MAINTAINING ECOSYSTEM SERVICES UNDER SUSTAINABLE INTENSIFICATION

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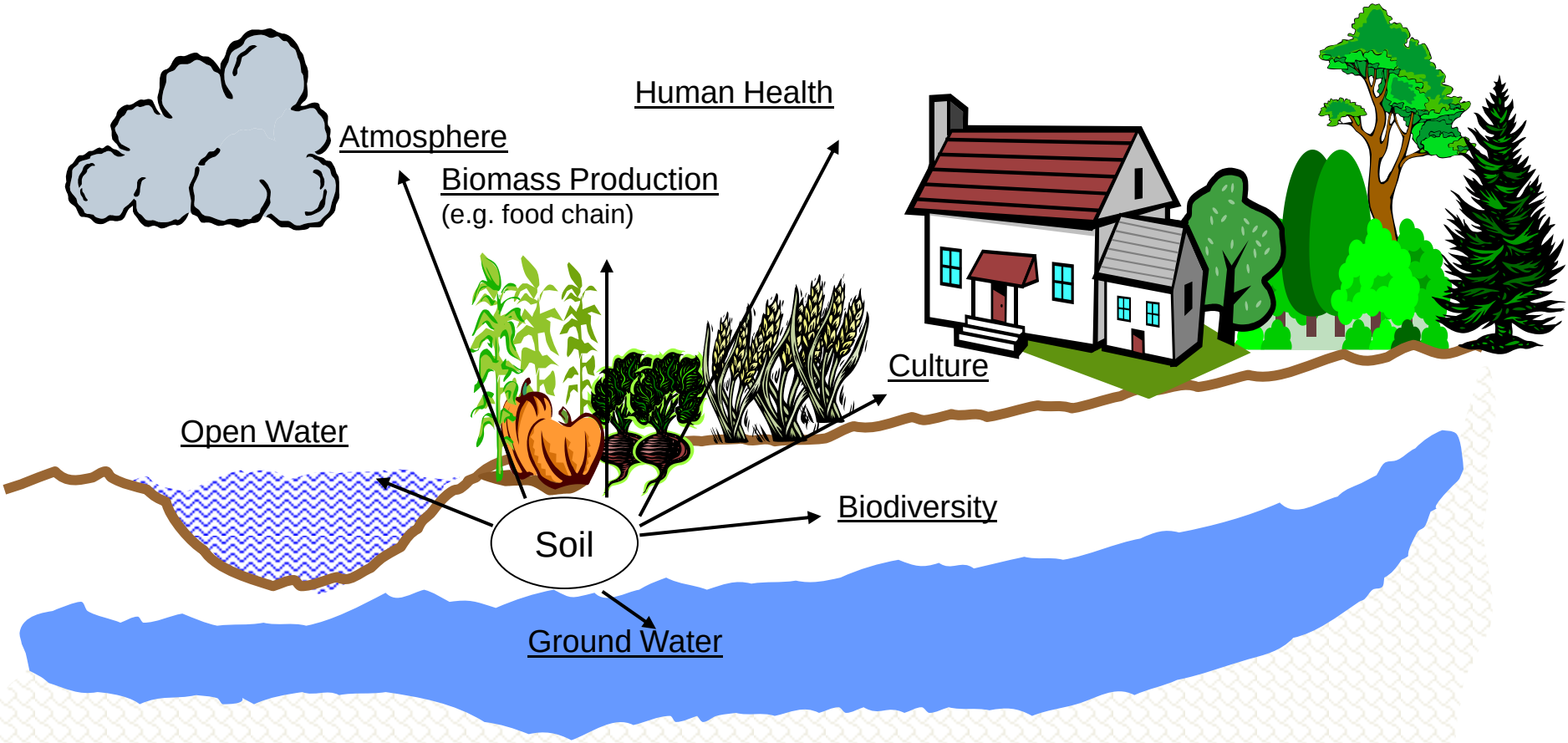
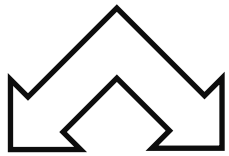
GOODS AND SERVICES PROVIDED BY LAND AND SOIL



W.E.H. Blum, 2004

INTENSIVE AGRICULTURE

- new crop varieties
- use of agro-chemicals
- fossil energy driven mechanization



+ Growth of agricultural output (food security)

- Negative impacts on ecosystem services

INTENSIVE AGRICULTURE

- new crop varieties
- use of agro-chemical
- fossil ener

SUSTAINABLE INTENSIFICATION

+ gricultural ou t (food security)

