INSEA

INTEGRATED SINK ENHANCEMENT ASSESSMENT

INSEA PARTNERS

# Bio-physical impacts of agricultural land use management systems in EU25

**Erwin Schmid, Juraj Balkovic, Elena Moltchanova, Michael Fuchs, Rastislav Skalsky, Katarina Poltarska, Radoslav Bujnovsky, Uwe Schneider, Rainer Baritz, Michael Obersteiner, Brigitte Müller, Vladimir Stolbovoy, Stephane De Cara, Daniel Blank**

*Final INSEA meeting* *Brussels, 21-22 June 2006*

# Outline

- Problem Statement and Research Objective
- INSEA Approach of bio-physical process Modelling in EU25
- Bio-physical impacts of agricultural land use management systems on
  - Crop Yields
  - Soil Organic Carbon
  - 'Direct' $N_2O$-N emissions
  - 'Indirect' $N_2O$-N emissions
  - biomass production (miscanthus and poplar coppice)
- Conclusions

# Problem Statement and Research Objective

⇒ Bio-physical **Impacts** of land use management are usually **discontinuous outcomes** of **stochastic natural processes** (erosion, leaching, etc.) under certain **local conditions** (weather, soil, topography, management, etc.).

⇒ Concept of **Homogeneous Response Units** (HRU) **+** bio-physical process model **EPIC**

⇒ **Tool** providing **spatially** and **temporally** explicit bio-physical impact vectors:

- Comparative Dynamic Impact Analysis
- Consistent Linkage with Economic Land use Optimisation Models

# Data for bio-physical modelling in EU25

| GROUP | DATA SET | DESCRIPTION |
| --- | --- | --- |
| climate | MARS<br>EAST ANGLIA<br>EMEP | Monitoring of Agriculture with Remote Sensing (50 km)<br>Tyndall Centre for Climate Change Research (0.5°)<br>Monitoring and evaluation of the long-range transmission of air-pollution in Europe (50 km) |
| Soil | ESDB v.2<br>OC TOP v. 1.2<br>HYPRESE | The European soil database v. 2. (10 km, 1 km)<br>The map of Organic Carbon in the Topsoils in Europe, Ver. 1.2<br>Hydraulic Properties of European Soils (PTF Data) |
| Topography | GTOPO30 | Global digital elevation model (30 arc seconds) |
| Land Cover | CORINE/PELCOM | Combined CORINE and PELCOM (1 km) |
| Admin. region | AGISCO | Geographic Information System of European Commission data |
| Reference grid | SWU | JRS Soil and Waste Unit reference grid (10 k) |
| Agricultural statistics | NEW CRONOS<br>LUCAS<br>MARS | New Cronos Regional Statistics (NUTS2, NUTS1)<br>Land use and land cover area frame statistical survey project data (Phase I.)<br>Monitoring of Agriculture with Remote Sensing (50 km) |

# HRU delineation

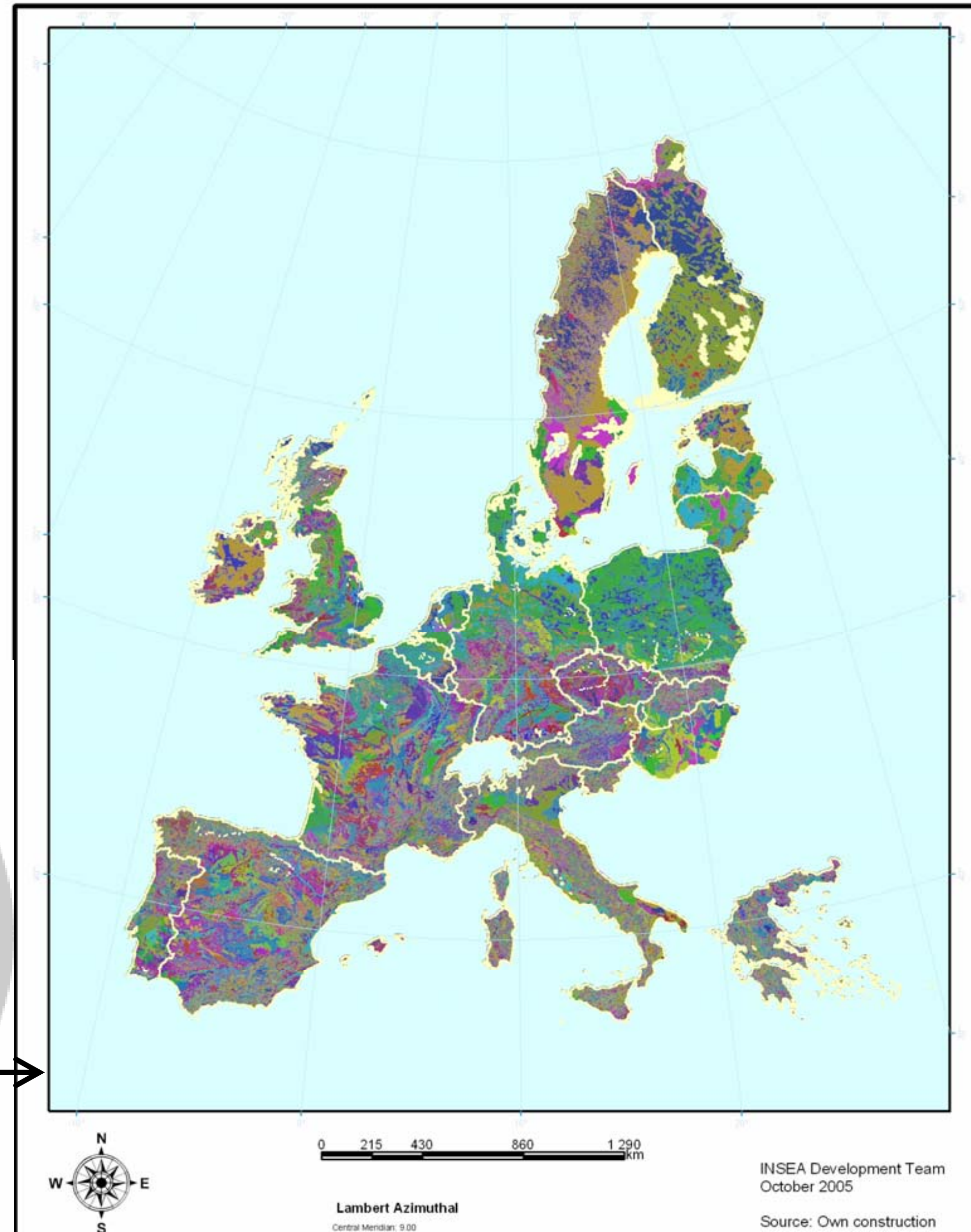
**Altitude:**
1. < 300 m
2. 300-600 m
3. 600-1100 m
4. >1100 m

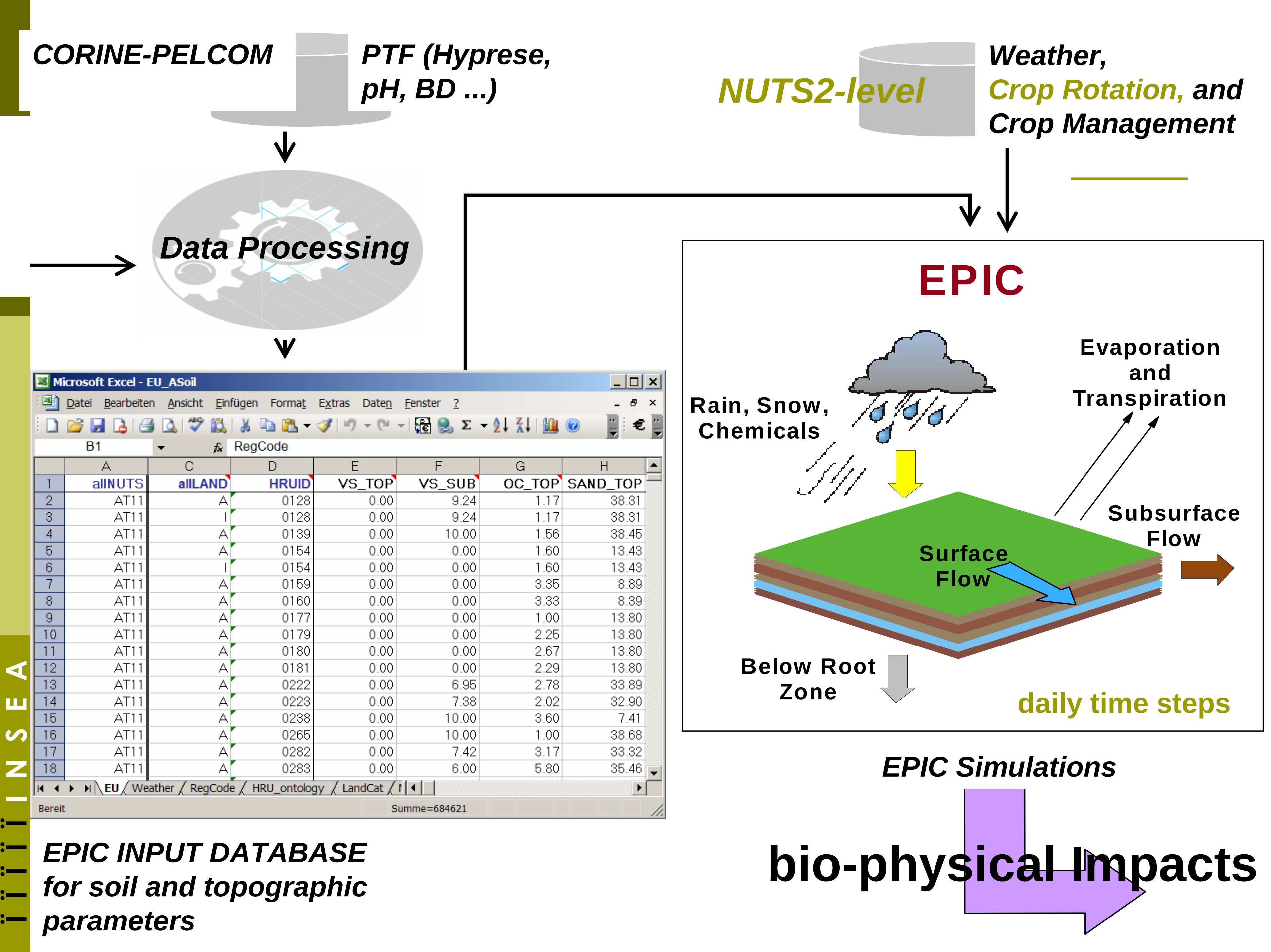
**Texture:**
1. Coarse
2. Medium
3. Medium-fine
4. Fine
5. Very fine

