



Land resources and sustainable intensification of agriculture in Europe

by

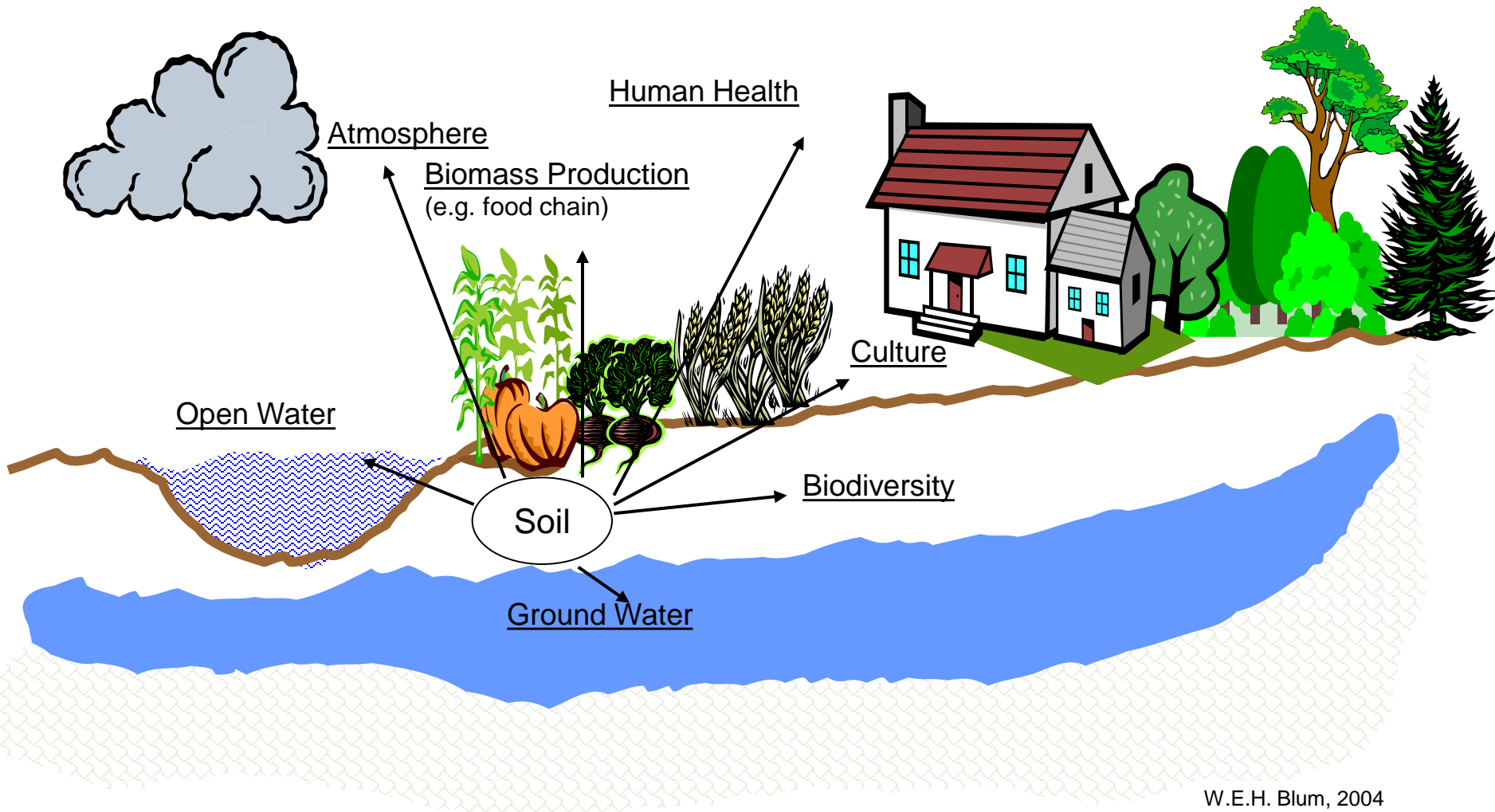
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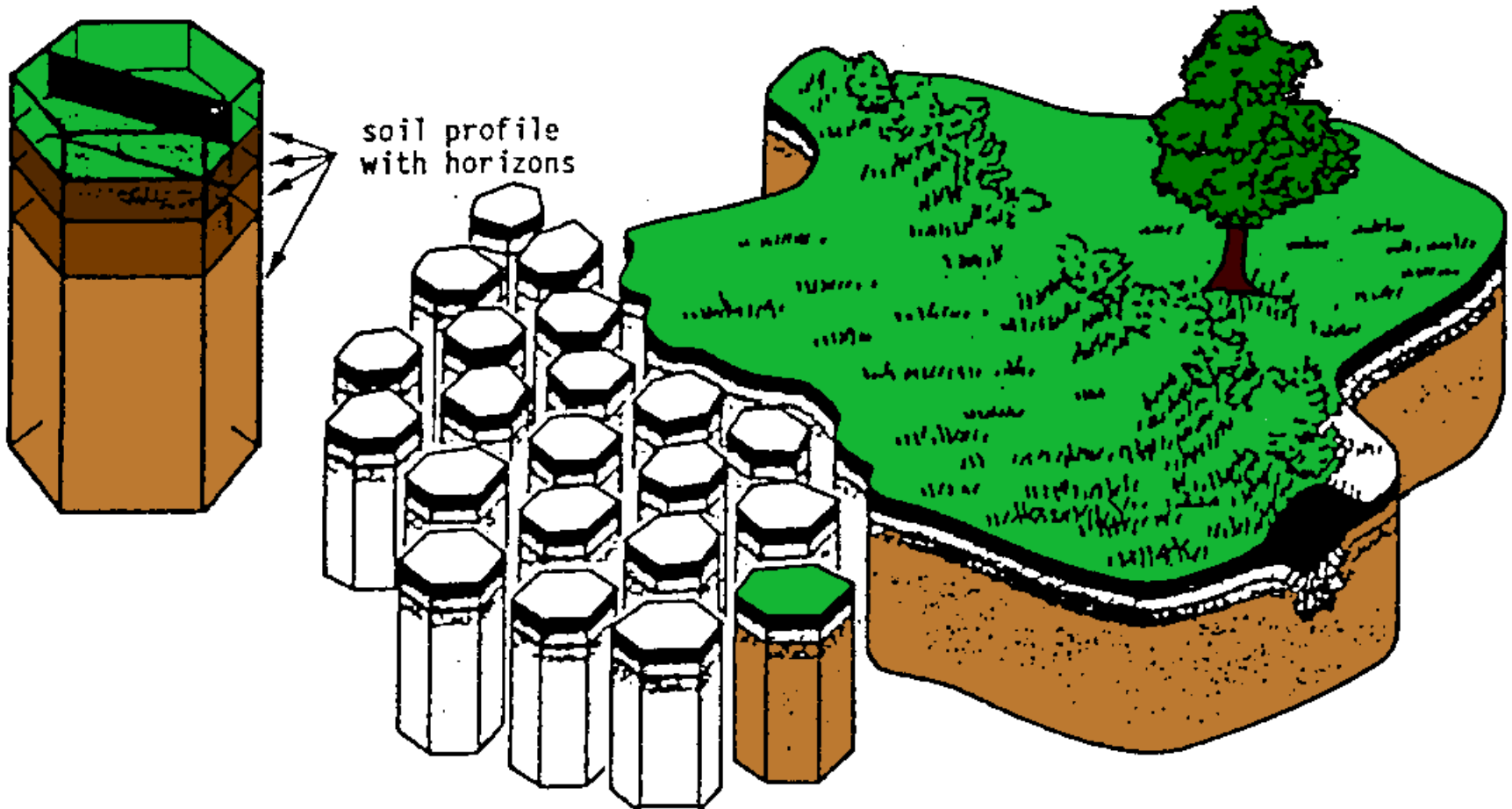
WHY SUSTAINABLE INTENSIFICATION OF AGRICULTURE?