- Negative impacts on ecosystem services

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

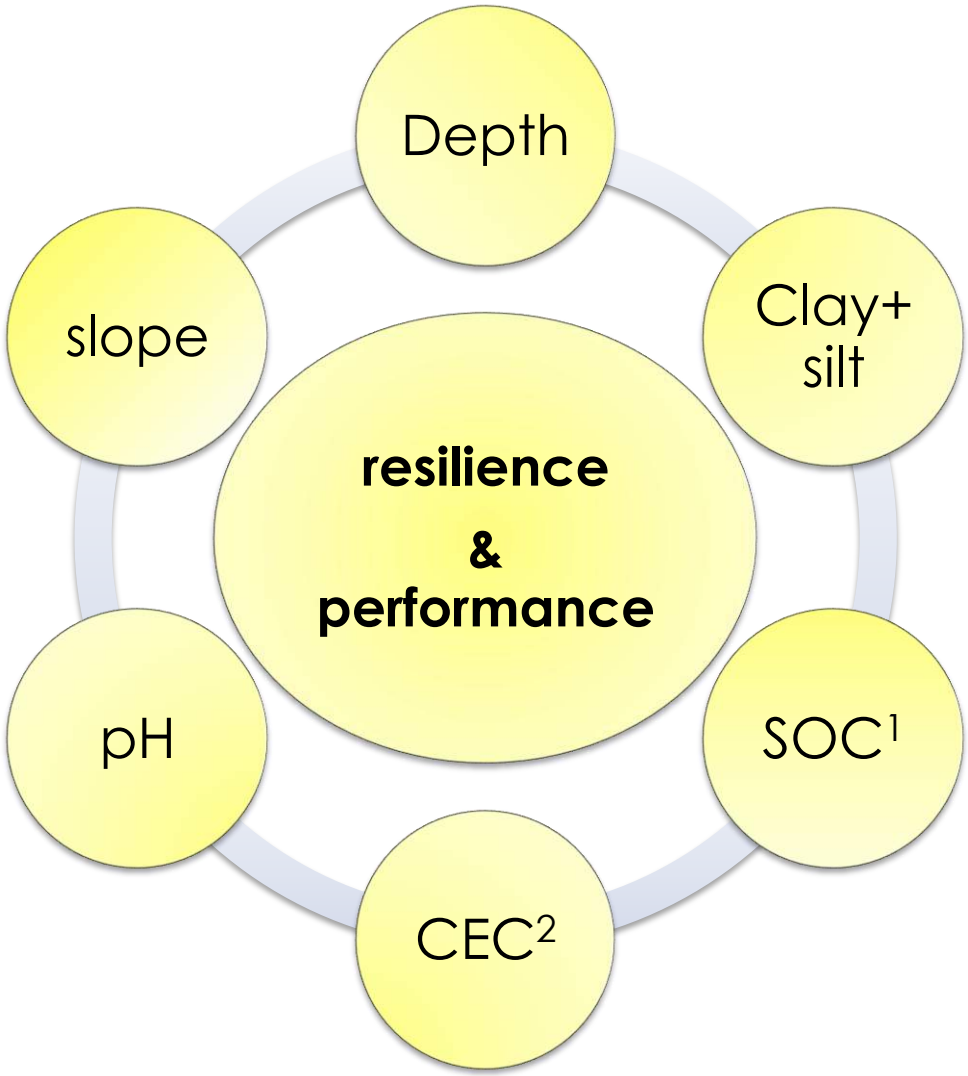
Resilience:
the capacity of systems to return to a (new) equilibrium after disturbance, e.g. depending on the input intensity, especially (damaging) external effects, such as fertilizers, crop protection compounds, mechanisation (compaction, erosion).

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.

OBJECTIVE

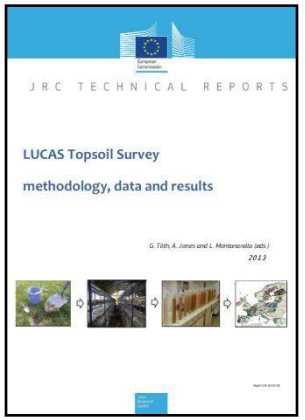
Development of a concept for delineating agricultural sites in Europe with good soil resilience and performance based on **5 soil intrinsic parameters** and **topography (= 6 indicators)** thus allowing for recommendations where sustainable agricultural intensification can be achieved without harming any ecosystem services.

6 KEY LAND AND SOIL PARAMETERS (INDICATORS)



[1] SOC= Soil Organic Carbon
[2] CEC= Cation Exchange Capacity

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

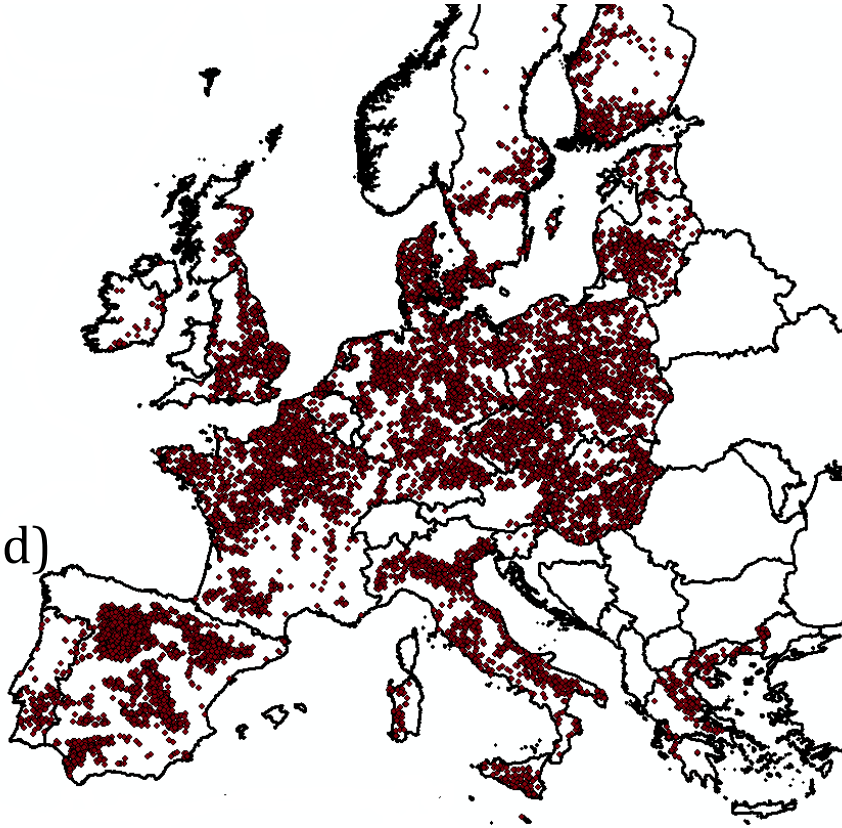
map of soil types and soil properties in Europe