**Stoniness:**
1. Low content
2. Medium content
3. High content

**Slope Class:**
1. 0-3%
2. 3-6%
3. 6-10%
4. 10-15%
5. …

**Soil Depth:**
1. shallow
2. medium
3. deep






| | A | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|
| 1 | allNUTS | allLAND | HRUID | VS_TOP | VS_SUB | OC_TOP | SAND_TOP |
| 2 | AT11 | A | 0128 | 0.00 | 9.24 | 1.17 | 38.31 |
| 3 | AT11 | I | 0128 | 0.00 | 9.24 | 1.17 | 38.31 |
| 4 | AT11 | A | 0139 | 0.00 | 10.00 | 1.56 | 38.45 |
| 5 | AT11 | A | 0154 | 0.00 | 0.00 | 1.60 | 13.43 |
| 6 | AT11 | I | 0154 | 0.00 | 0.00 | 1.60 | 13.43 |
| 7 | AT11 | A | 0159 | 0.00 | 0.00 | 3.35 | 8.89 |
| 8 | AT11 | A | 0160 | 0.00 | 0.00 | 3.33 | 8.39 |
| 9 | AT11 | A | 0177 | 0.00 | 0.00 | 1.00 | 13.80 |
| 10 | AT11 | A | 0179 | 0.00 | 0.00 | 2.25 | 13.80 |
| 11 | AT11 | A | 0180 | 0.00 | 0.00 | 2.67 | 13.80 |
| 12 | AT11 | A | 0181 | 0.00 | 0.00 | 2.29 | 13.80 |
| 13 | AT11 | A | 0222 | 0.00 | 6.95 | 2.78 | 33.89 |
| 14 | AT11 | A | 0223 | 0.00 | 7.38 | 2.02 | 32.90 |
| 15 | AT11 | A | 0238 | 0.00 | 10.00 | 3.60 | 7.41 |
| 16 | AT11 | A | 0265 | 0.00 | 10.00 | 1.00 | 38.68 |
| 17 | AT11 | A | 0282 | 0.00 | 7.42 | 3.17 | 33.32 |
| 18 | AT11 | A | 0283 | 0.00 | 6.00 | 5.80 | 35.46 |

# Scenario Analysis

## I) Alternative Crop Residue Systems:

1) <u>conventional tillage</u>
~5% of crop residues after crop planting

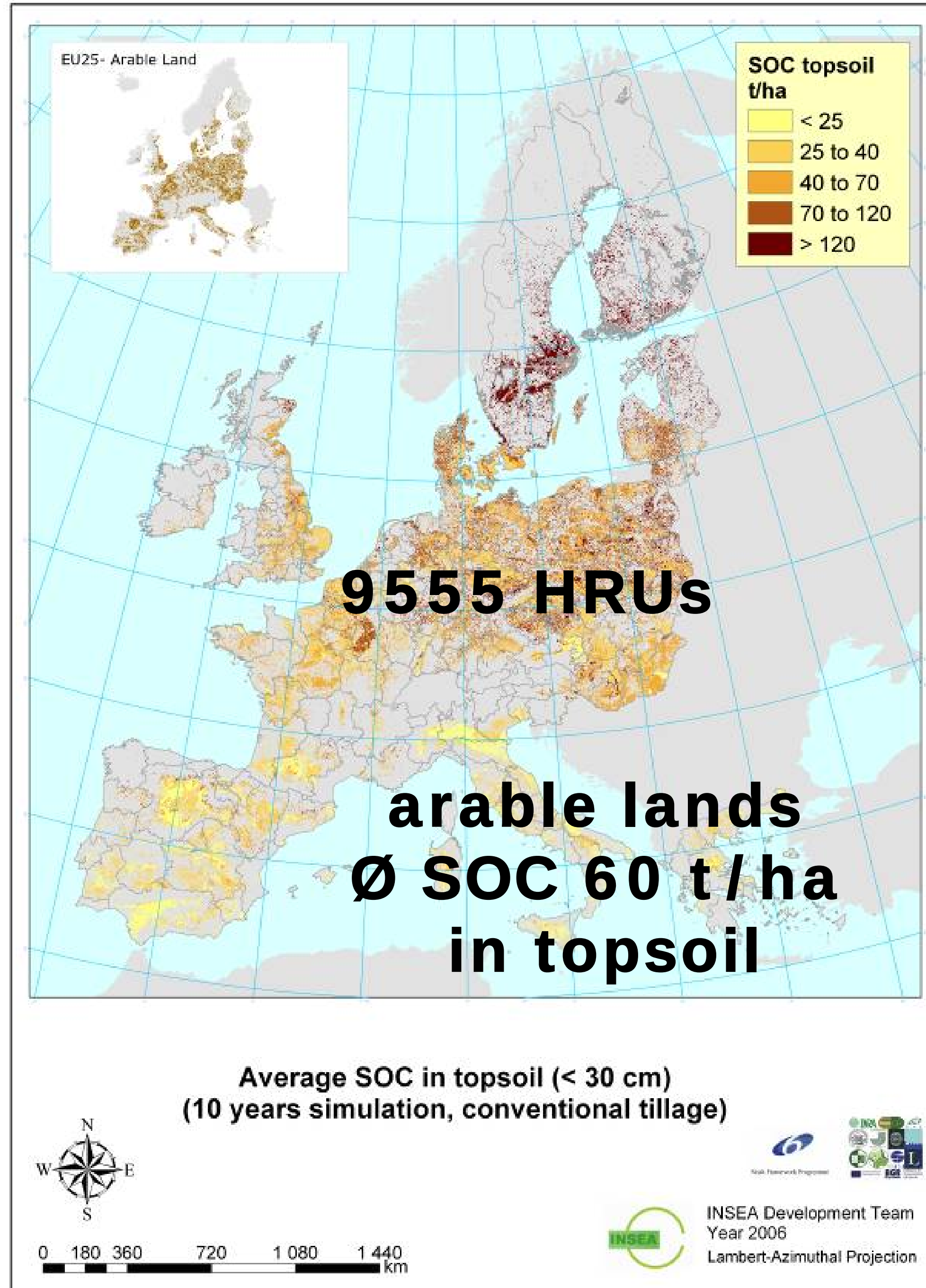
2) <u>reduced tillage</u>
~15% of crop residues after crop planting

