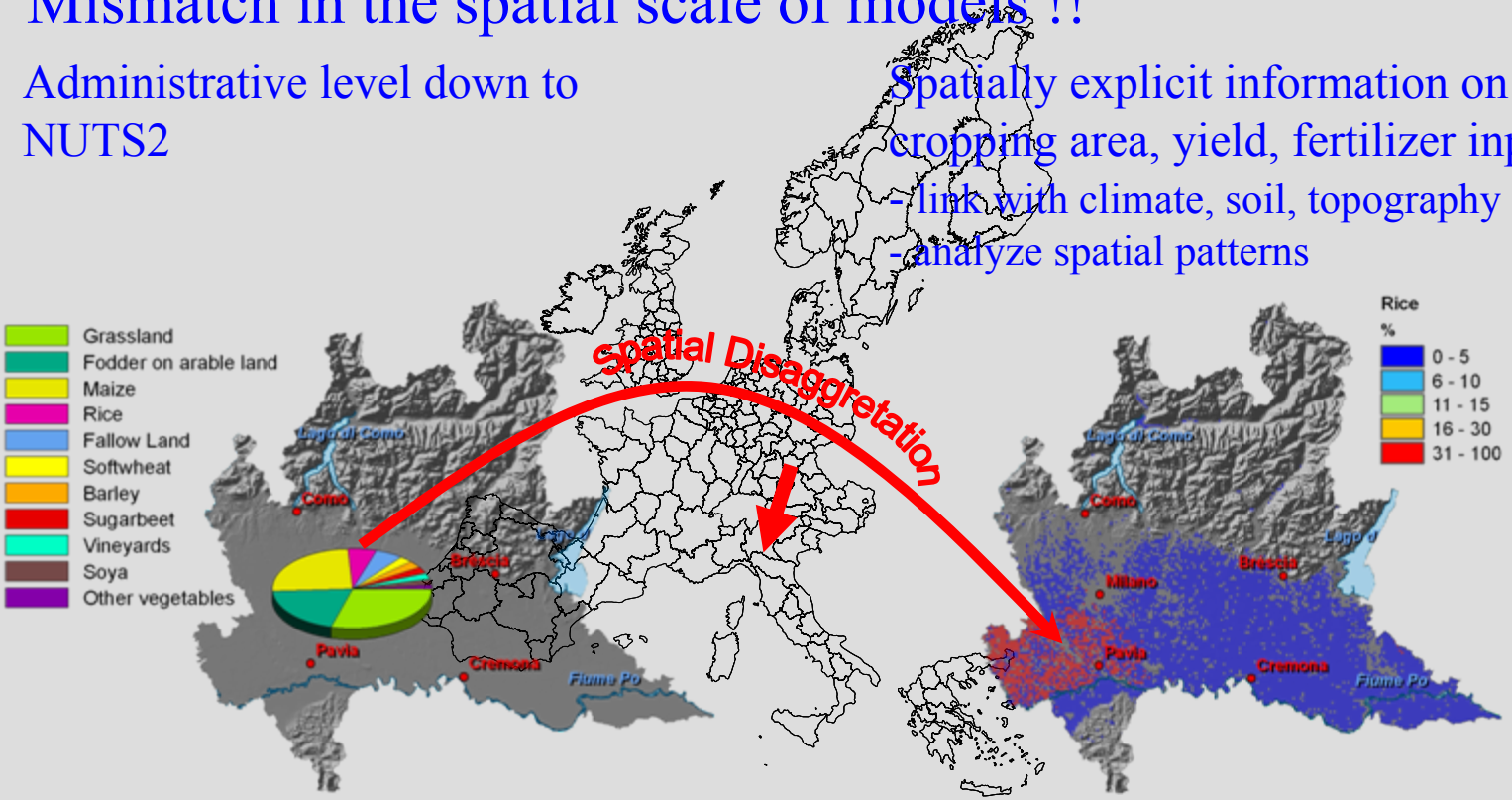
University of Bonn, Institute for Agricultural Policy, Market Research and Economic Sociology, Bonn, Germany

OUTLINE

Mismatch in the spatial scale of models !!

Administrative level down to NUTS2

Spatially explicit information on e.g. cropping area, yield, fertilizer input to
- link with climate, soil, topography
- analyze spatial patterns