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



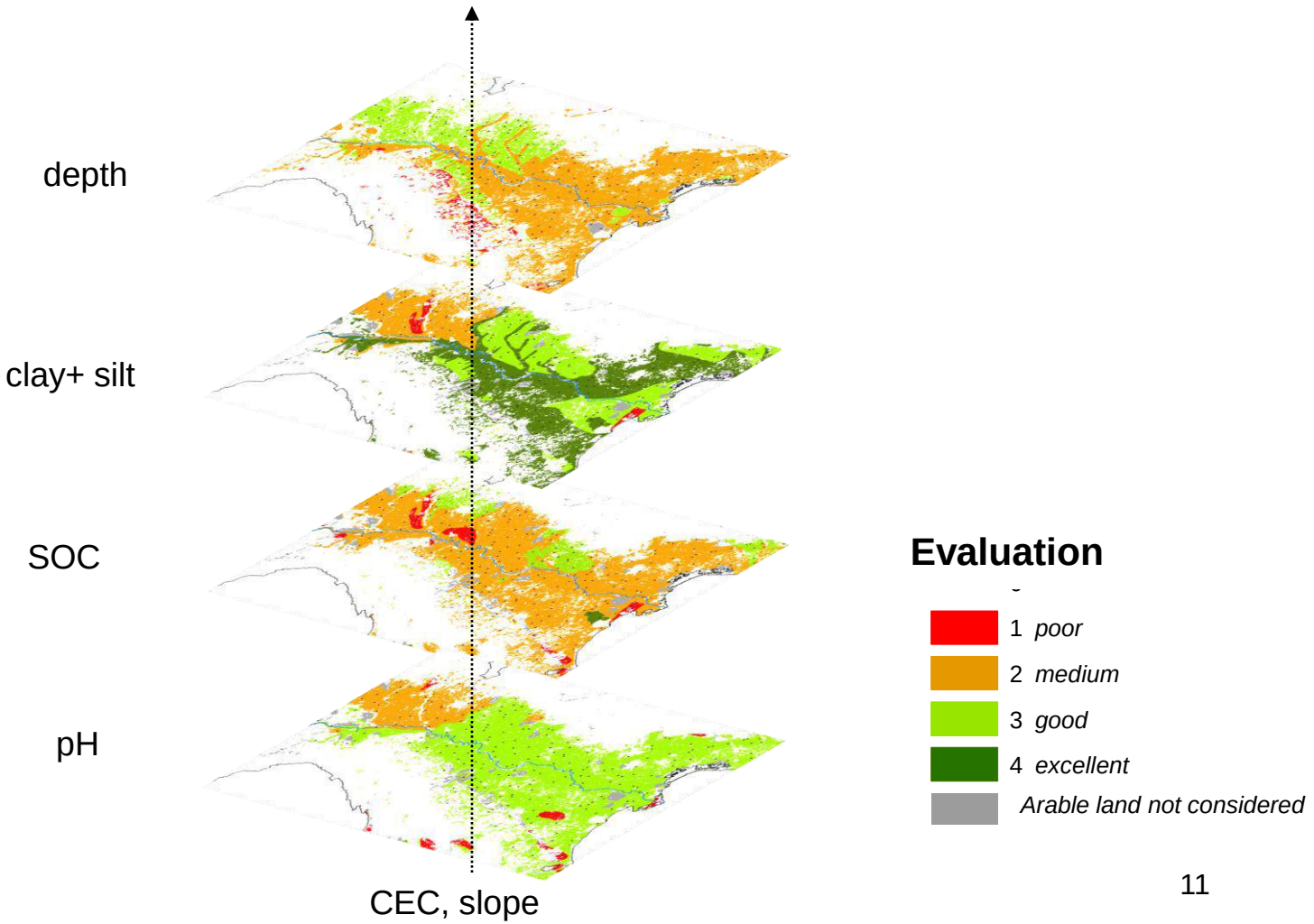
RANKING OF SOIL AND TOPOGRAPHIC INDICATORS (THRESHOLD VALUES) BASED ON LITERATURE AND EXPERT JUDGEMENT