For satisfying the needs of a growing world population (2014= 7.2 bil.; 2050~ 9.4 bil.; 2100~ 11 bil.) we must provide more goods and services from land and soil.

GOODS AND SERVICES PROVIDED BY LAND AND SOIL



WHICH SOILS SERVE FOR ENVIRONMENTALLY SUSTAINABLE AGRICULTURE?





Environmentally sustainable agriculture is directly related to soil resilience and performance.

Resilience:

the capacity of systems to return to a (new) equilibrium after disturbance, e.g. depending on the input intensity, especially (damaging) external effects, such as fertilizers, crop protection compounds, mechanisation (compaction, erosion).



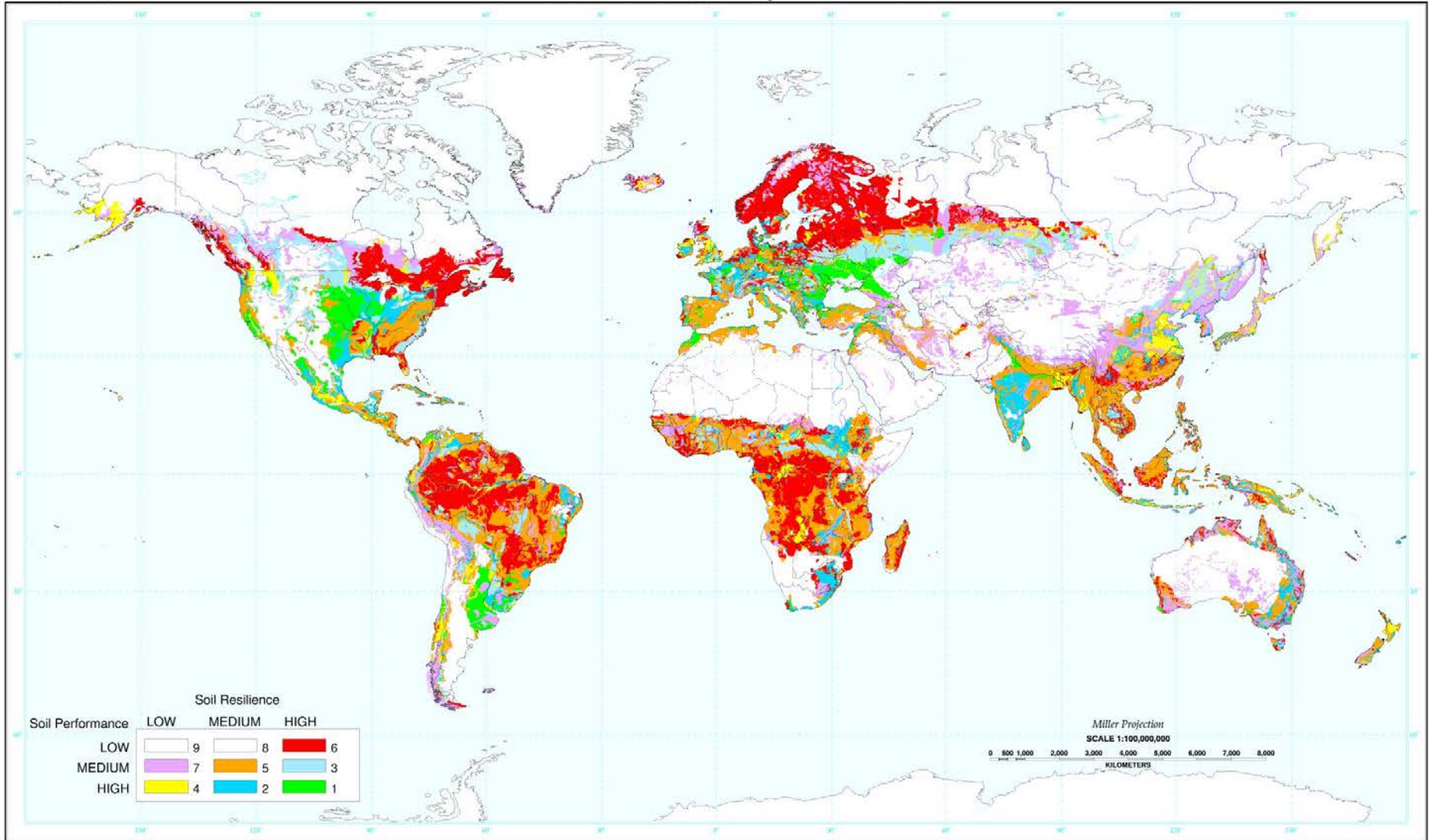
Performance:

the capacity of systems to produce over long periods- output intensity, not only in biomass production but also in environmental services such as rainwater filtration and production of clean groundwater, maintenance of biodiversity, etc.

GLOBAL MAP OF LAND QUALITY

Inherent Land Quality Assessment

U.S. Dept. of Agriculture
Natural Resources Conservation Service
Soil Survey Division
World Soil Resources



Country boundaries are not authoritative

Blum and Eswaran, 2004

Washington DC, 1998

GLOBAL LAND QUALITY WITH REGARD TO LAND SURFACE AND POPULATION DISTRIBUTION

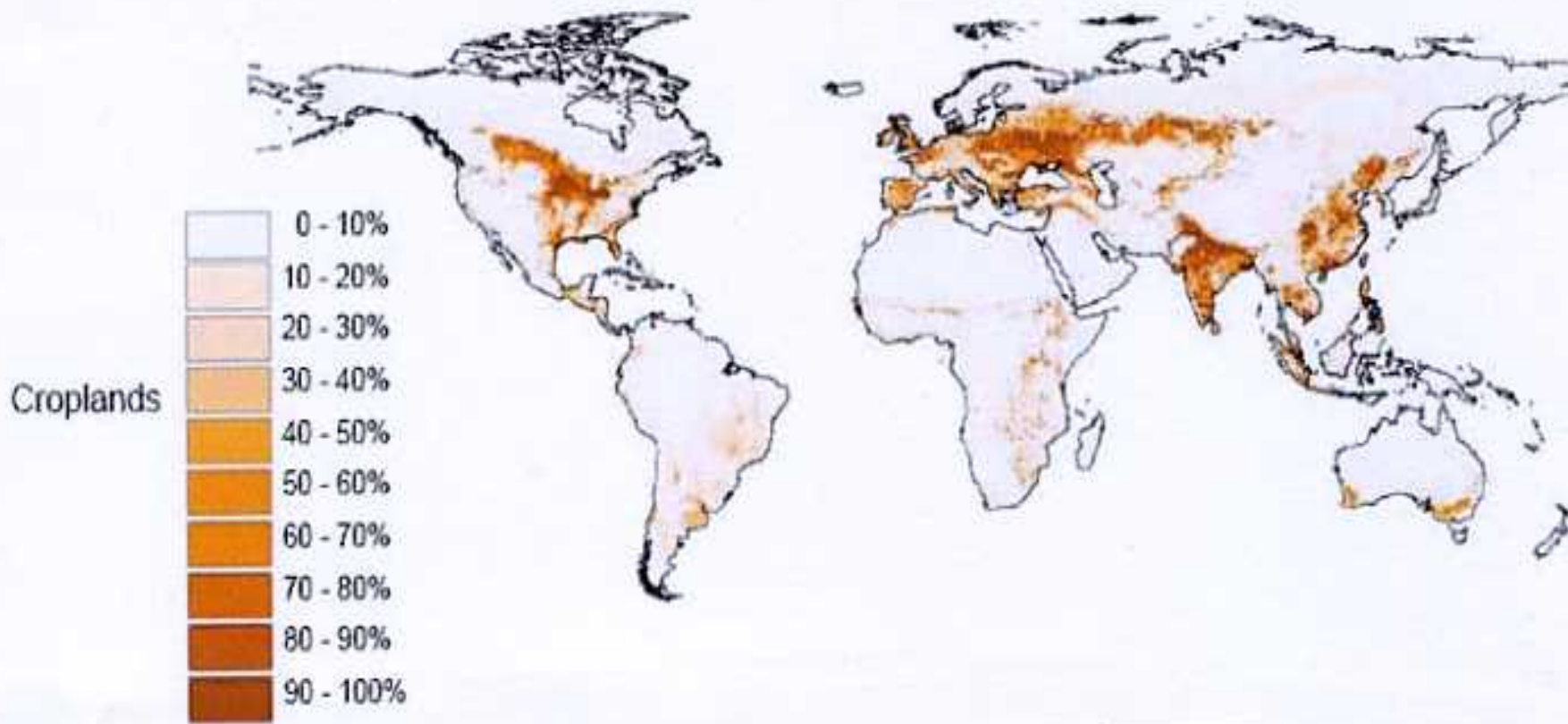
Land Quality Class	Total Land Surface	World Population:
I	2,4 %	6,1 %
II, III	9,5 %	19,0 %
IV, V, VI	33,8 %	53,6 %
VII	9,0 %	11,5 %
VIII, IX	45,3 %	13,1 %