Agricultural sector model CAPRI

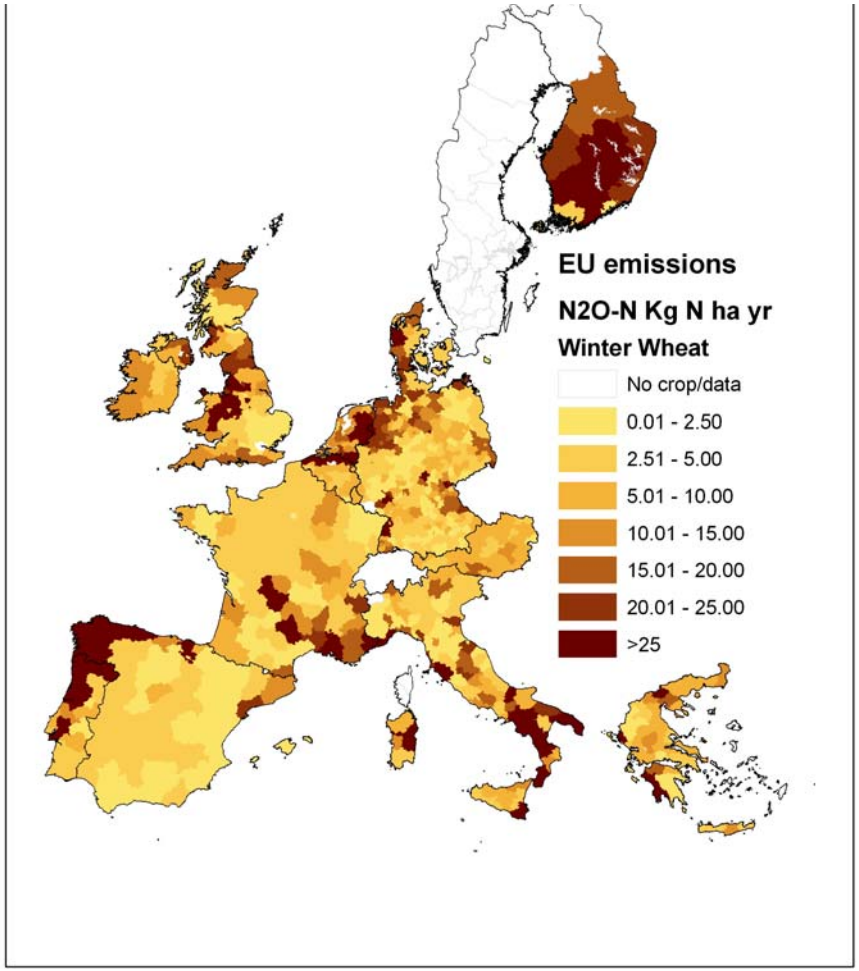
LINK

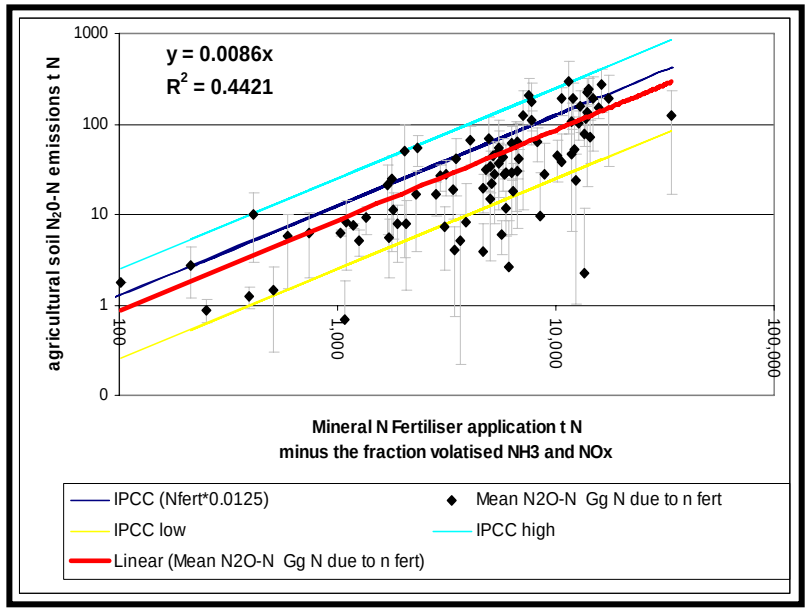
Biogeochemical Model DNDC

CAPRI-DynaSpat project

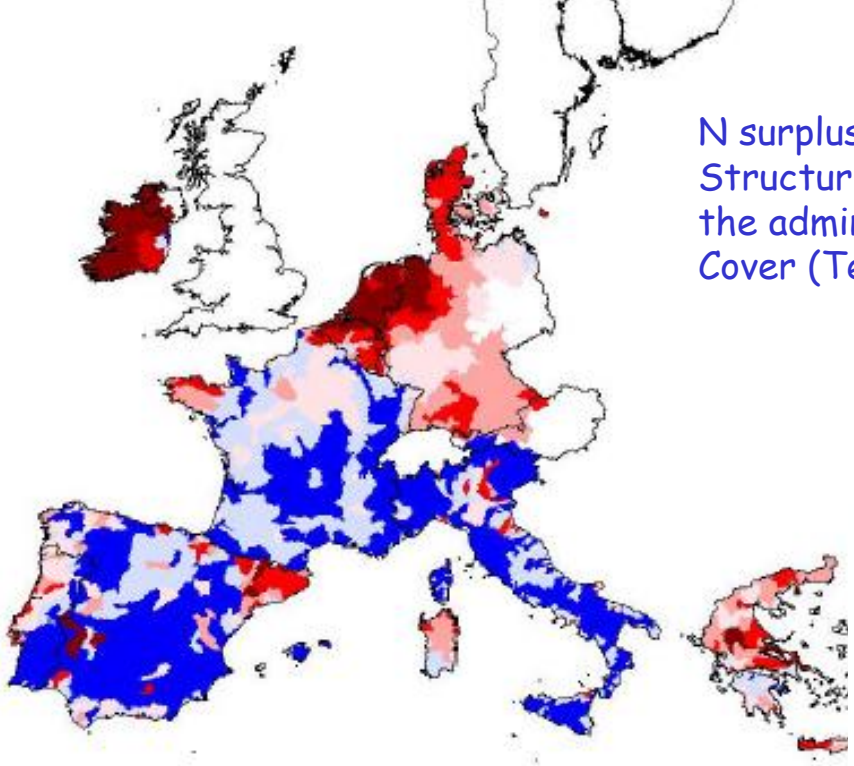
CAP Regional Impact Assessment – Dynamic and Spatial dimension