	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_2O
Slope**		<8	8-15	15-25	%

* Estimated according to WRB 2006
** Sites with slopes >25% were excluded from calculations

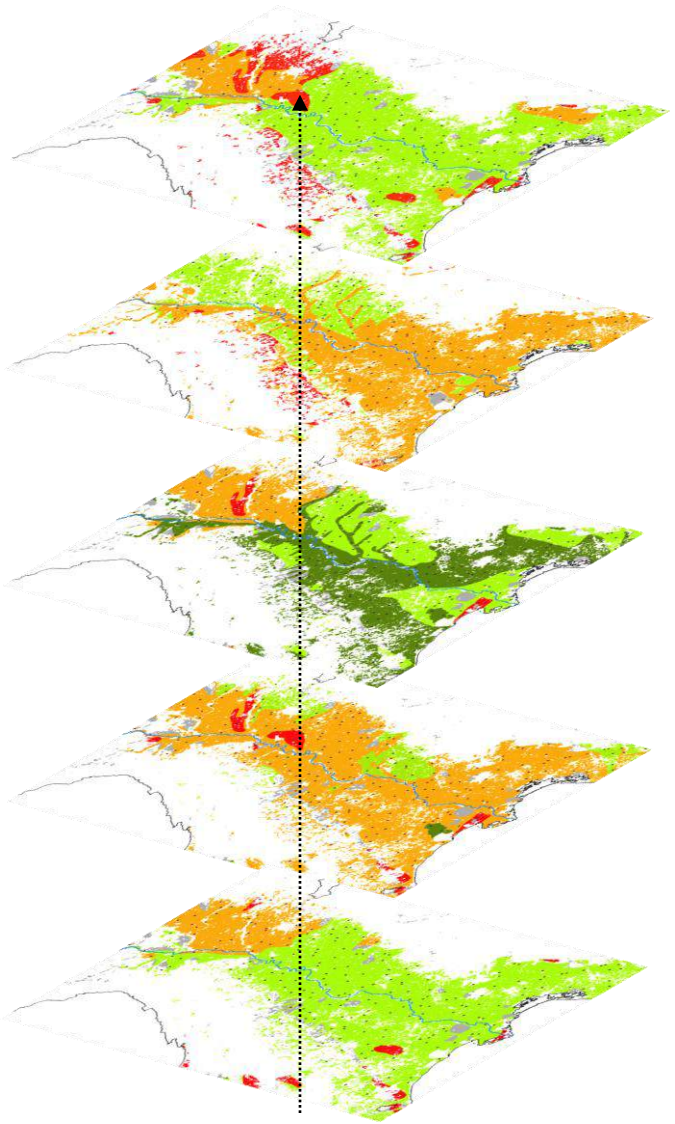
Based on this scheme data from CORINE, ESDB and LUCAS were used in a Geographical Information System (ArcGIS).

EXAMPLE FOR DEFINING SI SUITABILITY BY KEY INDICATORS



EXAMPLE FOR DEFINING SI SUITABILITY BY KEY INDICATORS

Land potential for SI after overlaying 6 land and soil indicators



Evaluation

- 1 *poor*
- 2 *medium*
- 3 *good*
- 4 *excellent*
- *Arable land not considered*