3) <u>minimum tillage</u>
~40% of crop residues after crop planting

## II) Biomass Production Systems:

4) miscanthus

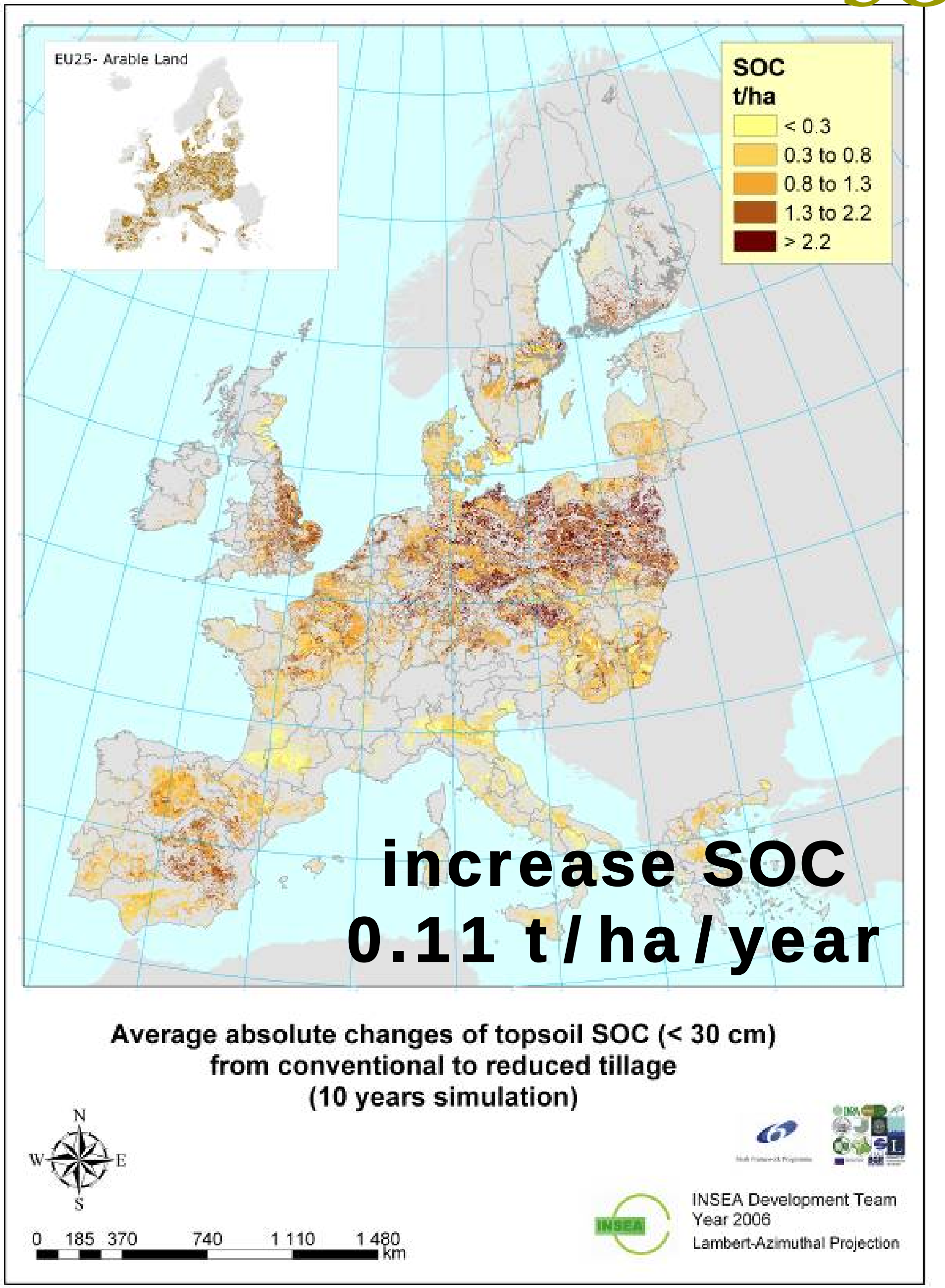
5) poplar coppice

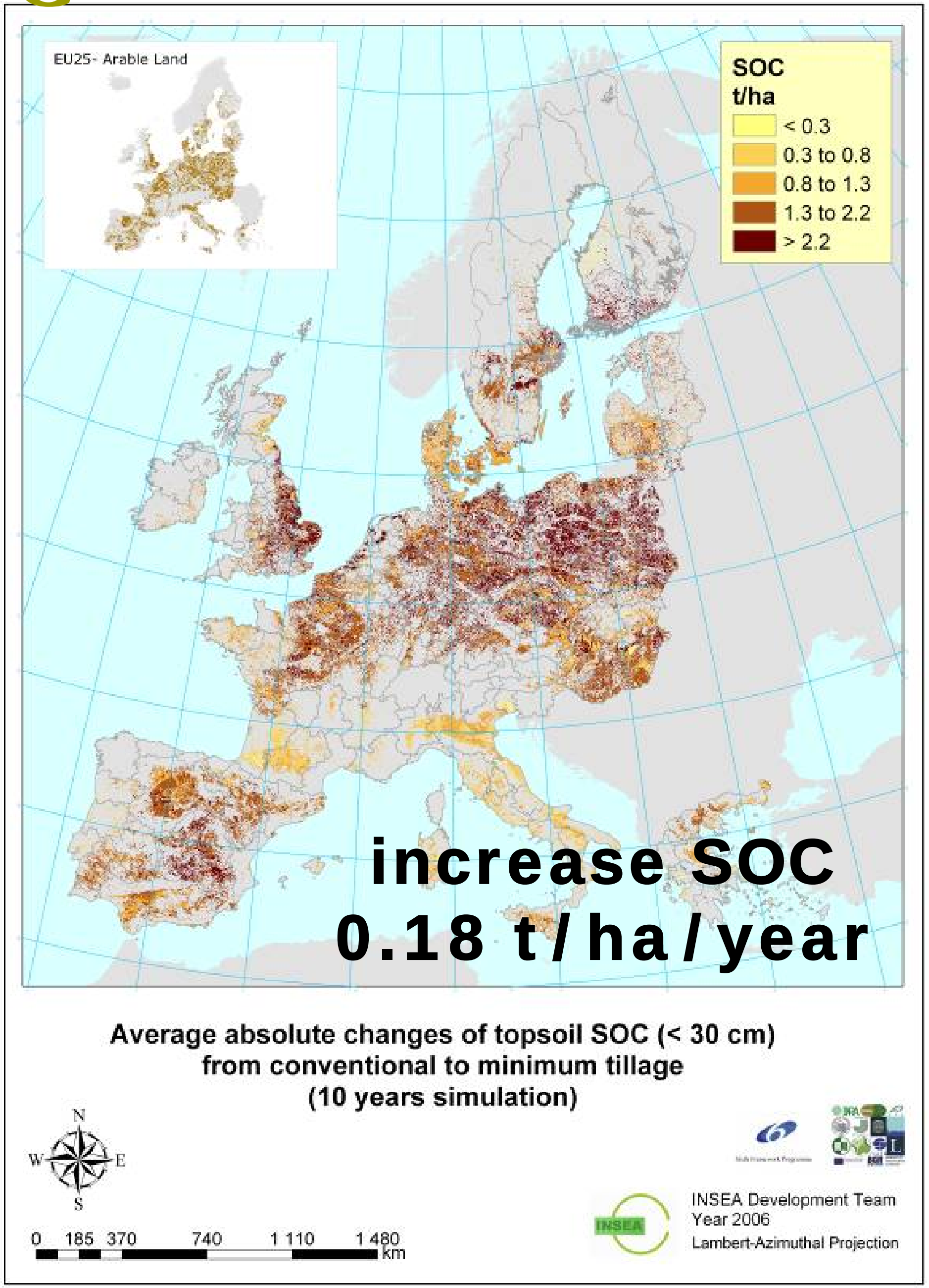


conv. => redu. till

# SOC

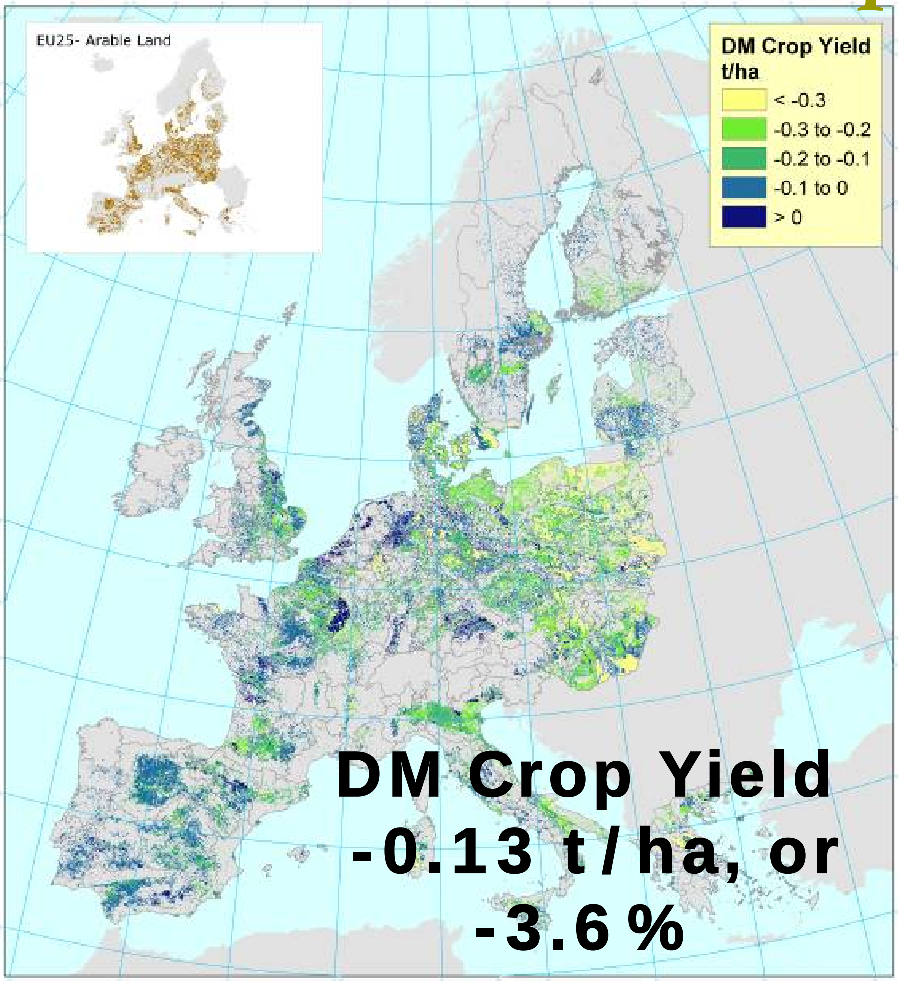
conv. => mini. till



# Crop Yield

**conv. => redu. till**



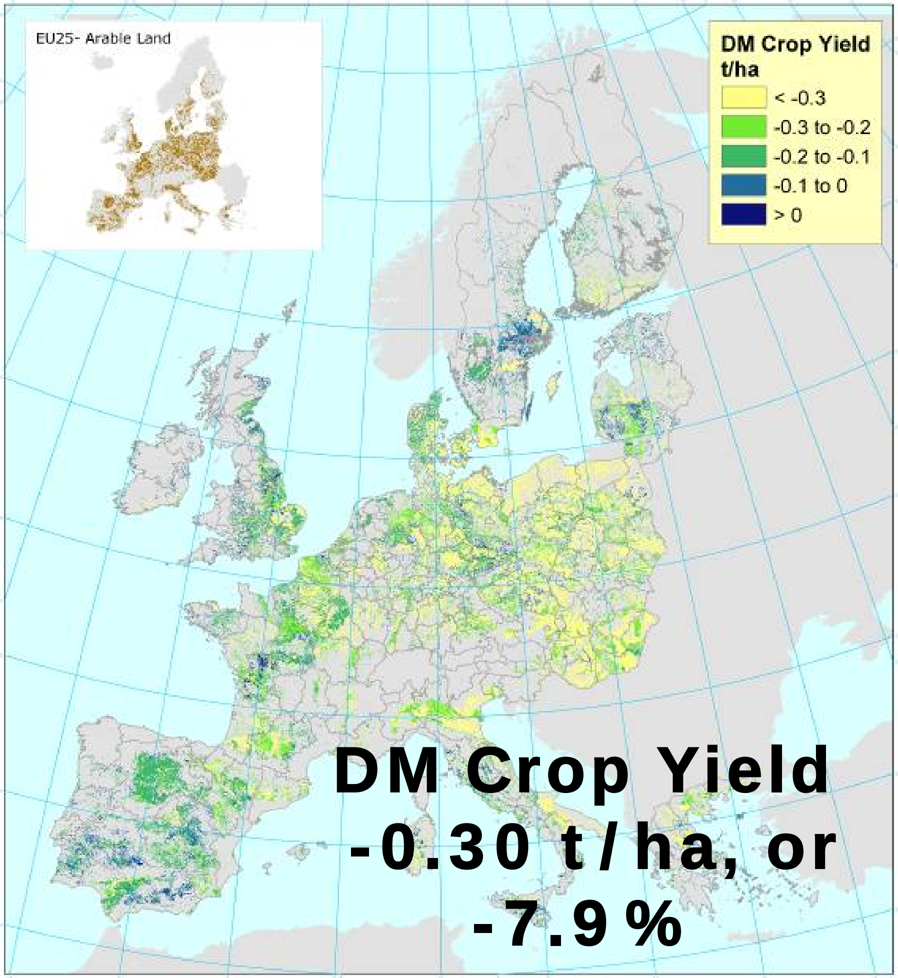

Average absolute changes in dry matter crop yields from conventional to reduced tillage (10 years simulation)

N W E S

0 185 370 740 1 110 1 480 km

INSEA Development Team
Year 2006