N2O emissions from EU simulated with DNDC (Mulligan, 2005)



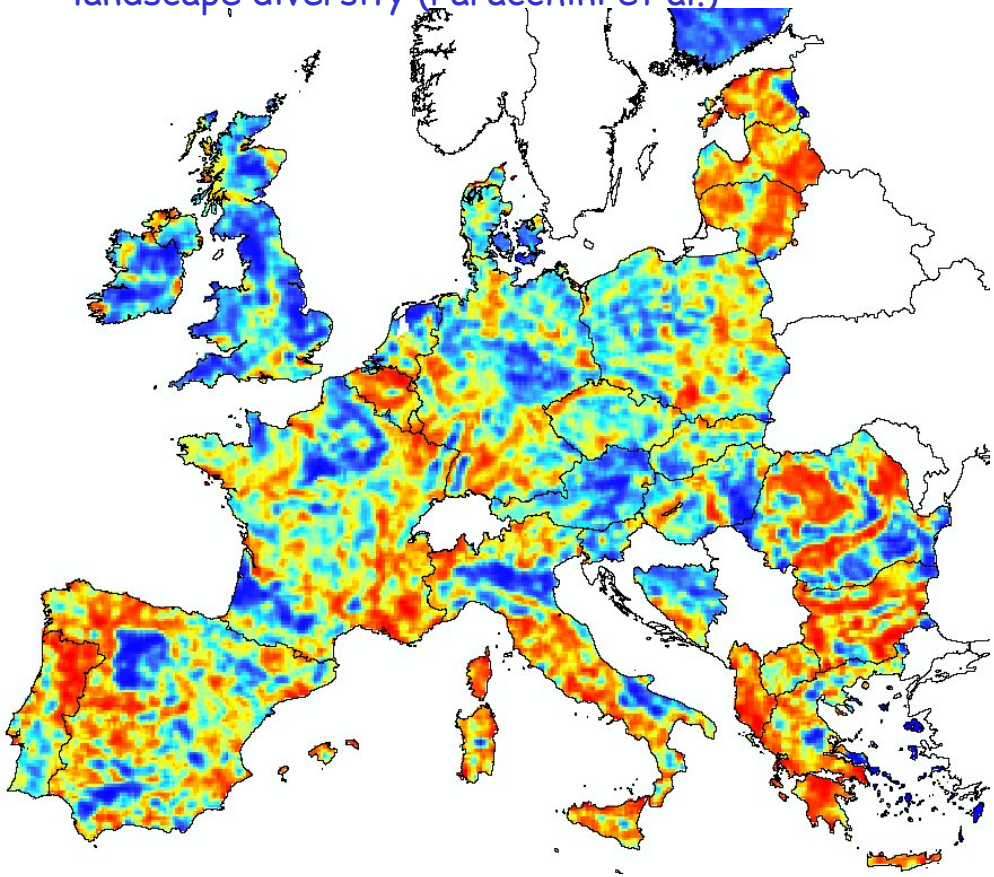


Range of N2O emissions simulated with minimum and maximum SOC values, ITALY, NUTS 3



N surplus calculation using NUTS 3 census data (Farm Structure Survey 2000) and an overlay overlay between the administrative areas, river basins and CORINE Land Cover (Terres et al., 2002)

SHANNON DIVERSITY INDEX to measure landscape diversity (Paracchini et al.)



Matching scales for …

- → Reducing uncertainty
- → Landscape assessment
- → Emissions of air pollutants

Facilitating interpretation

- → Less-favored areas
- → Nitrate vulnerable zones
- → Assessment of farm practices

MAPPING PROCEDURE

BASIC SPATIAL AND TEMPORAL FRAME:

area of interest: currently EU15

30 Crops: Common wheat, Durum Wheat, Barley, Rye , Oats, Maize, Rice, Other cereals, Potatoes, Sugar beet, Other root crops, Sunflower, Rape and turnip rape, Soya, Fibre and oleaginous crops, Tobacco, Other non permanent industrial crops, Dry pulses, Tomatoes, Other fresh vegetables, Floriculture, Fodder other on arable land, Fallow land, Fruit tree and berry plantations, Citrus fruits, Olive groves, Vineyards, Nurseries, Other crops, Permanent grass and grazing

temporal reference: year ~2000

resolution: 1km by 1km

STEP1: Delineate Homogenous Spatial Mapping Units -HSMU's- i.e. areas with similar environmental conditions (200 NUTSII → ~140000 HSMU's in EU15)