Interpretation of the Results

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

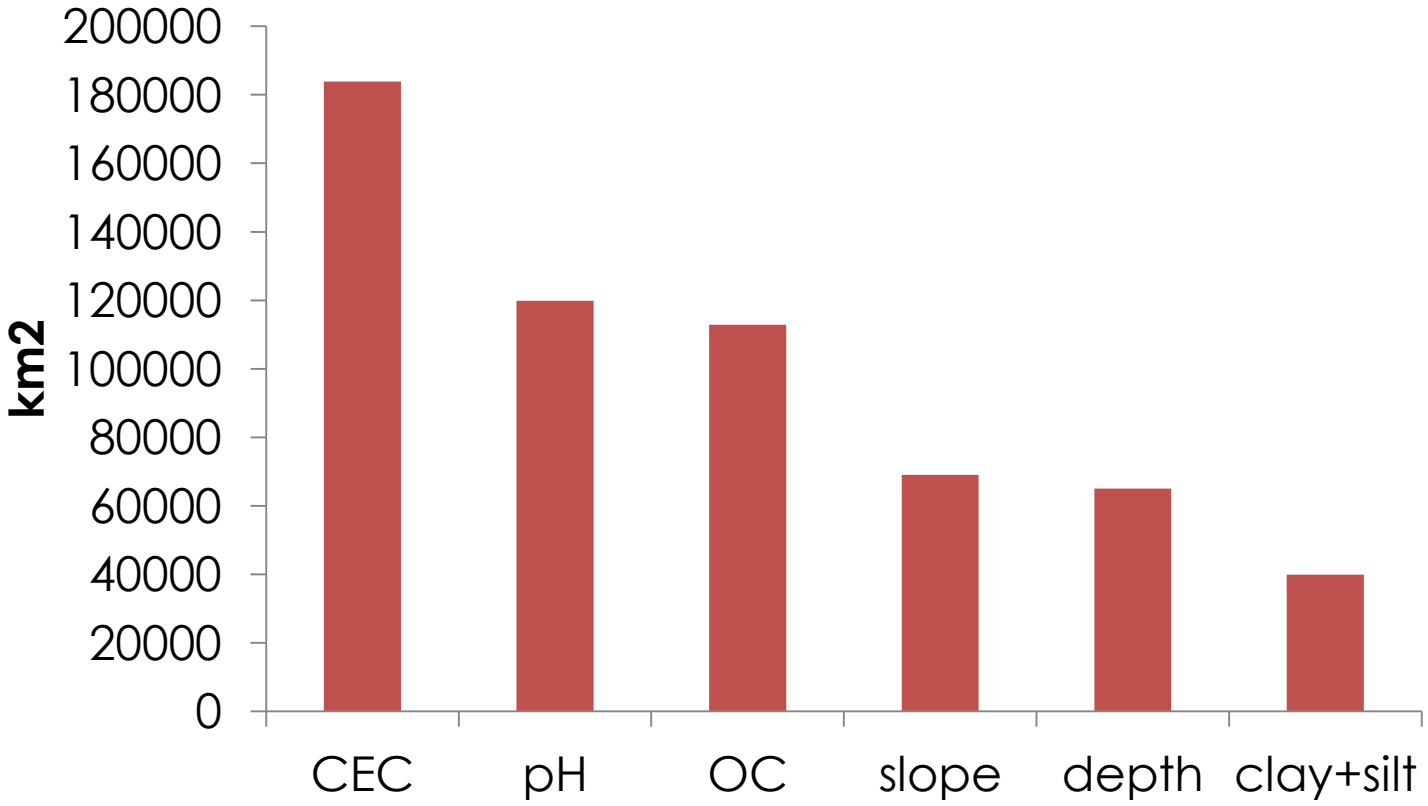
1 (--)… no intensification possible - extensification suggested

2 (-)… in general good conditions but at least one indicator out of range - not recommended for SI