Lambert-Azimuthal Projection

**conv. => mini. till**




Average absolute changes in dry matter crop yields from conventional to minimum tillage (10 years simulation)

N W E S

0 185 370 740 1 110 1 480 km

INSEA Development Team
Year 2006
Lambert-Azimuthal Projection

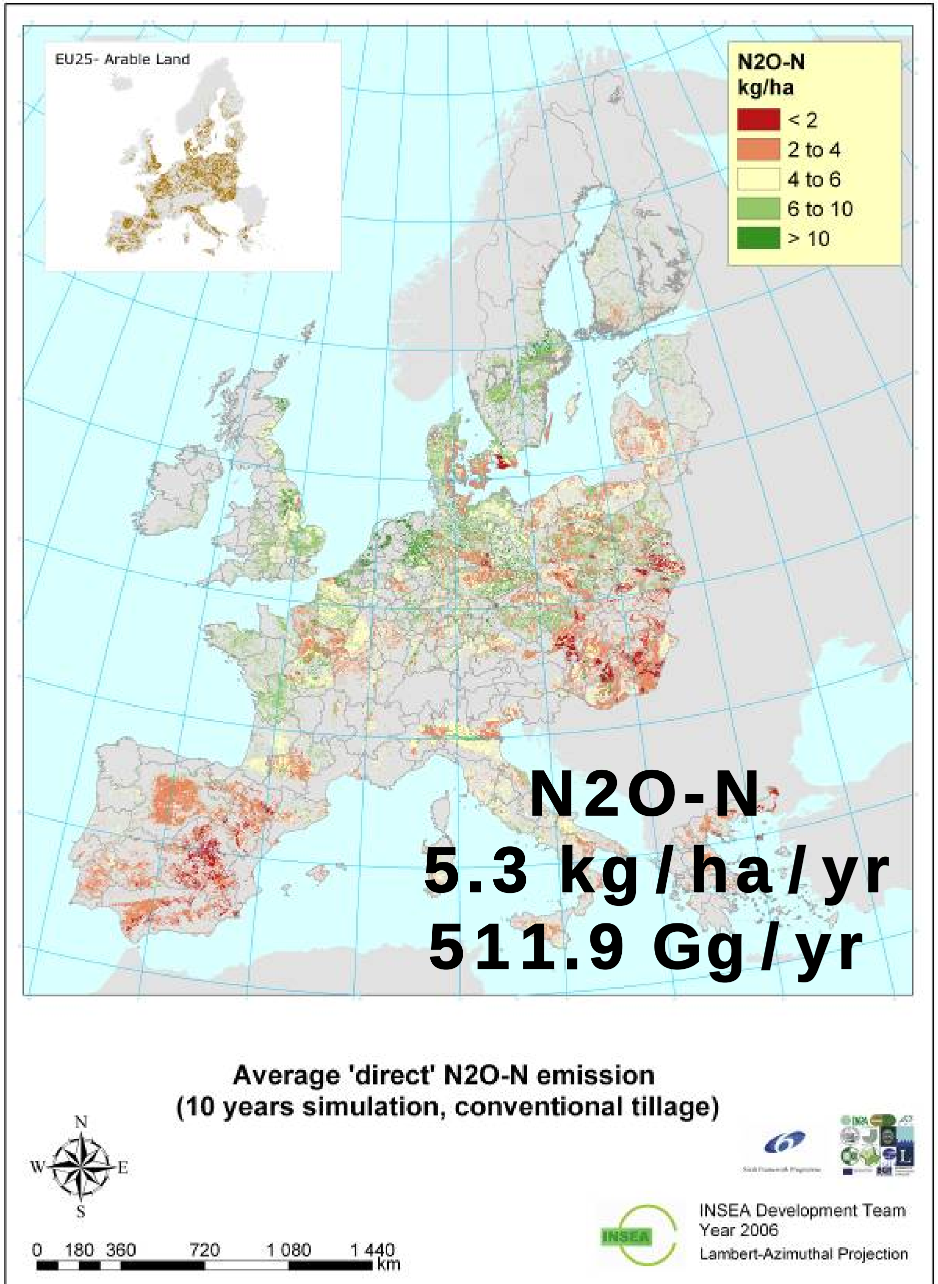
# N2O-N emissions

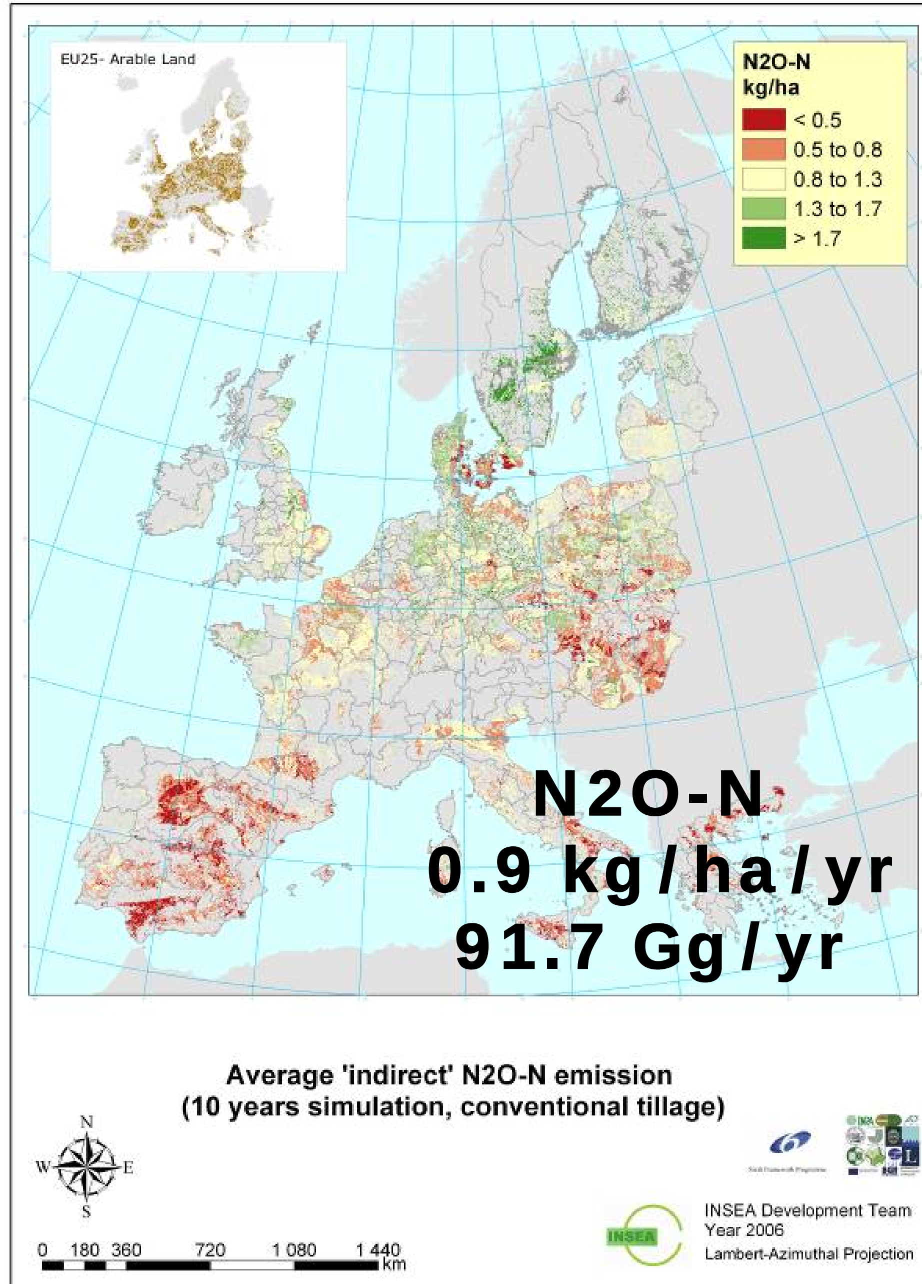
- **IPCC default values for direct and indirect N2O-N emissions**
- **We base it on**
  - **nitrification (0.54%), and**
  - **de-nitrification (11%).**
    **Khalil, Mary, and Renault (2004) in Soil Biology & Biochemistry.**