STEP2: Construct models to estimate "crop shares" at observation points in different land cover classes

STEP3: Estimating the shares of the individual crops in the HSMU's consistently with ESTAT statistics at NUTS 2 level

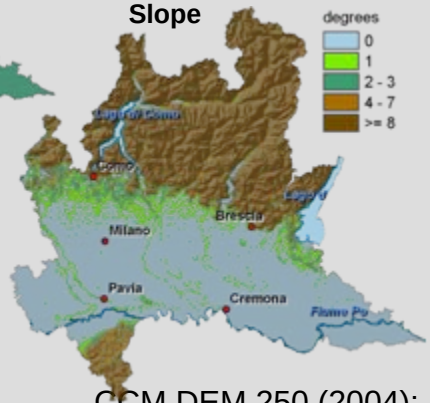
STEP 1: Defining Homogeneous Spatial Mapping Units (HSMU's)

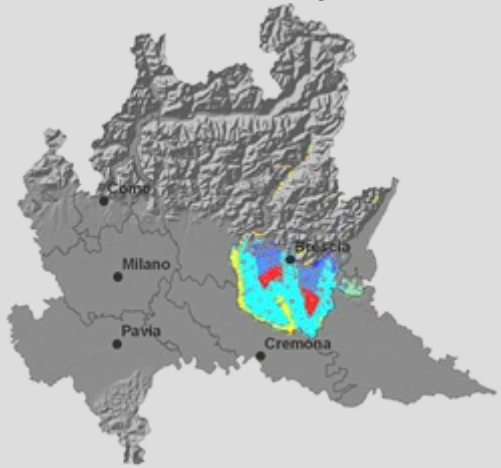
28 HSMU's in
NUTSIII: Brescia
Land cover class: non irrigated arable land

NUTS3 Regions

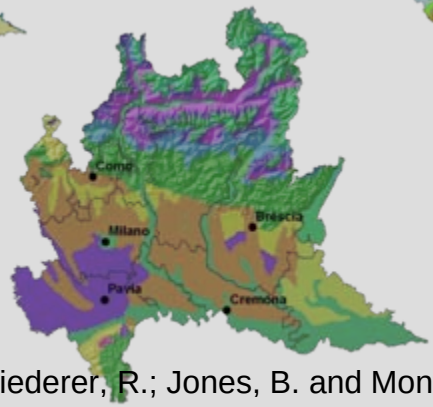
CORINE Land Cover

Slope





Soil Mapping Unit



ETC-TE - European Topic Centre on Terrestrial Environment (2000): Corine land cover database

CCM DEM 250 (2004): EuroLandscape/Agri-Environment Catchment Characterization and Modeling Activity.

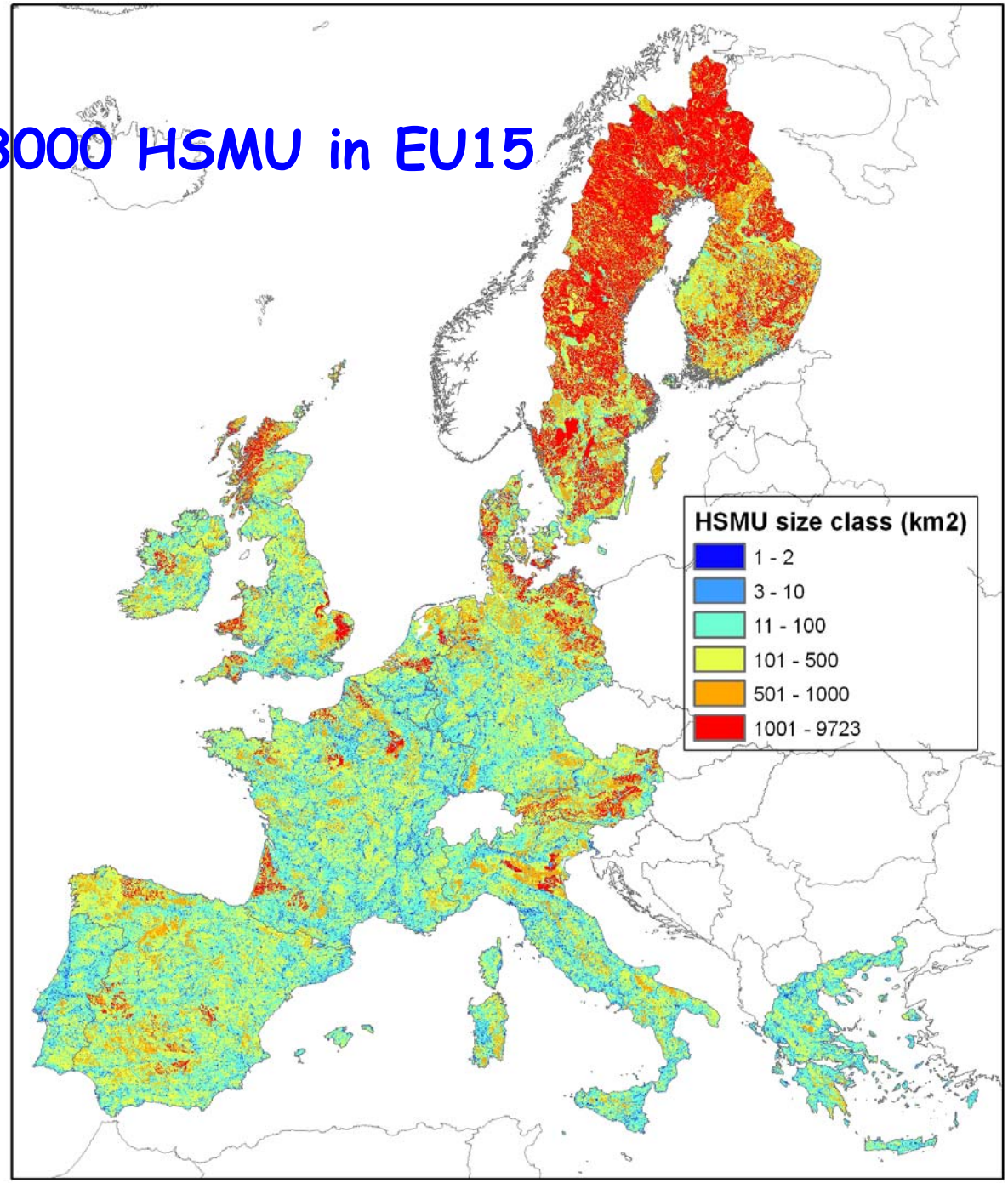
Hiederer, R.; Jones, B. and Montanarella L. (2003): European Soil Raster Maps (1km by 1km)