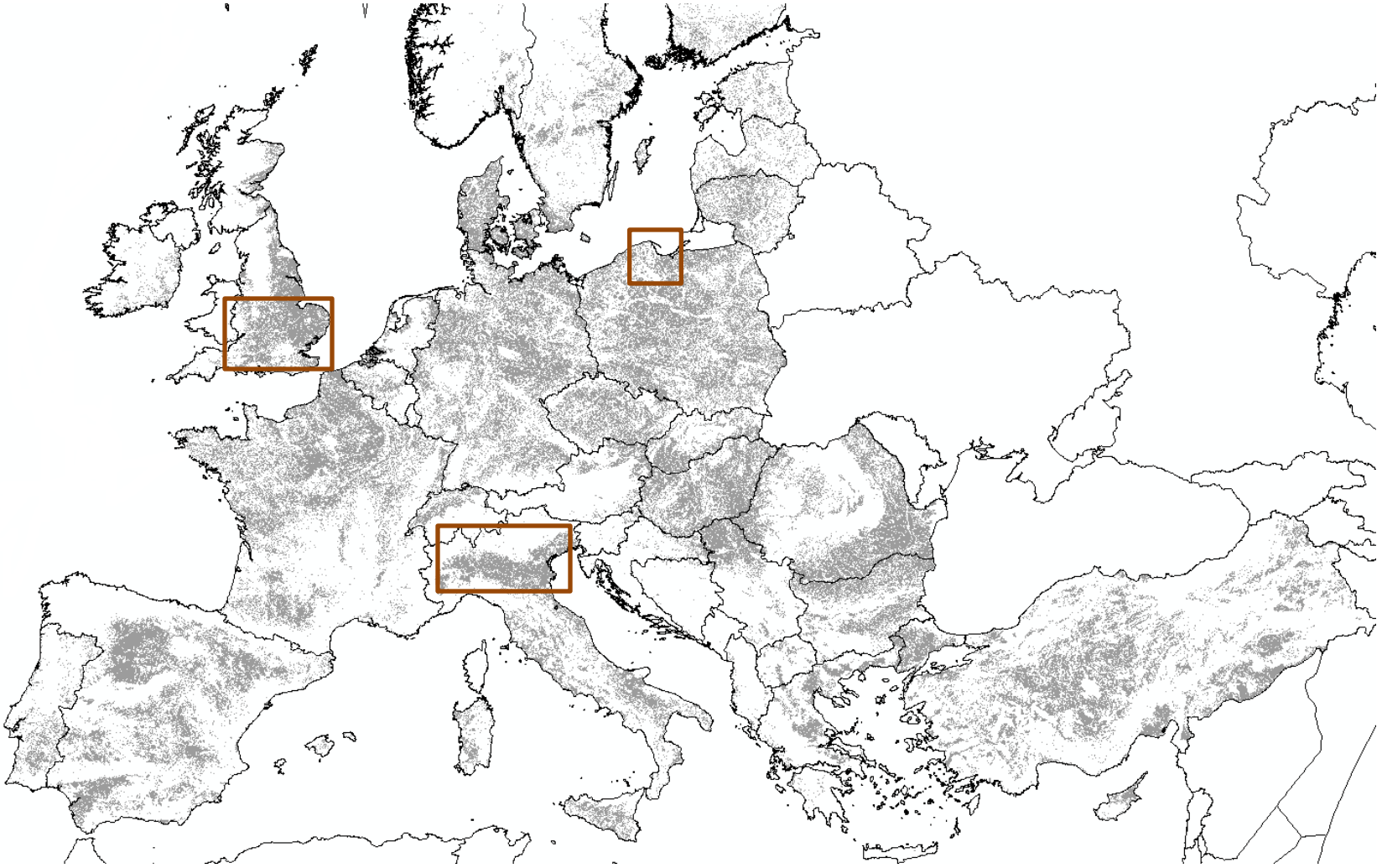
3 (~)… SI possible with restrictions

4 (+)… land recommended for SI

Main limiting factors for SI in arable land in Europe (in km^2)