  **=> 'direct' N2O-N emissions**

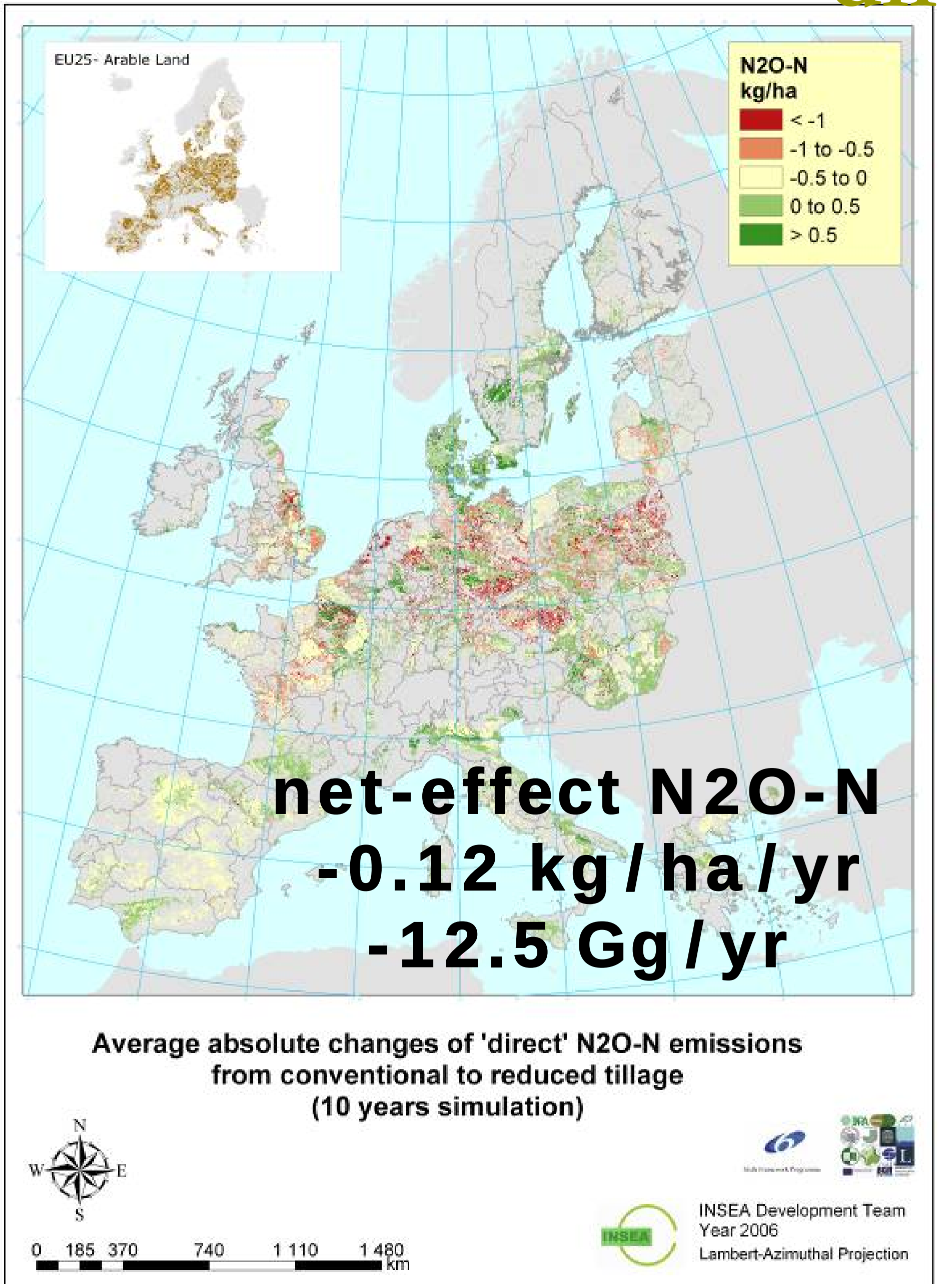
- **'indirect' N2O-N emissions we use N in leaching (2.5%), run-off (2.5%), volatiliziation (1%)**

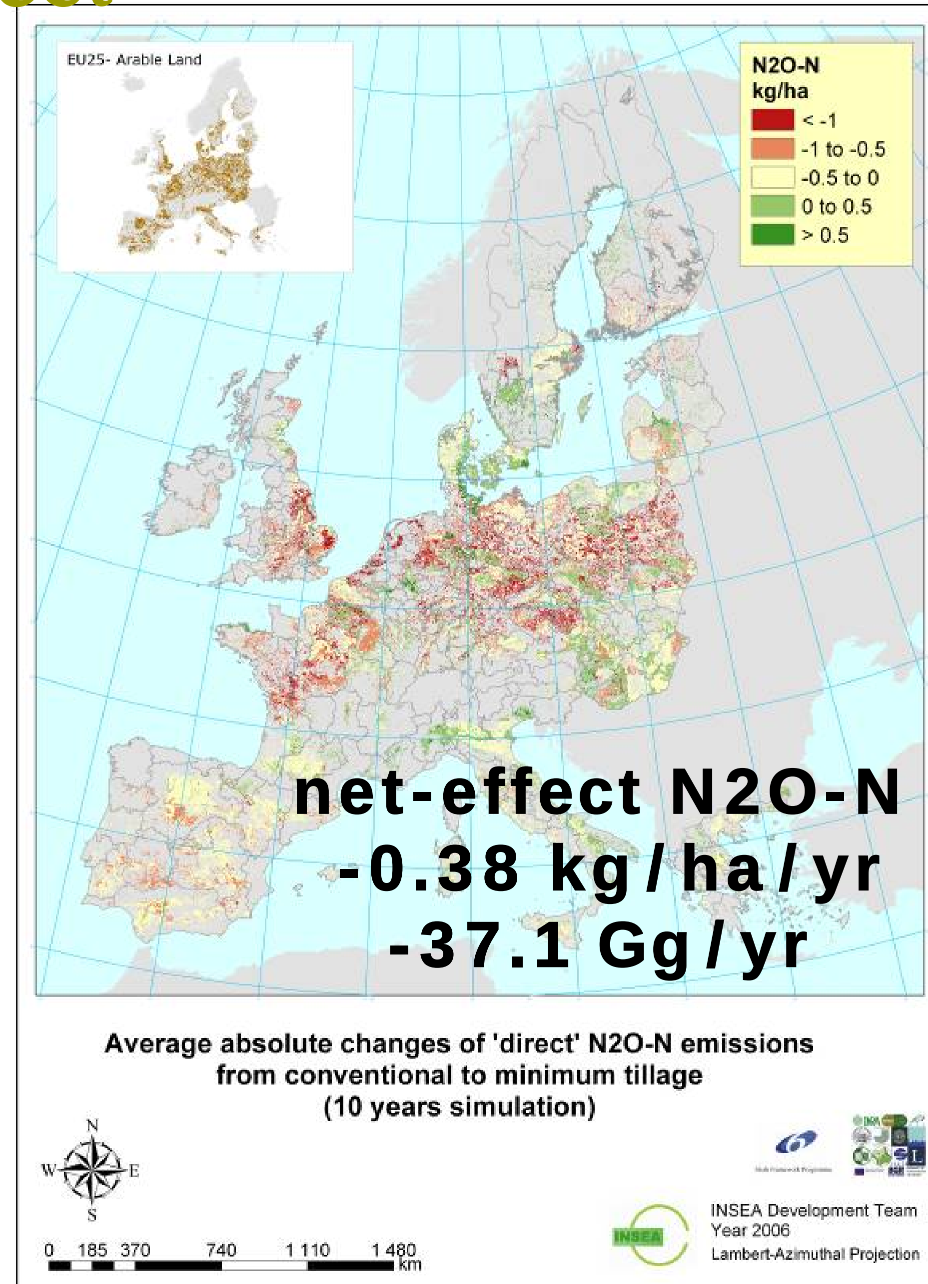
# 'direct' N2O-N emissions 'indirect' N2O-N emissions