SMU	SLOPE CLASS	AREA km2
536	0	120
	1	1
543	4-7	1
	>8	8
437	0	2
	1	3
	2-3	5
	4-7	7
	>8	15
555	0	138
	1	33
	2-3	2
	4-7	1
557	>8	5

SMU	SLOPE CLASS	AREA km2
560	0	5
	1	31
	2-3	6
	4-7	1
563	0	756
	1	84
	2-3	18
	4-7	2
	>8	4
567	0	131
	1	59
	2-3	13
	4-7	6
	>8	6

> 143000 HSMU in EU15

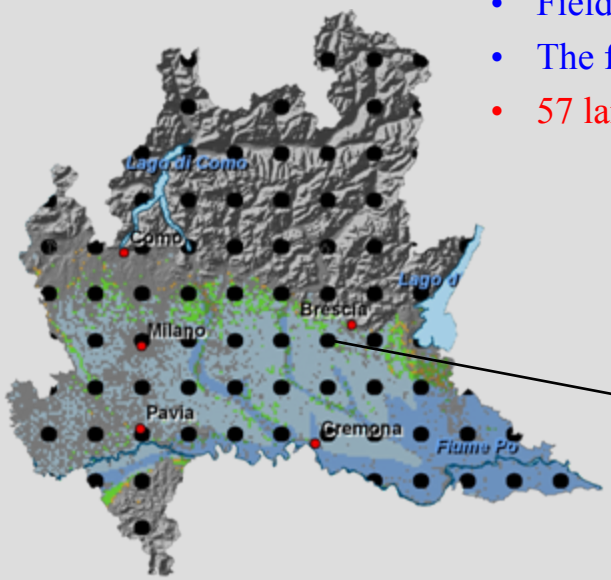
→58400 in CORINE pure agricultural and agricultural mixed classes

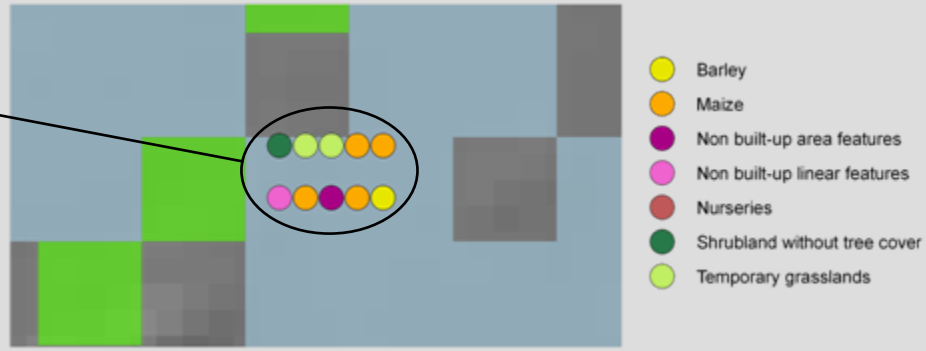


LUCAS
Land Use / Land Cover Area frame statistical Survey

Observation points of the (LUCAS)

- Main land cover/use survey raster:
  18 km by 18 km with 10 subsampling Units
- Field survey at ~100 000 observation points in EU15
- The first survey has been carried out in 2001 (UK 2002)
- 57 land cover classes are separated including 34 agricultural classes





Data Source:
European Commission (2003a): The Lucas survey. European statisticians monitor territory. . Theme 5: Agriculture and fisheries. Series Office for Official Publications of the European Communities, Luxembourg, 2003. 24 pp