Blum and Eswaran, 2004

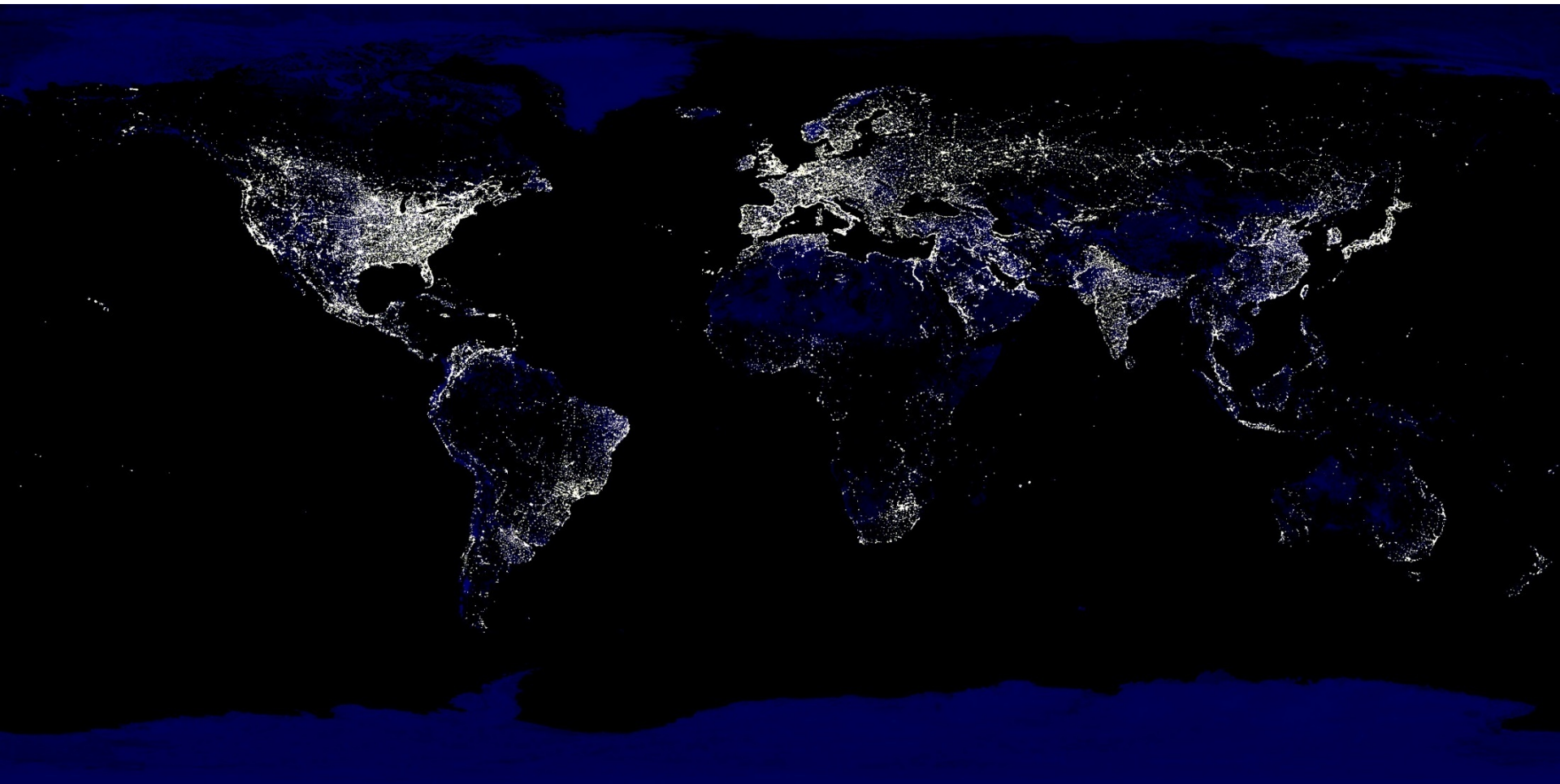
WORLD SOIL SUITABILITY FOR SUSTAINING LIFE AND BIOMASS PRODUCTION

- ~ 12 % of the land surface suitable for food and fiber production;
- ~ 24 % can be used for grazing
- ~ 31 % produce forests
- ~ 33 % unsuitable for any kind of sustainable use

(Buringh, 1998; FAO 1995)



(Foley et al. 2005)