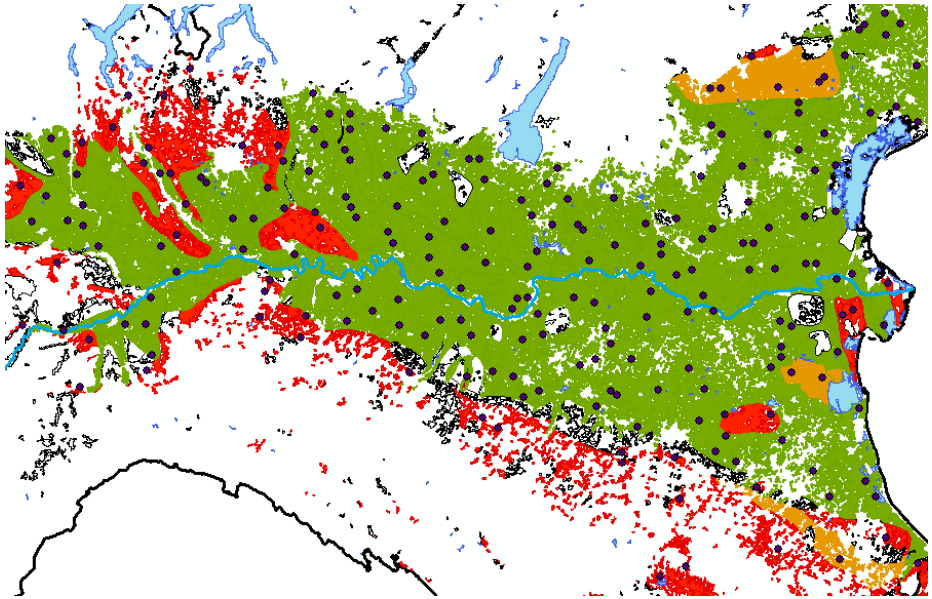


RESULTS: 3 EXAMPLES



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

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

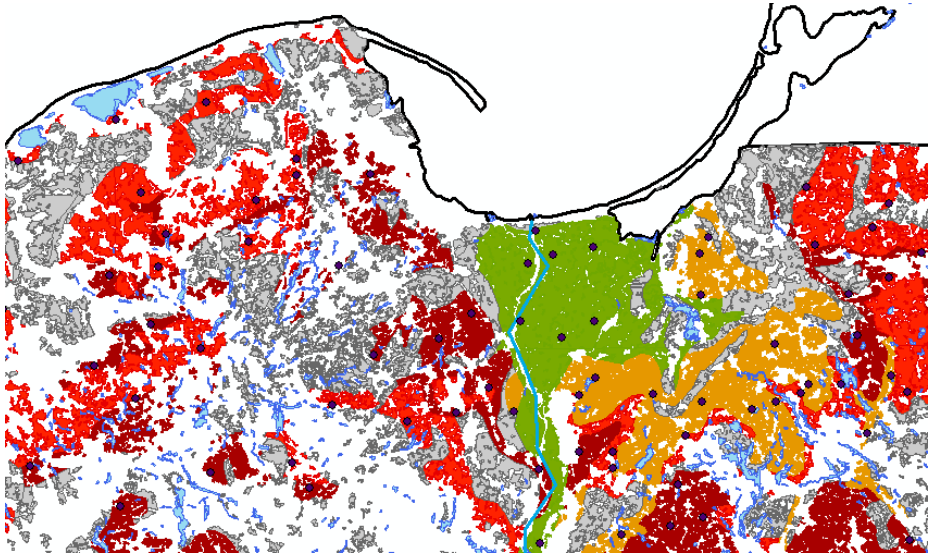


Legend

- 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



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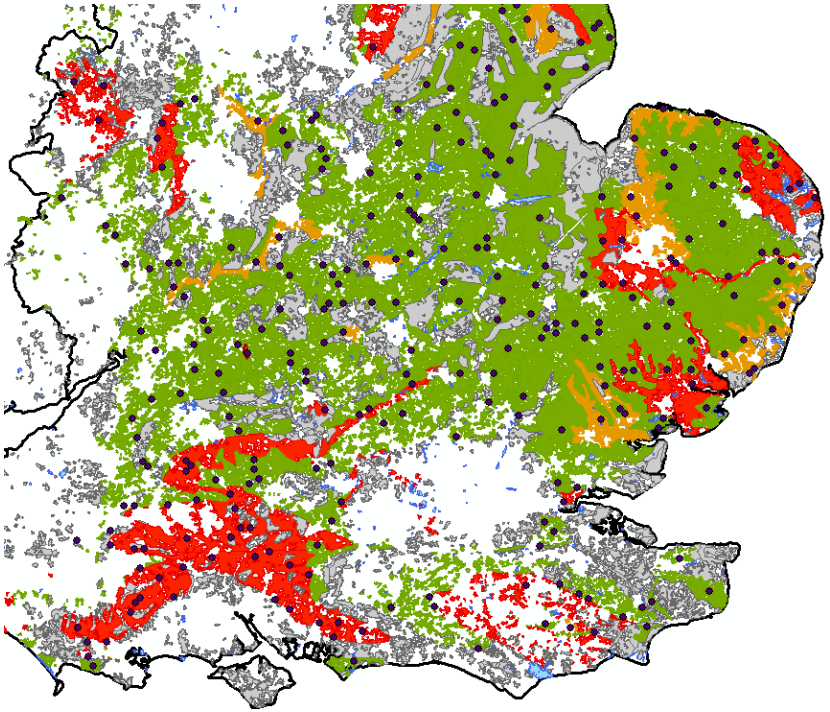
EXAMPLE: RESULTS FOR SOUTHERN ENGLAND, GREAT BRITAIN



Legend

- LUCAS point_arable
- Large rivers
- Lakes

- 1 *Extensification suggested*
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- 3 *Suitable for SI with restrictions*
- 4 *Suitable for SI*
- ***Arable land not considered***