Attributes of the HSMU and LUCAS

The following parameters are calculated for each LUCAS sampling unit and as average, minimum and maximum value for each HSMU

Climate:

- Temperature sum
- Temperature (monthly)
- Rainfall
- Duration of the vegetation period

Topography:

- Slope
- Elevation

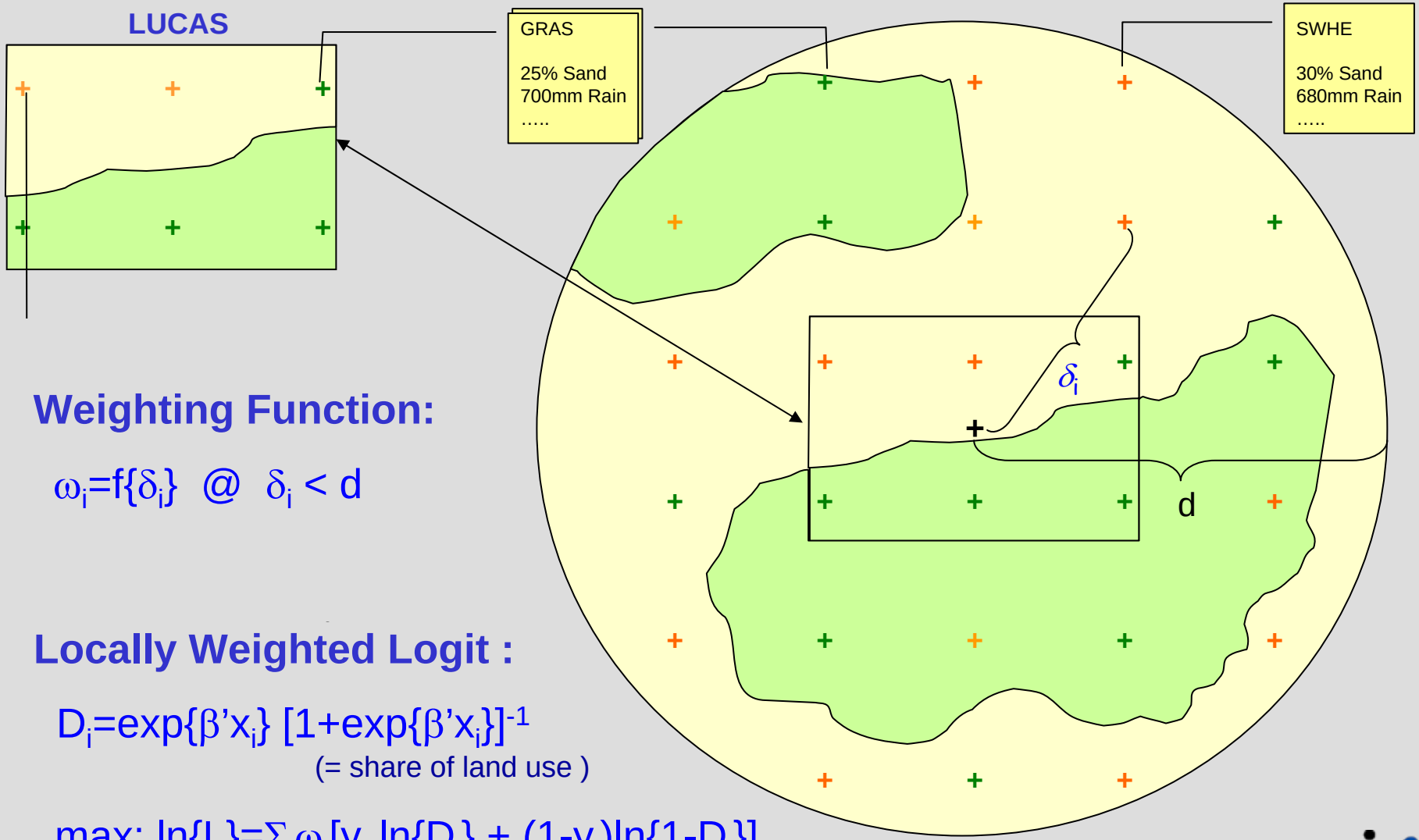
Soil:

- Top soil organic carbon content
- Base saturation of the topsoil
- Soil texture
- Depth to an impermeable layer
- Most important limitation to agricultural use
- Volumes of stones
- …

Other:

- Less Favored Areas
- Nitrogen Vulnerable Zones
- Potential yield

Step 2: Locally Weighted Max. Likelihood



Weighting Function:

$\omega_i = f\{\delta_i\} \quad @ \quad \delta_i < d$

Locally Weighted Logit :

$D_i = \exp\{\beta' x_i\} \, [1+\exp\{\beta' x_i\}]^{-1}$

(= share of land use)

$\max: \ln\{L\} = \Sigma_i \omega_i [y_i \ln\{D_i\} + (1-y_i)\ln\{1-D_i\}]$

Step 3: Highest Posterior Density

HSMU

60ha 30% Sand 650mm Rain .....

40 ha 20% Sand 700mm Rain .....