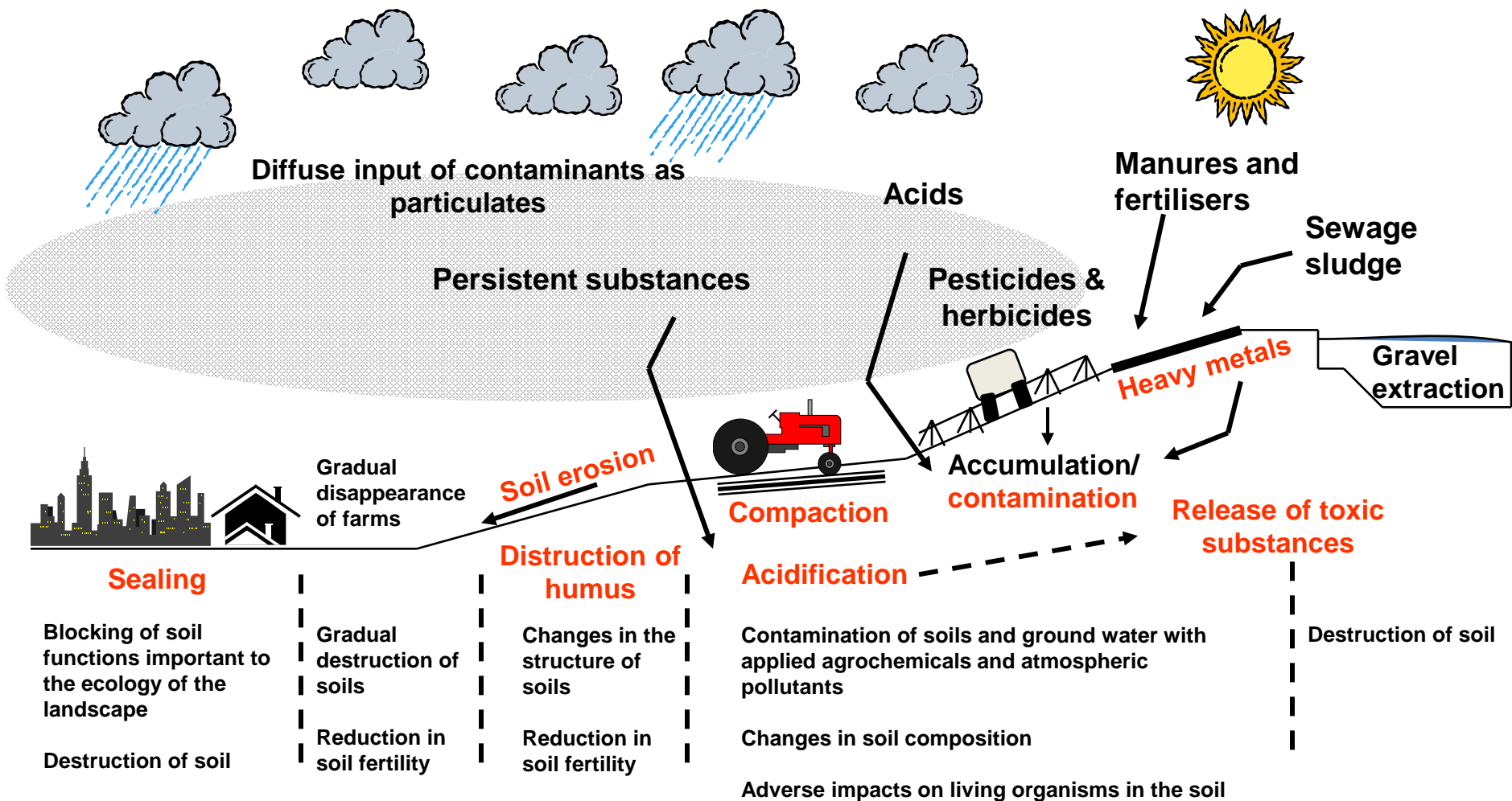
Europe's built environment

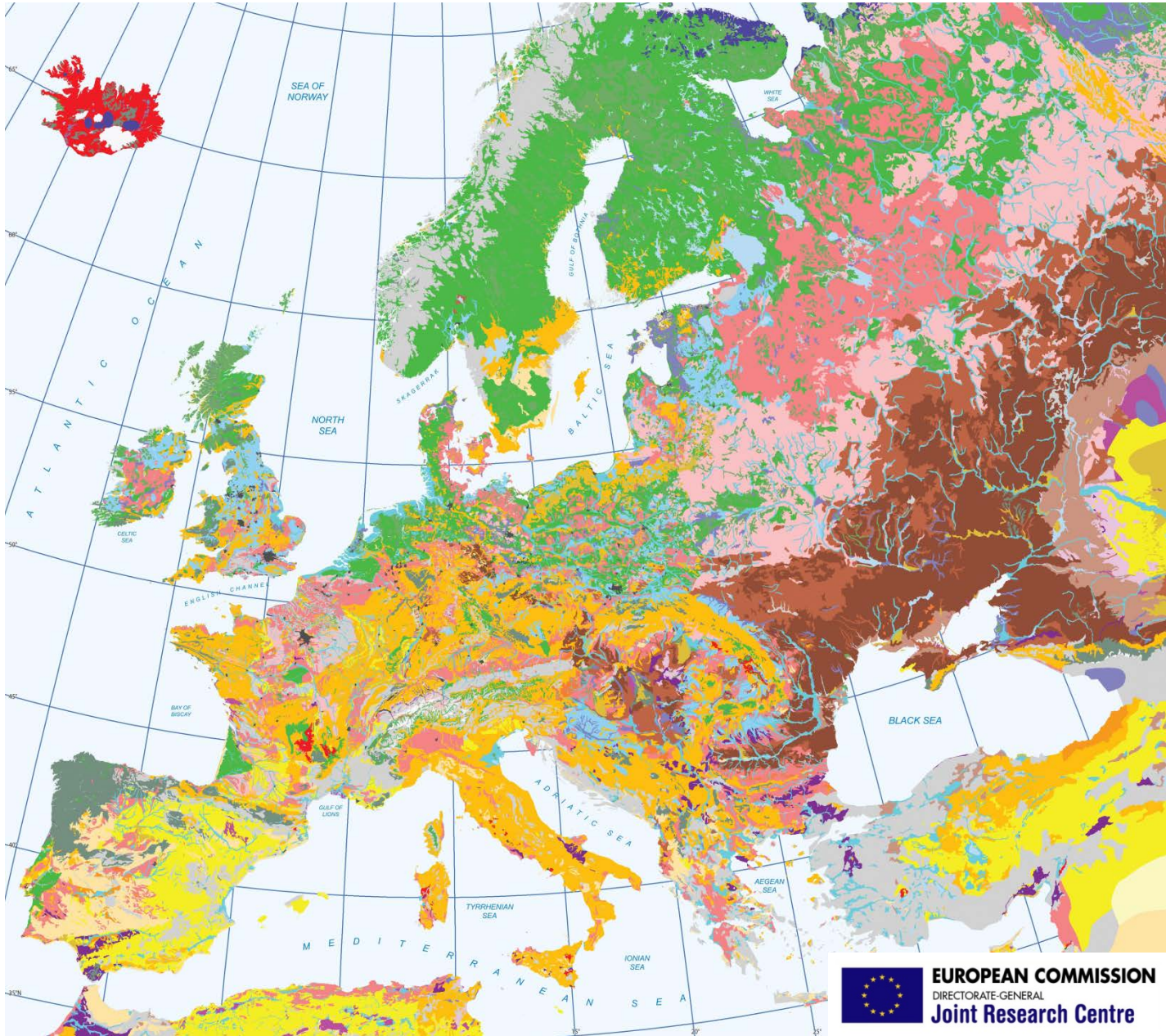
SEALING OF SOILS AND LANDSCAPES BY SETTLEMENTS AND ROADS



(Example: south-western part of Baden-Württemberg, Germany)¹³

THE IMPACT OF HUMAN ACTIVITIES ON SOIL



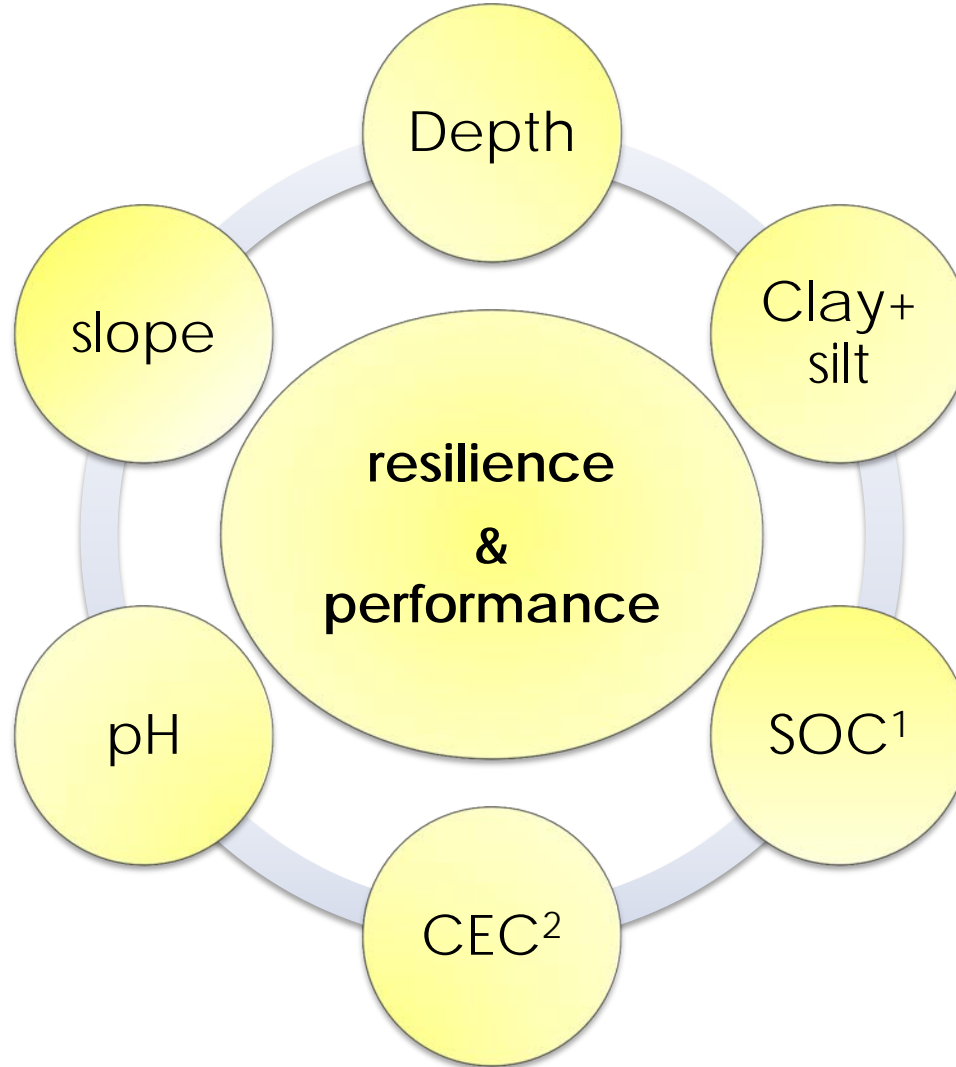




OBJECTIVE

Search for arable land in Europe with good soil resilience and performance based on **6 indicators** for recommendation where sustainable agricultural intensification can be achieved.

6 KEY LAND AND SOIL PARAMETERS (INDICATORS)



¹ SOC= Soil Organic Carbon

² CEC= Cation Exchange Capacity

RANKING OF SOIL AND TOPOGRAPHIC INDICATORS (THRESHOLD VALUES) BASED ON LITERATURE AND EXPERT JUDGEMENT