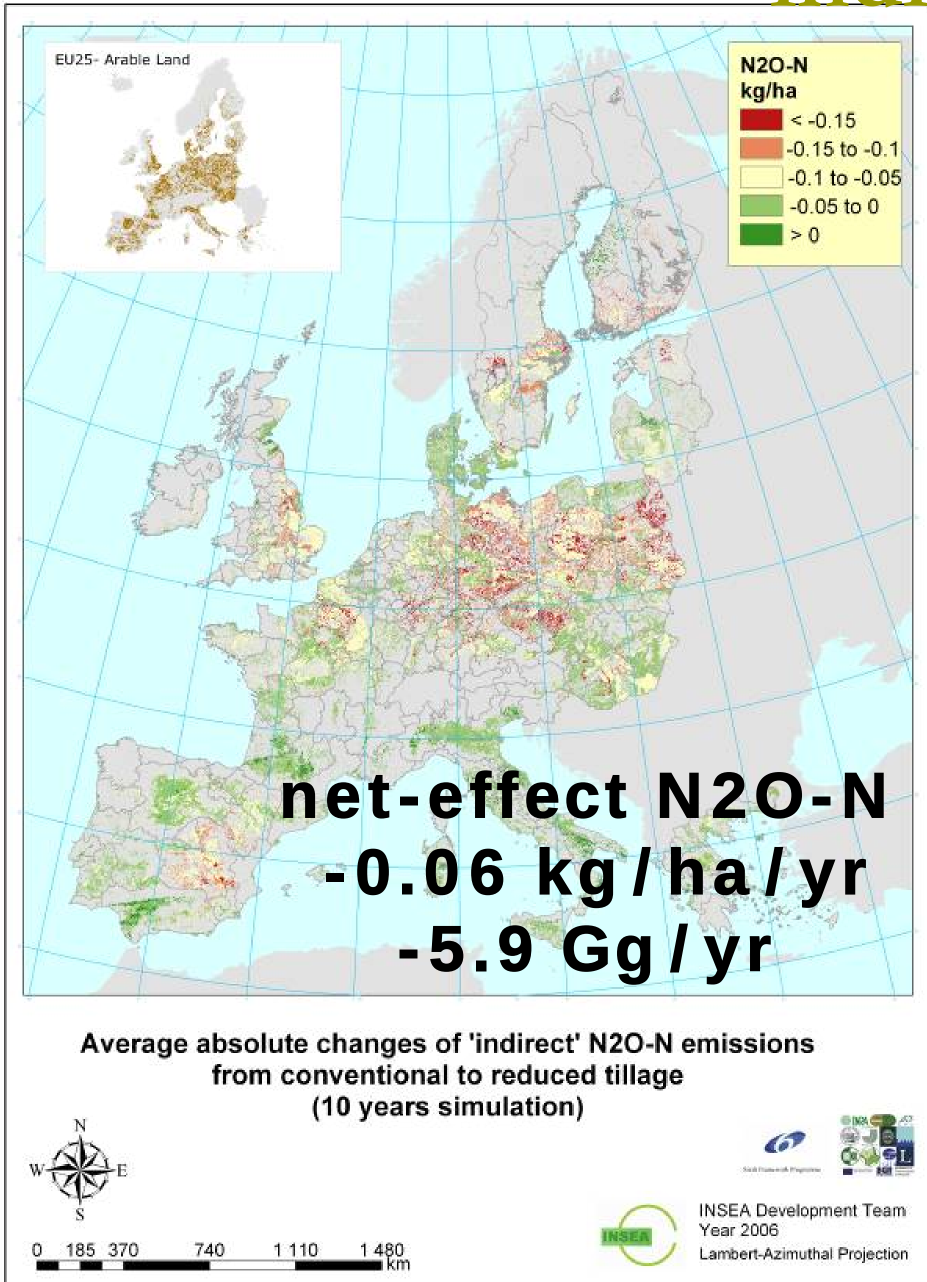



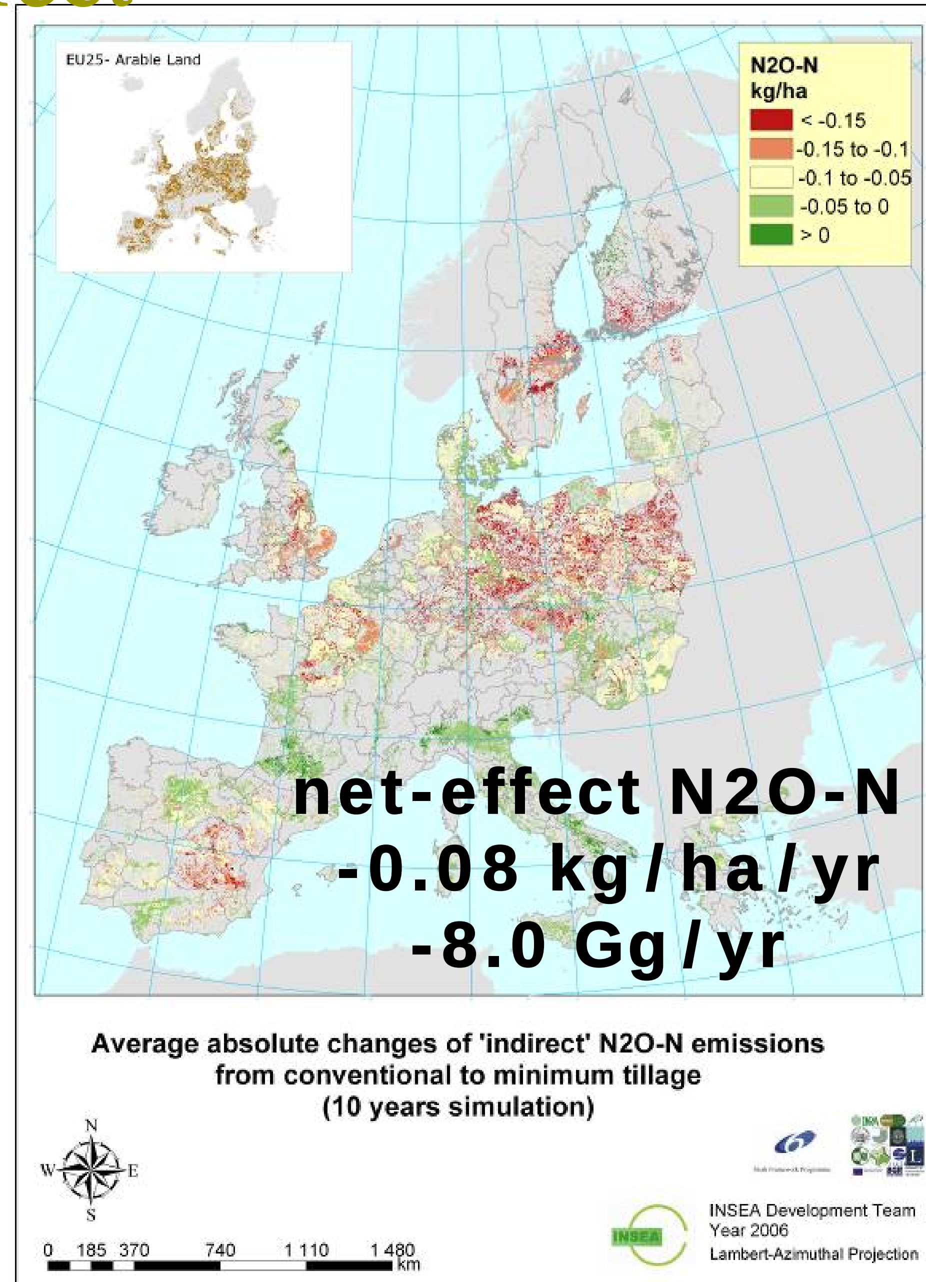
conv. => redu. till 'direct' conv. => mini. till



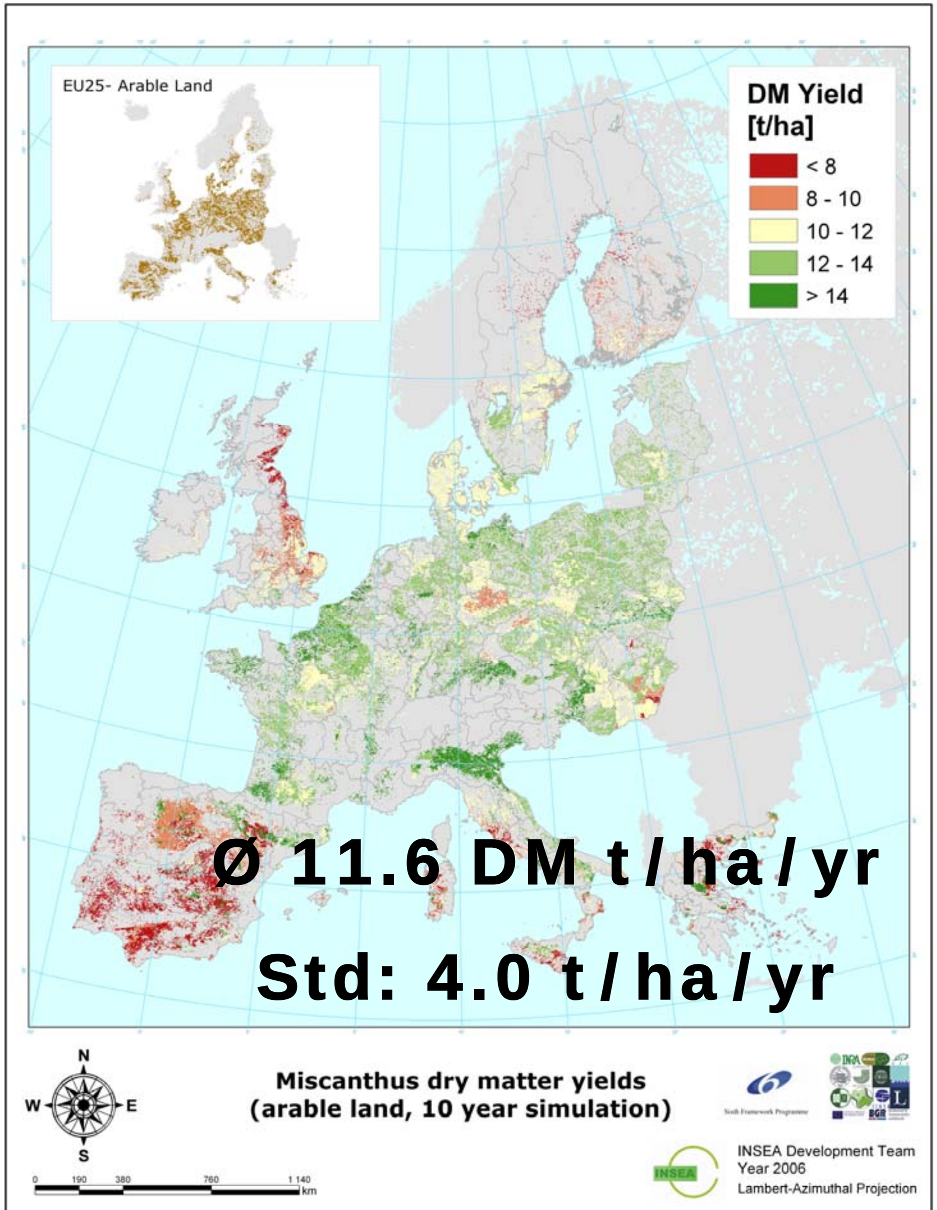
conv. => redu. till 'indirect' conv. => mini. till