$Y_{est}(h,c)=f\{\beta_c, x_h\}$

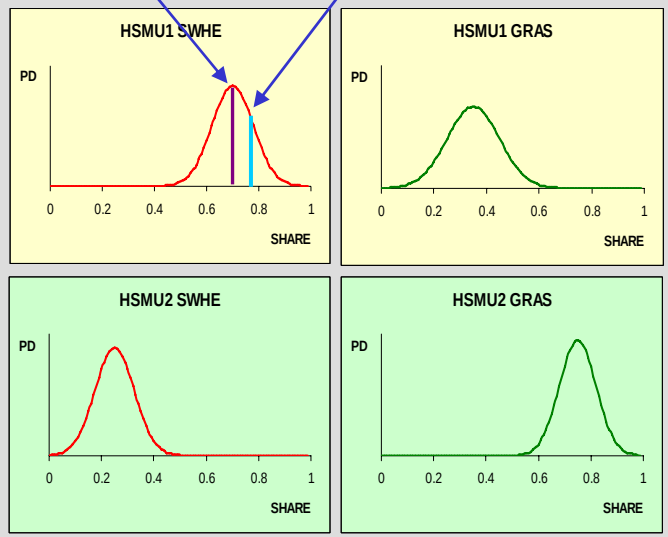
ESTIMATION

70% SWHE -> 42 ha
35% GRAS -> 21 ha

26% SWHE -> 10.4 ha
72% GRAS -> 28.8 ha

y_{est} y_{con}

pdf{Y(h,c)}



Y(h,c)

Nuts II

55 ha SWHE

45 ha GRAS

Data consistenst shares $Y_{con}(h, c)$ for all crops c and HSMU h

$$\max: \Sigma_i\Sigma_j[Y_{con}(h_ic_j)]$$
$$\text{s.t. } \Sigma_i Y_{con}(h_ic_j)\, A_i=A_j$$
$$\Sigma_j Y_{con}(h_ic_j) =1$$