	excellent	good	medium	poor	unit
Depth*		>60	30-60	<30	cm
Clay+ Silt	>50	35-50	15-35	<15	%
SOC	>4	2-4	1-2	< 1	%
CEC		>25	10-25	<10	cmol/kg
pH		6.5-8	5.5-6.5	<5.5; >8	in H ₂ O
Slope**		<8	8-15	15-25	%

* Estimated according to WRB 2006

** Sites with slopes >25% were excluded from calculations

Based on this scheme data from CORINE, ESDB and LUCAS were used in a Geographical Information System (ArcGIS).

AVAILABLE DATA

- Corine Land Cover 2006 (CLC 2006)

European land use map

Used data: *arable land* delineation

- European Soil Data Base 2004

(ESDB; vers 2.0) 1:1,000,000

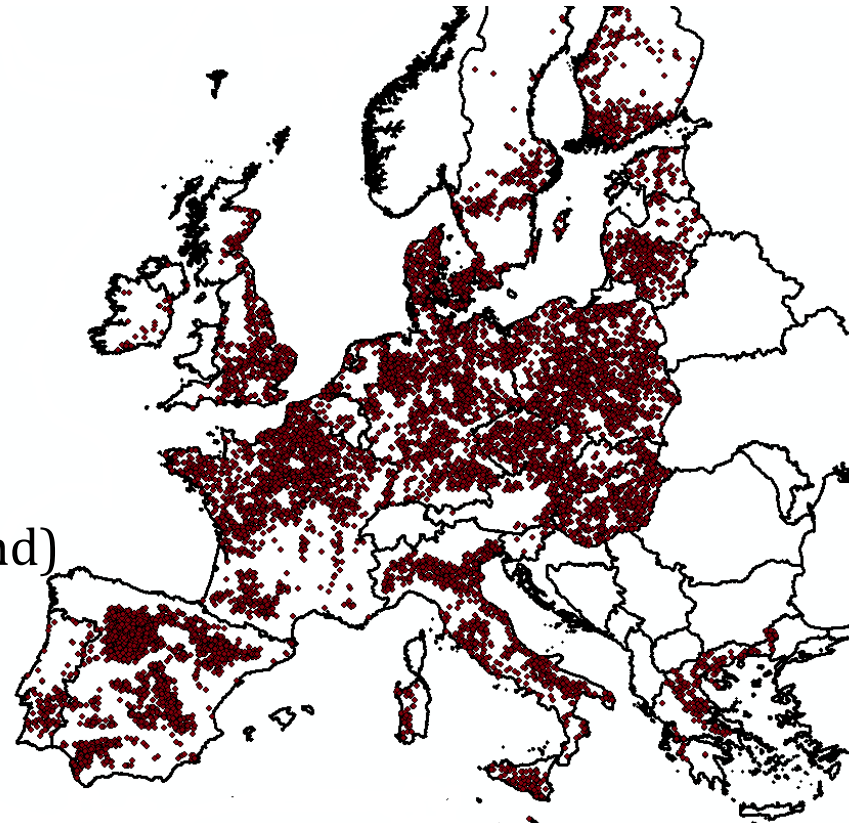
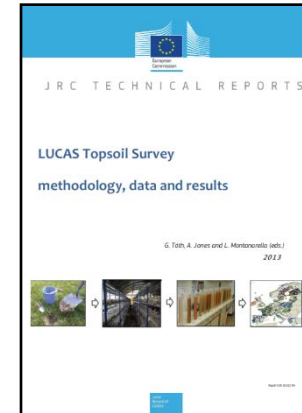
map of soil types and soil properties
in Europe