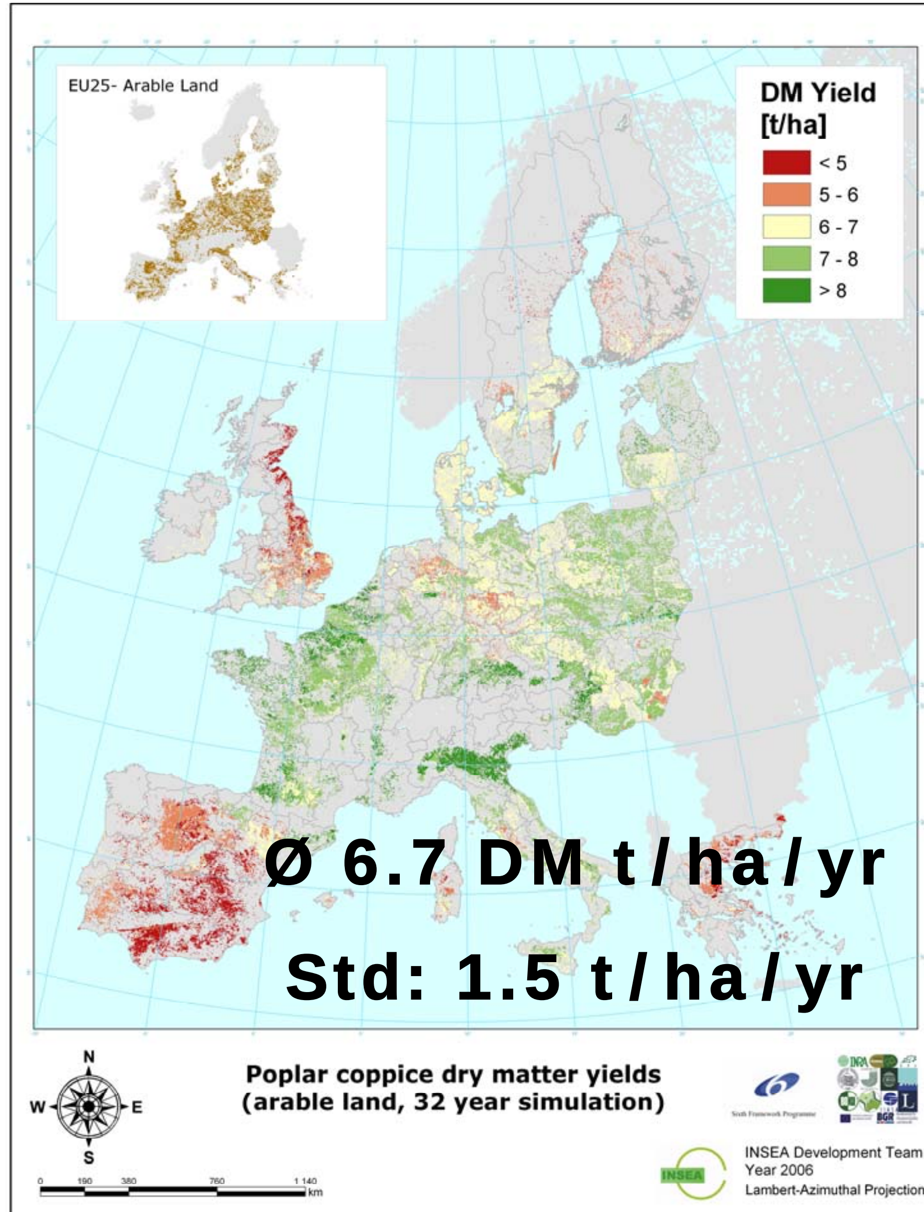



# biomass

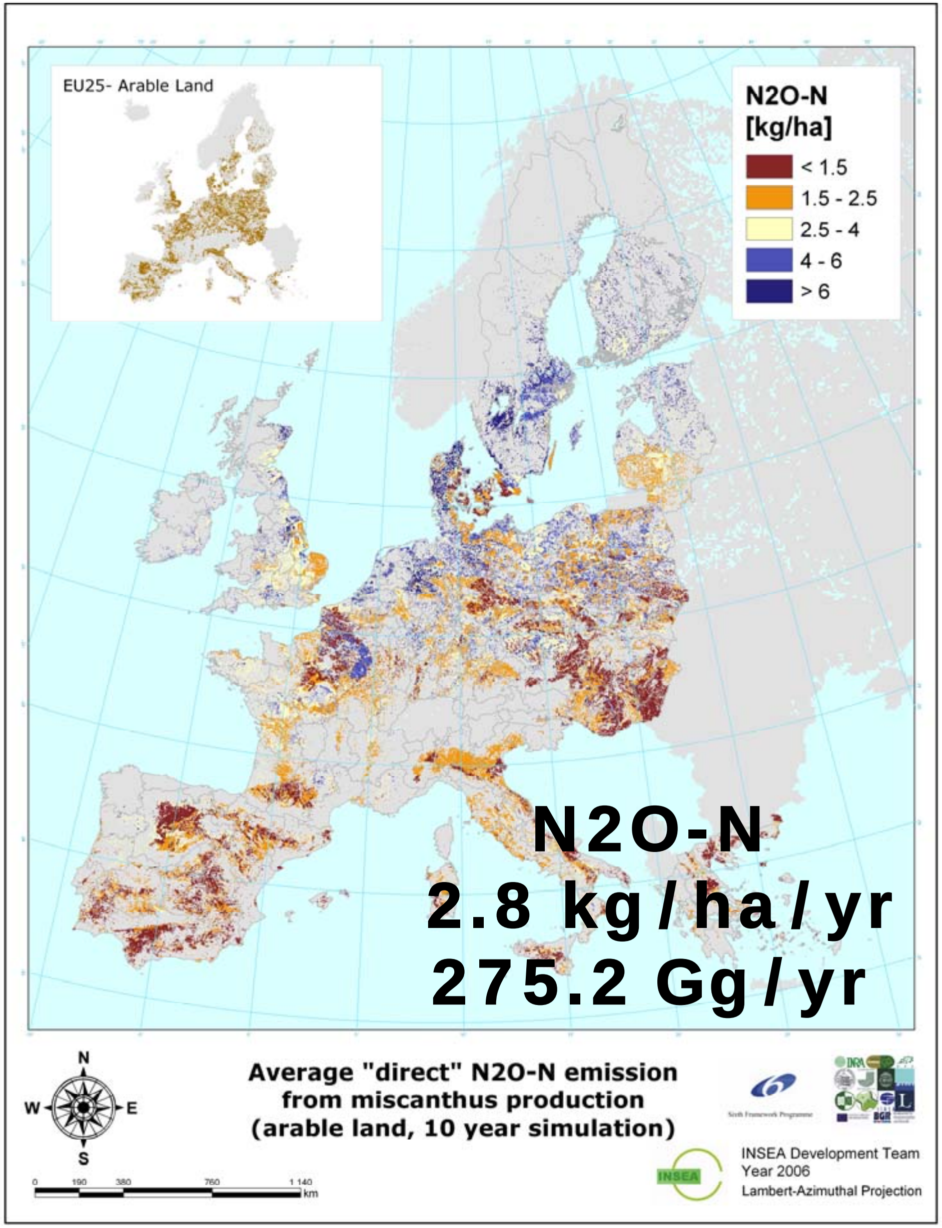
## miscanthus

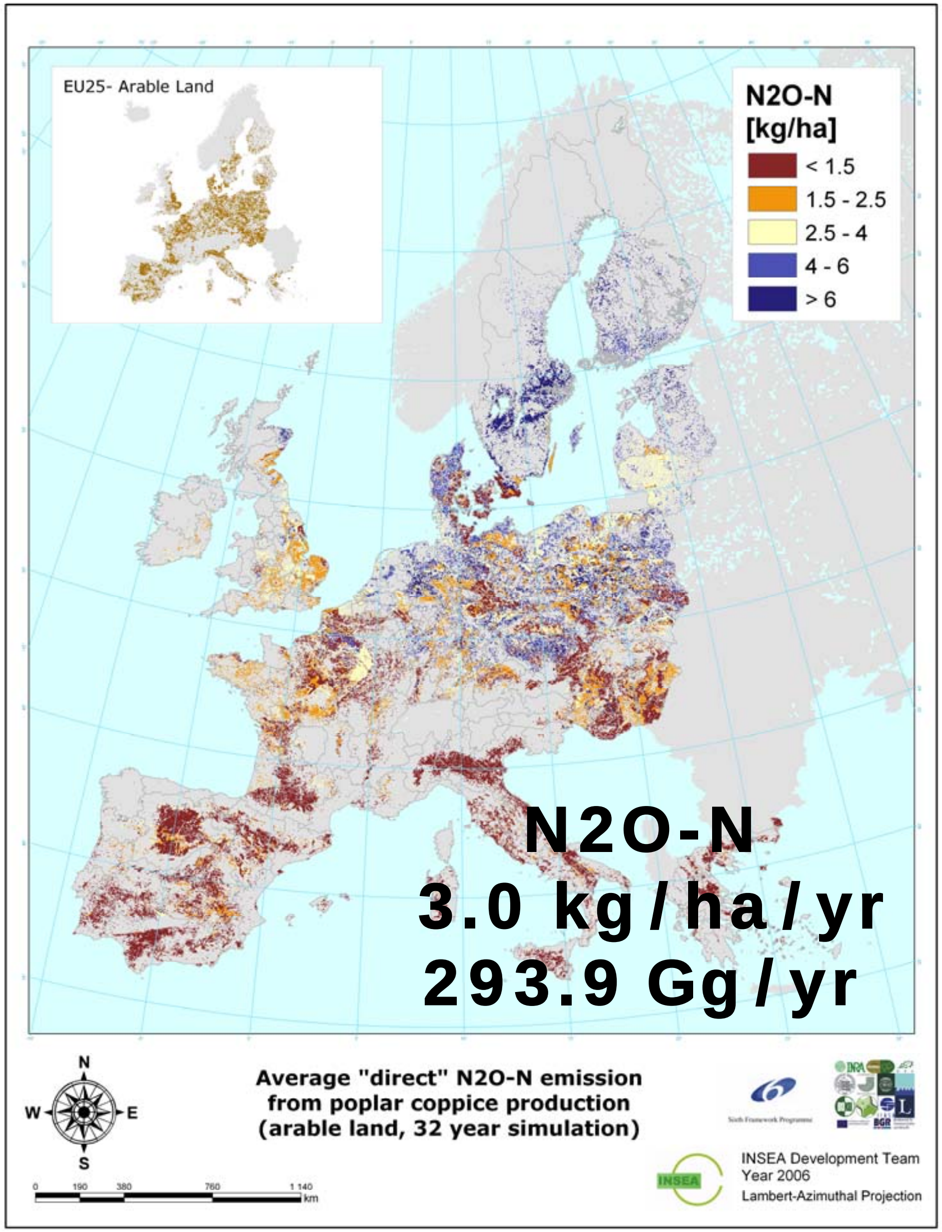



## poplar coppice



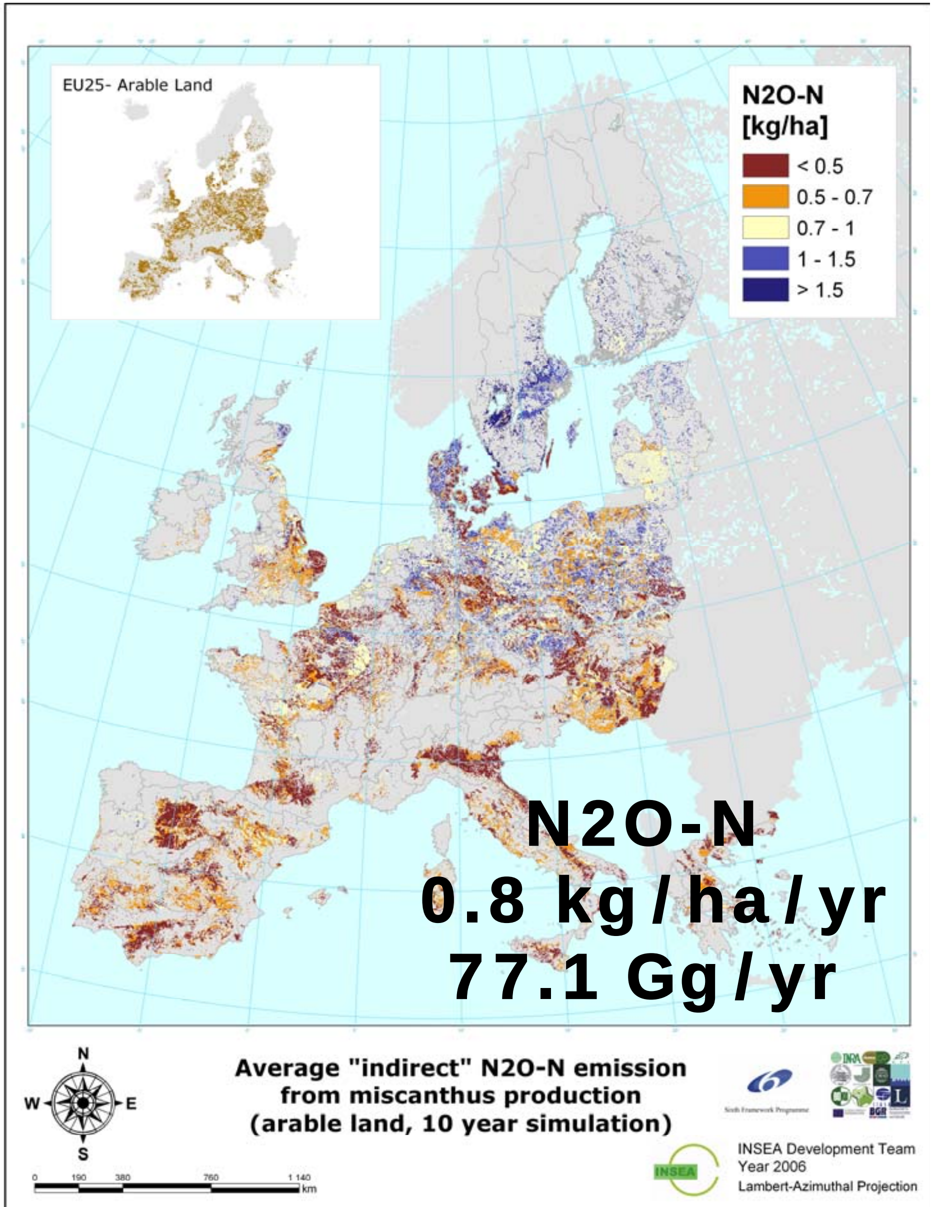
# miscanthus direct N2O poplar coppice



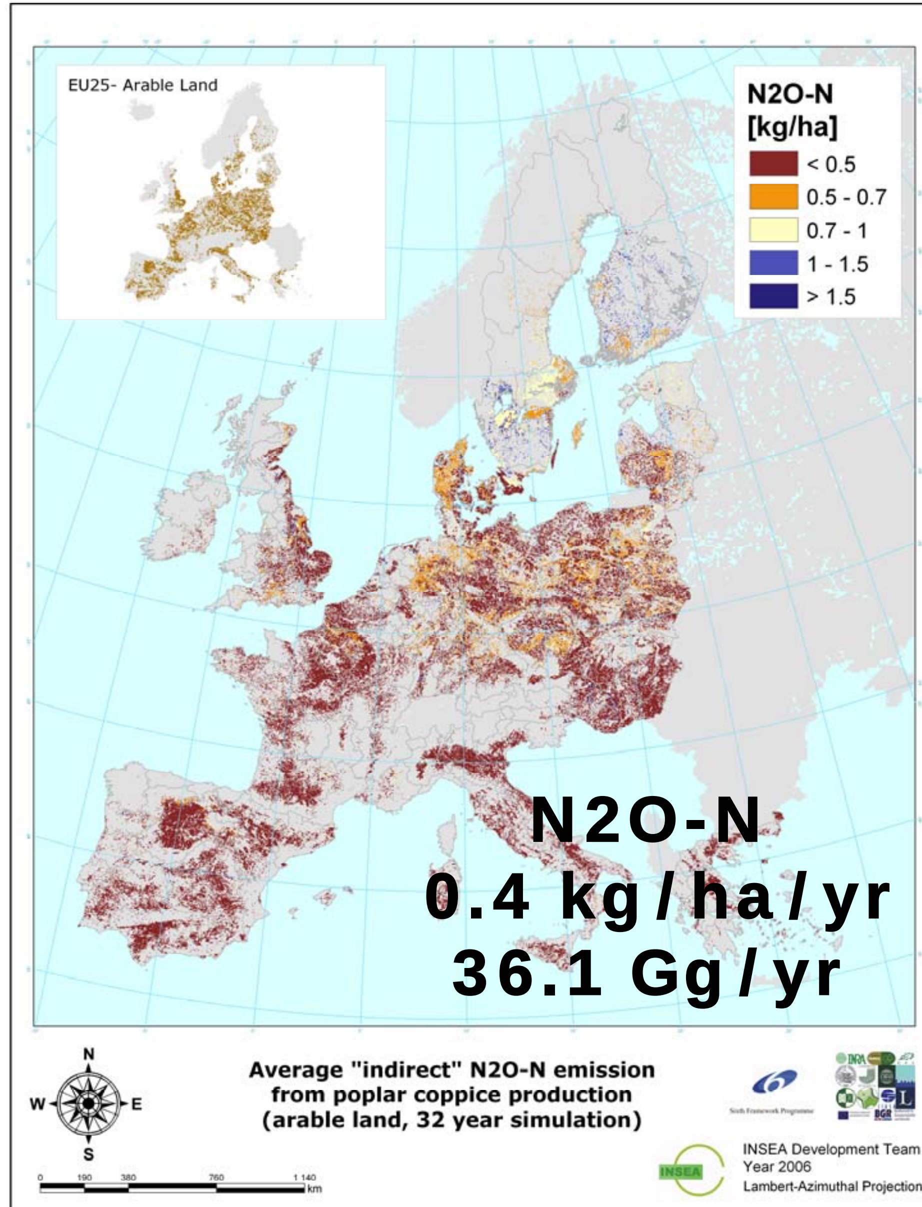



# indirect N2O

**miscanthus**




**poplar coppice**



# Conclusions

- **Tool** -HRU concept and EPIC- addressing **land use** and **management** specific bio-physical **impacts** spatially and temporally explicit!
- a change in **Crop Residue Systems**
  - increases SOC by 0.1 and 0.2 t/ha/yr (c.p.)
  - reduces **direct** N2O-N emissions at EU25 level by 2.4% and 7.2%
  - reduces **indirect** N2O-N emissions at EU25 level by 6.4% and 8.7%
  - but with +/- effects locally
  - reduces crop yield output by 4% and 8% (c.p.)
- other side effects (increased pesticide use, fertilizer, etc.)
- evaluate **environmental impacts** of **biomass** production systems