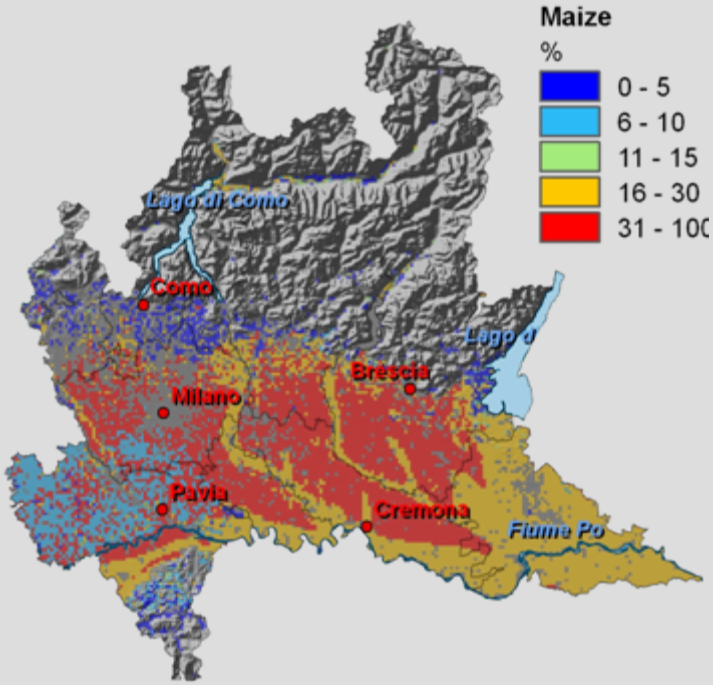
y_{con}

76% SWHE -> 45 ha
25% GRAS -> 15 ha

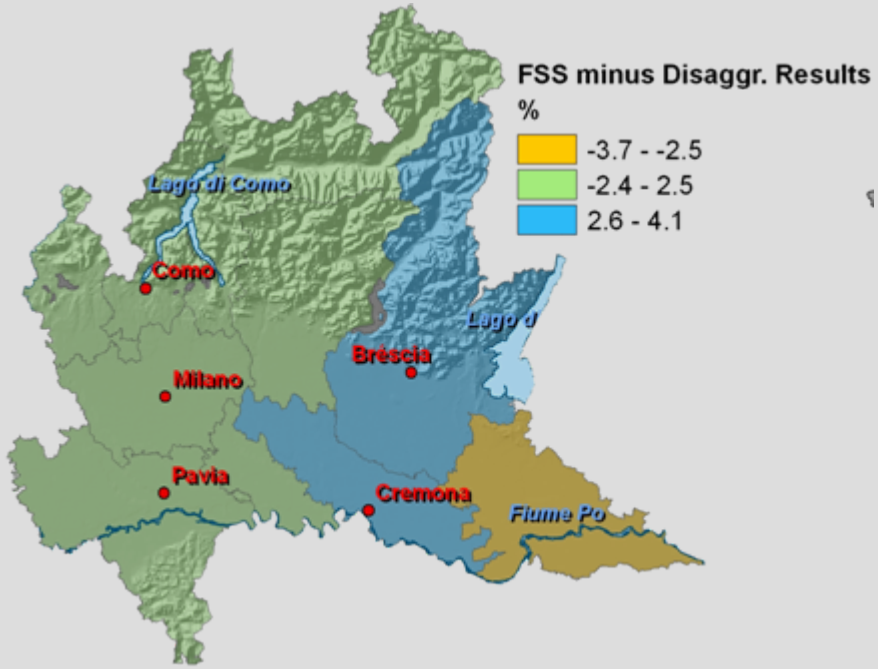
25% SWHE -> 10 ha
75% GRAS -> 30 ha

Preliminary results

Results for the Lombardy Region



Comparison with Farm Structure Survey Statistics on NUTSIII

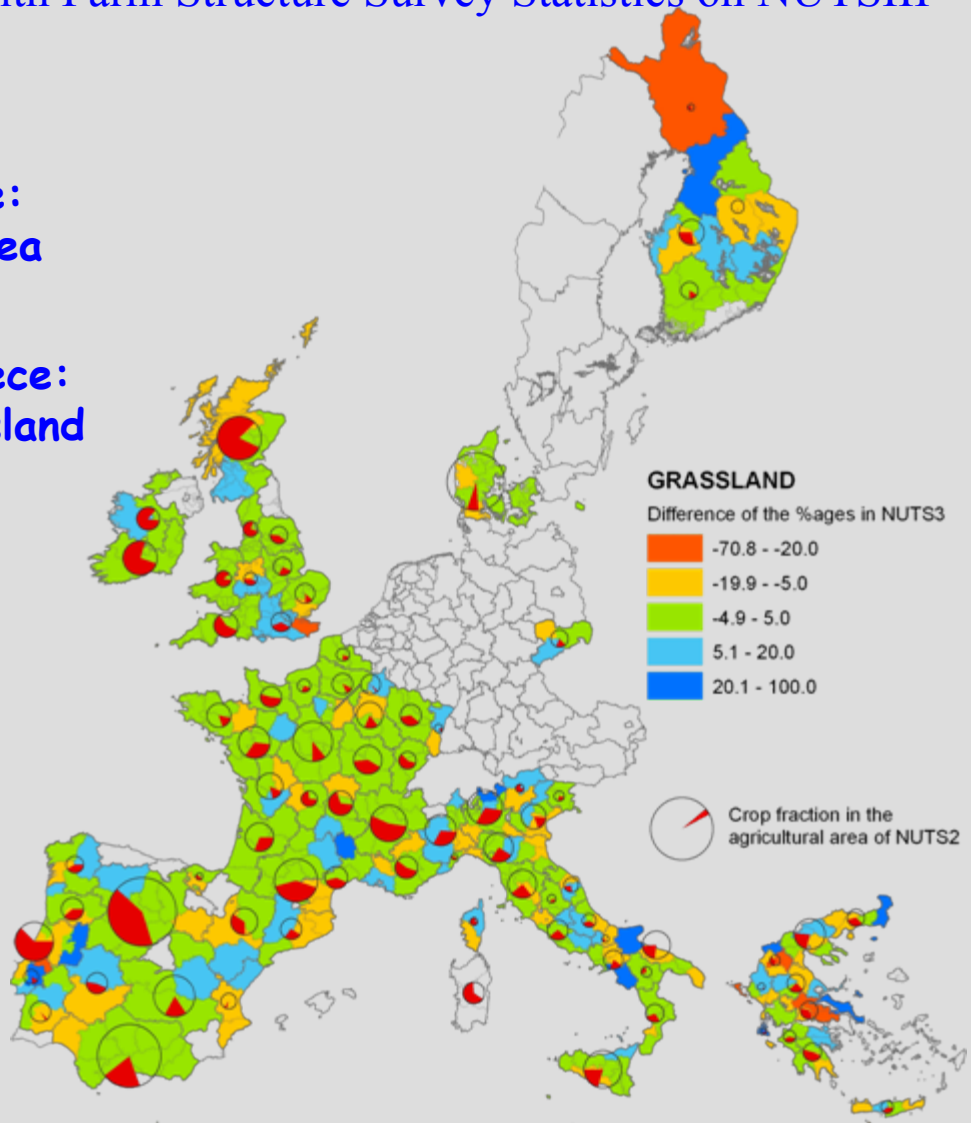


Preliminary results and uncertainties

Comparison with Farm Structure Survey Statistics on NUTSIII

size of the pie: agricultural area in region

size of red piece: share of grassland in region



Outlook (after finalization …)

→ Improve input data set
- Expand to EU25
- Topsoil organic carbon
- Corine2005 – LUCAS 2006

→ Disaggregate farm management
- Synthetic Fertilizer input
- Organic fertilizer production/input
- Yield

→ Allocation of farm typologies
- FADN typology
- Most probable crop-mix
- Less favoured areas etc.

→ Expand to other land uses (forests)

→ Improve economic core model (CAPRI) with fine-scale spatial information

Conclusions

- → The new land use map will be of an unprecedented resolution
- → "Pre-validations" are encouraging
- → The approach offers good opportunities for expansion
- → We expect that the remaining uncertainty will be outweighed by the improved spatial accuracy of the applied biogeochemical models
- → Finalization in spring 2006


Thank you for your attention