Used data: *depth* (estimated from WRB
soil type) and *slope*

- LUCAS 2009 Topsoil Data

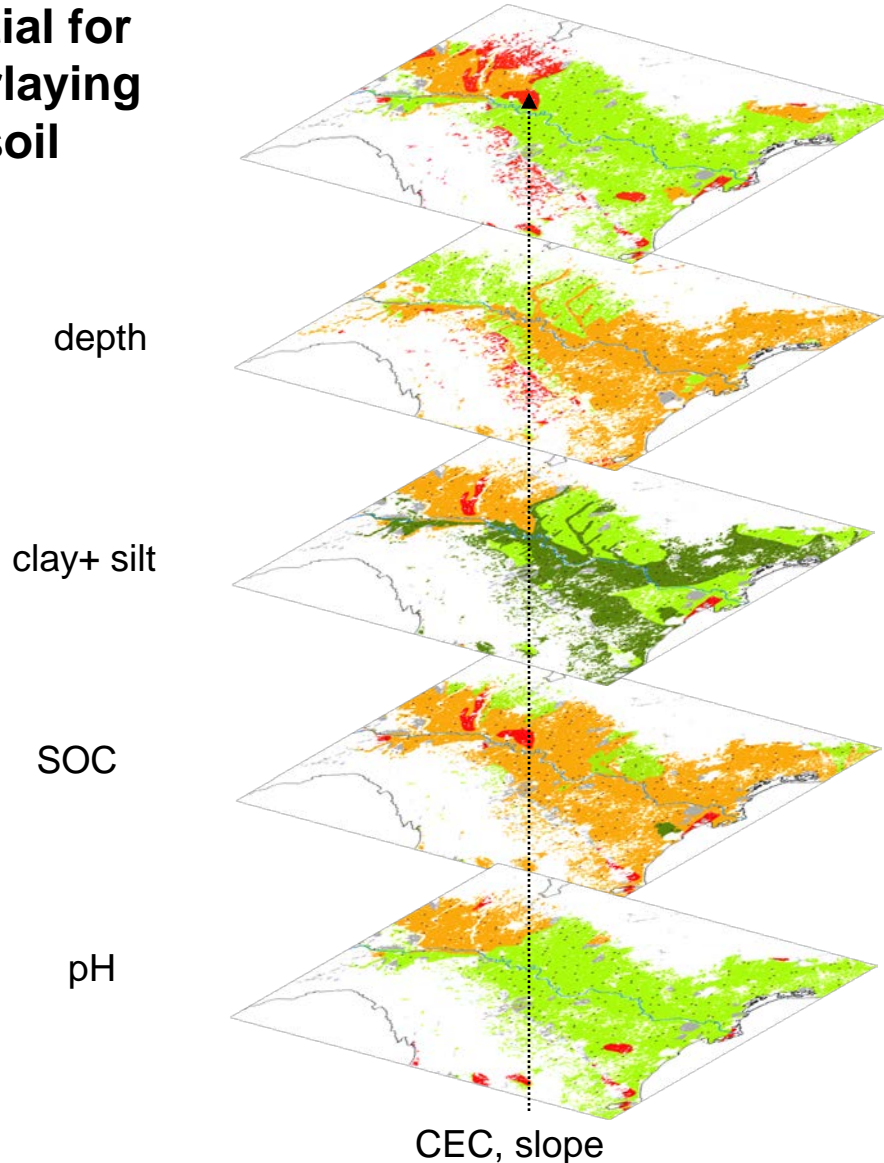
homogenous and newest dataset with
~20,000 points (forest, arable and grassland)
sampled in 25 EU- member states

Used data: *SOC, pH, CEC, clay and
silt* content

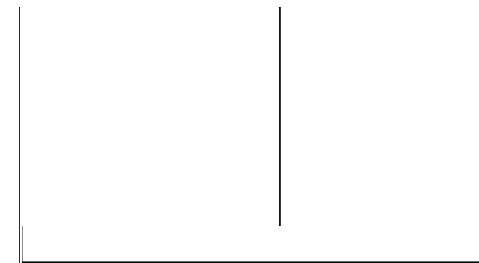


EXAMPLE FOR DEFINING SI SUITABILITY BY KEY INDICATORS

Land potential for SI after overlaying 6 land and soil indicators



Evaluation

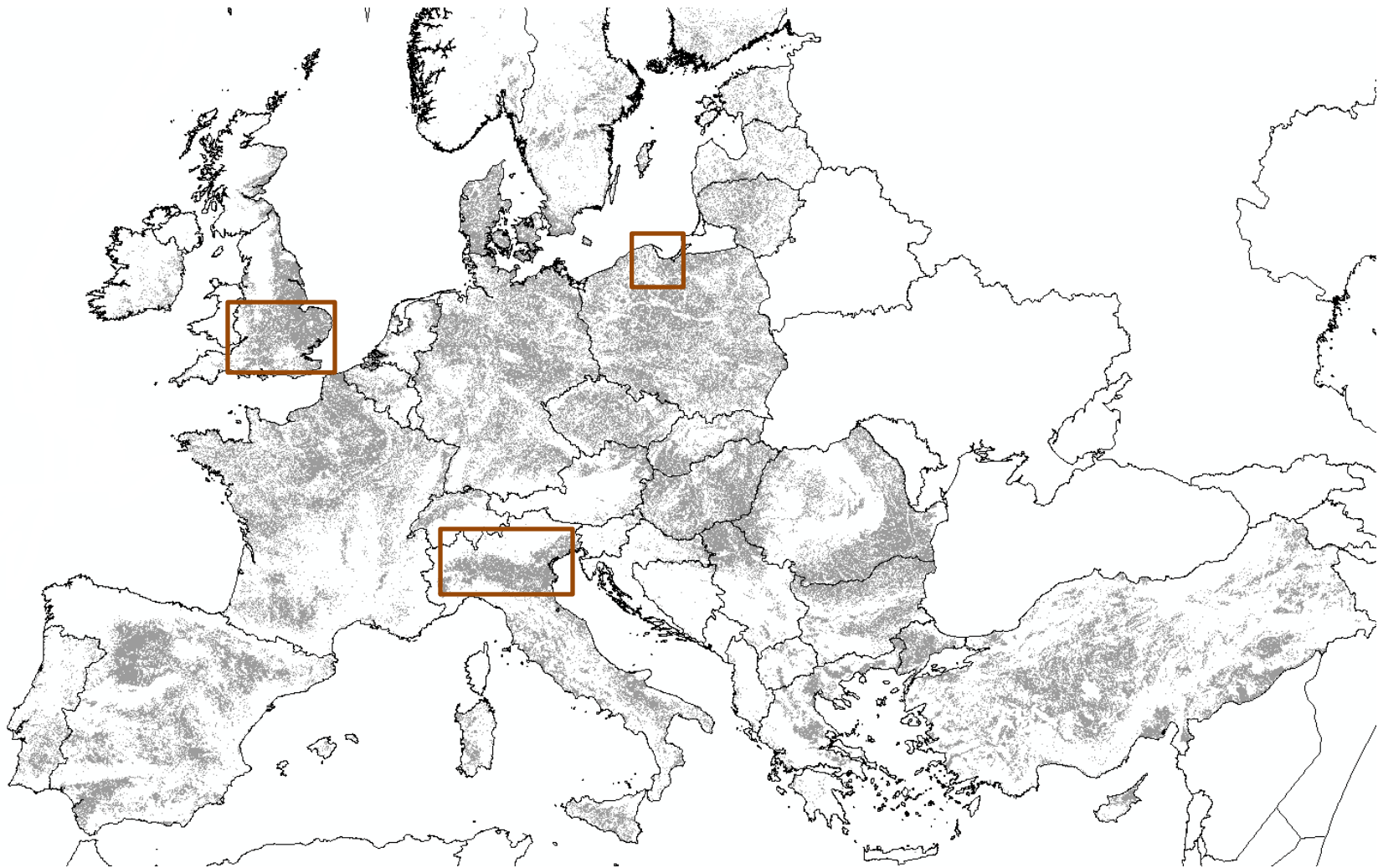


INTERPRETATION OF THE RESULTS

In total, four different classes for sustainable intensification (SI) suitability were distinguished:

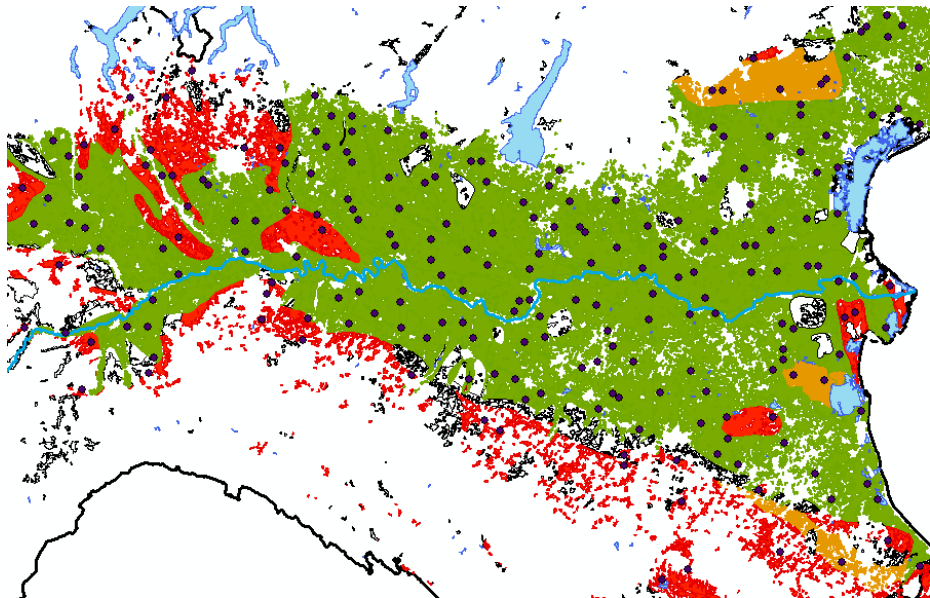
- 1 (--)... no intensification possible - extensification suggested
- 2 (-)... in general good conditions but at least one indicator out of range - not recommended for SI
- 3 (~)... SI possible with restrictions
- 4 (+)... land recommended for SI

RESULTS: 3 EXAMPLES



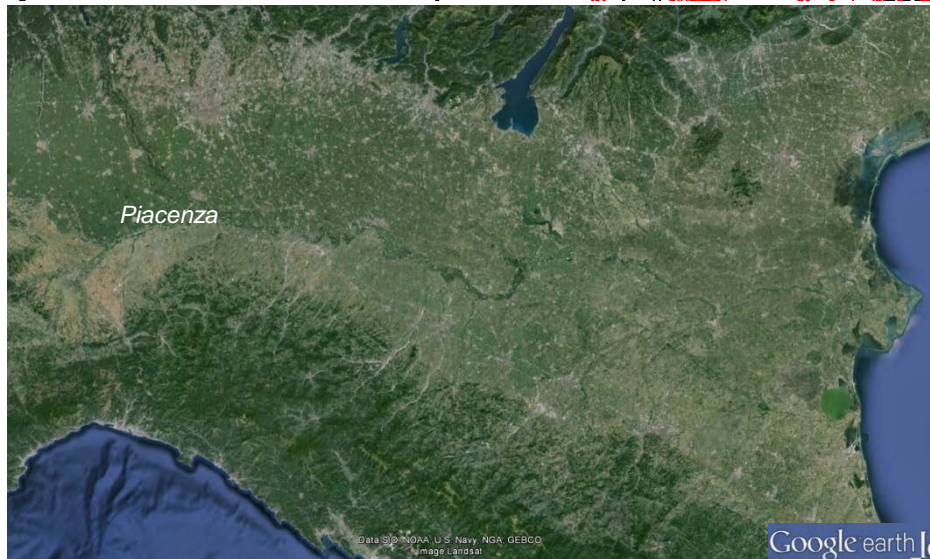
Examples: Lombardy (Italy); Vistula River Estuarine (Poland); Southern England (GB)

EXAMPLE: RESULTS FOR THE PO BASIN OF THE LOMBARDY, ITALY

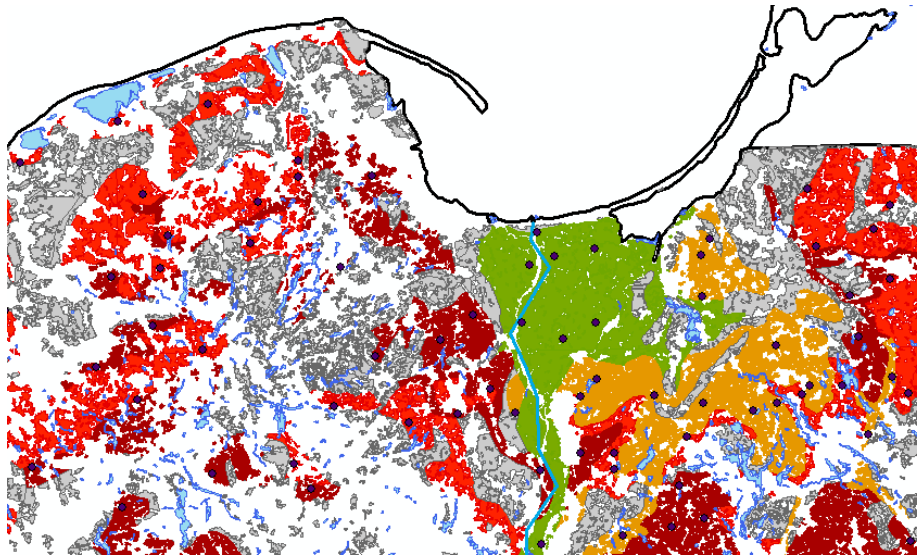


Legend

- LUCAS point_arable
- Large rivers
- Lakes
- 1 Extensification suggested
- 2 Not suitable for SI
- 3 Suitable for SI with restrictions
- 4 Suitable for SI
- Arable land not considered



EXAMPLE: RESULTS FOR THE VISTULA RIVER ESTUARINE, POLAND

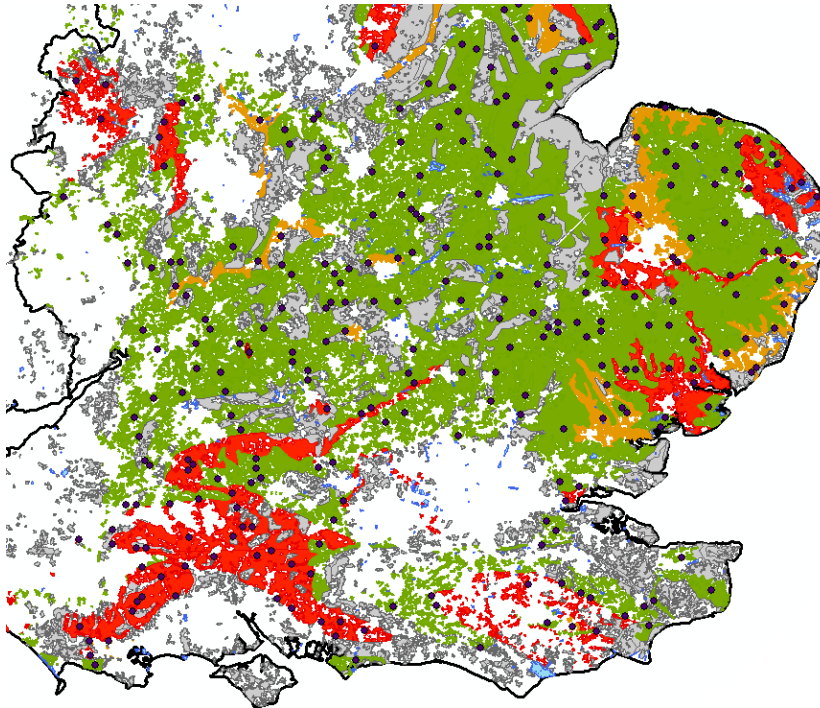


Legend

- LUCAS point_arable
- Large rivers
- Lakes
- 1 *Extensification suggested*
- 2 *Not suitable for SI*
- 3 *Suitable for SI with restrictions*
- 4 *Suitable for SI*
- *Arable land not considered*



EXAMPLE: RESULTS FOR SOUTHERN ENGLAND, GREAT BRITAIN



Legend

- LUCAS point_arable
- Large rivers
- ▭ Lakes
- ▭ 1 Extensification suggested
- ▭ 2 Not suitable for SI
- ▭ 3 Suitable for SI with restrictions
- ▭ 4 Suitable for SI
- ▭ Arable land not considered

RESULTS FOR 25 EU- MEMBER STATES*

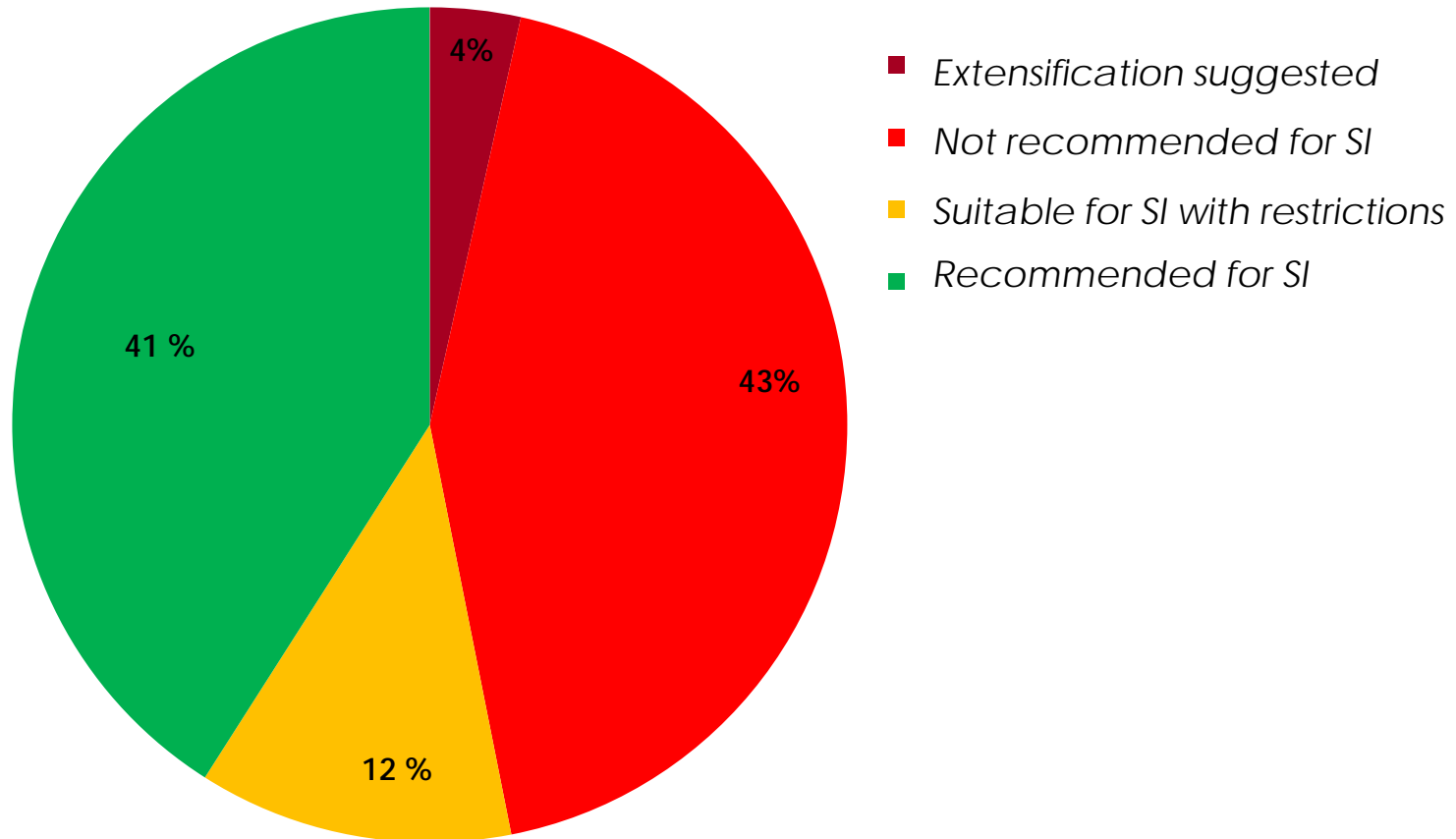
EVALUATION RESULTS IN %

	Extensifi- cation suggested (%)	Not recommended for SI (%)	Recom- mended with restrictions (%)	Recom- mended for SI (%)	Analysed arable land (km ²)	% of arable land**
Austria	0	19.7	25.1	55.2	7872.3	71.6
Belgium	0	7.0	0.1	92.9	3793.8	56.5
Cyprus	9.7	90.3	0.0	0.0	693.4	26.5
Czech Republic	1.3	26.9	23.9	47.9	23856.4	73.2
Denmark	1.3	50.5	21.1	27.1	22048.6	79.9
Estonia	0.5	34.5	0.1	64.9	3822.8	58.0
Finland	0.2	28.7	6.1	65.0	12658.6	79.2
France	0.5	43.4	5.4	50.7	113658.6	74.0
Germany	1.6	44.3	15.4	38.7	87885.6	64.4
Greece	3.4	69.4	3.5	23.7	16903.3	77.4
Hungary	1.8	18.4	14.5	65.3	40855.3	82.5
Ireland	0.0	12.0	31.5	56.5	2986.1	55.4
Italy	1.0	39.4	8.7	50.9	69563.0	83.8
Latvia	0.0	19.1	9.6	71.3	6370.0	69.9
Lithuania	2.5	27.3	8.4	61.9	12757.2	57.5
Luxembourg	0.0	0.0	0.0	100.0	2.5	1.1
Malta	100.0	0.0	0.0	0.0	1.2	100.0
Netherlands	0.0	24.6	4.2	71.1	5700.7	75.1
Poland	16.7	59.1	16.7	7.5	91742.9	65.8
Portugal	12.9	56.6	17.6	12.9	8846.7	66.1
Slovakia	0.1	6.6	16.9	76.3	13441.7	80.6
Slovenia	0.0	56.7	13.8	29.5	505.5	44.9
Spain	2.9	69.1	14.1	13.8	98607.6	80.3
Sweden	1.1	42.1	8.9	47.9	27067.3	90.7
United Kingdom	0.0	18.9	8.2	72.9	45171.7	84.6

* without *Bulgaria, Croatia and Romania*

**according to Corine Land Cover (CLC 2006)

RESULTS FOR 25 EU MEMBER STATES*



* without *Bulgaria, Croatia and Romania*

- Sustainable intensification of agriculture is only possible on limited areas (in Europe 41%);
- For reaching sustainability, on 4% of the surface extensification is needed;
- On 55% of the surface intensification is only possible in a limited way;
- These judgment don't consider hydrographical and climatic conditions;
- For operational approaches the local conditions must be observed;
- This classification does not allow for intensification by all means, due to environmental limitations.
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ACKNOWLEDGEMENTS

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THANK YOU!