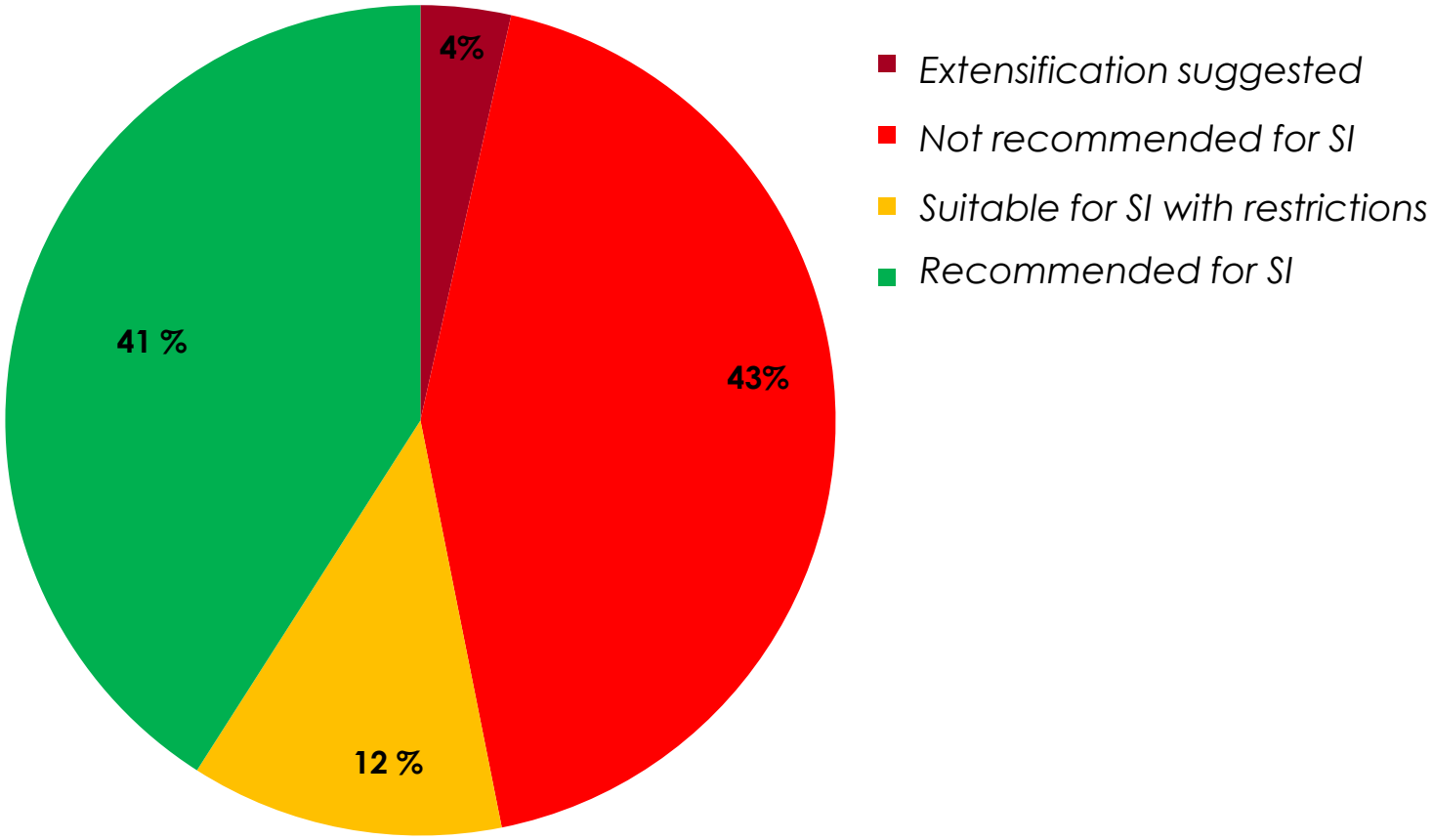
RESULTS FOR 25 EU- MEMBER STATES*
EVALUATION RESULTS IN %

	Extensifi-cation suggested (%)	Not recommended for SI (%)	Recom-mended with restrictions (%)	Recom-mended for SI (%)	Analysed arable land (km²)	% 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 *Romania, Bulgaria, and Croatia*

**according to Corine Land Cover (CLC 2006)

PRELIMINARY RESULTS FOR 25 EU MEMBER STATES*



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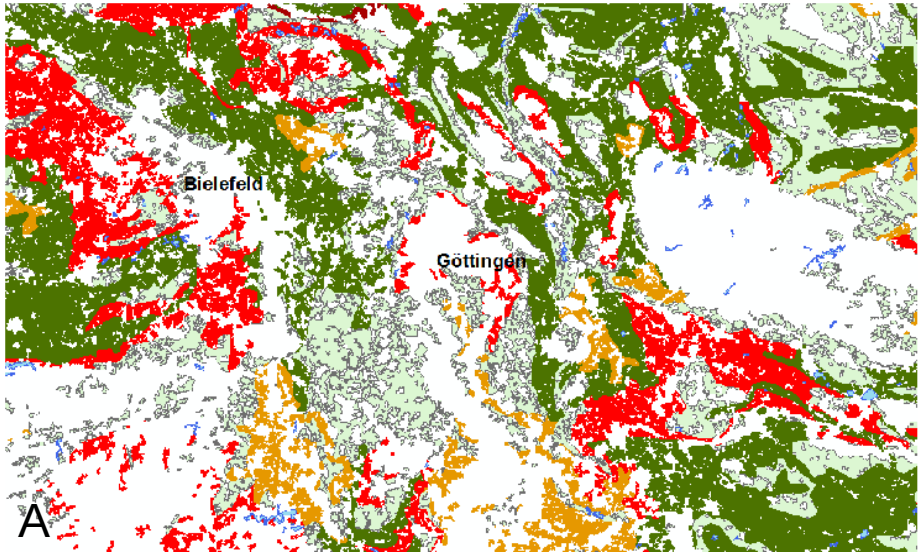
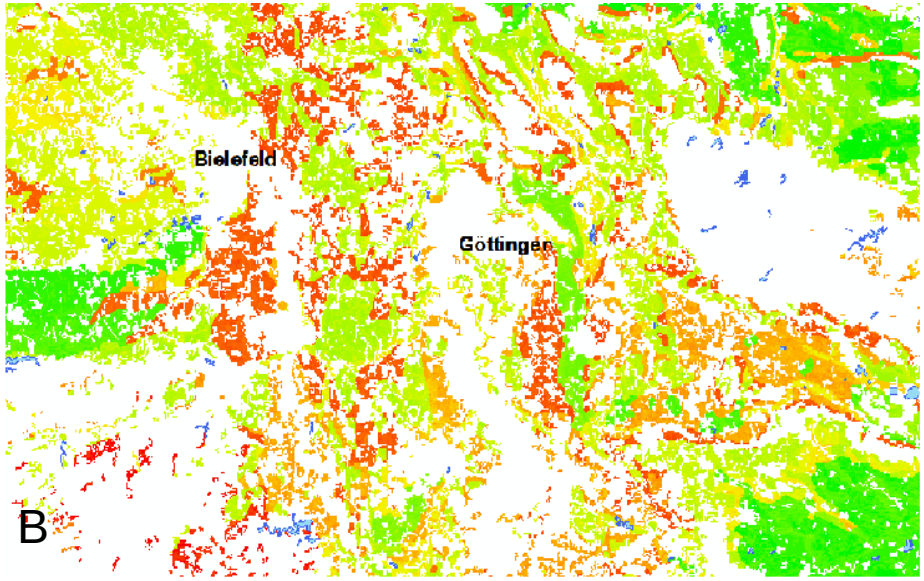
Comparison of the potential for Sustainable Intensification (A) and the agricultural yield potential according to the German Soil Quality Rating (B) western of the Harz region (Germany)





1 *Extensification suggested*
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Arable land not considered

Good yield potential

Poor yield potential

Conclusion and Outlook

- Ecosystem services are dependent on soil resilience and performance
- Intensive agriculture which does not harm ecosystem services is only possible on limited areas (in the EU on 41%);
- On 4% of the surface extensification is needed for reaching sustainability and on 55% of the surface sustainable intensification is only possible in a limited way;
- Because land and soil are very heterogeneous natural resources, for any final decision the local conditions must be considered;
- In order to measure farm environmental performance further indicators have to be considered, targeting at water resources, biodiversity and the atmosphere.

ACKNOWLEDGEMENTS

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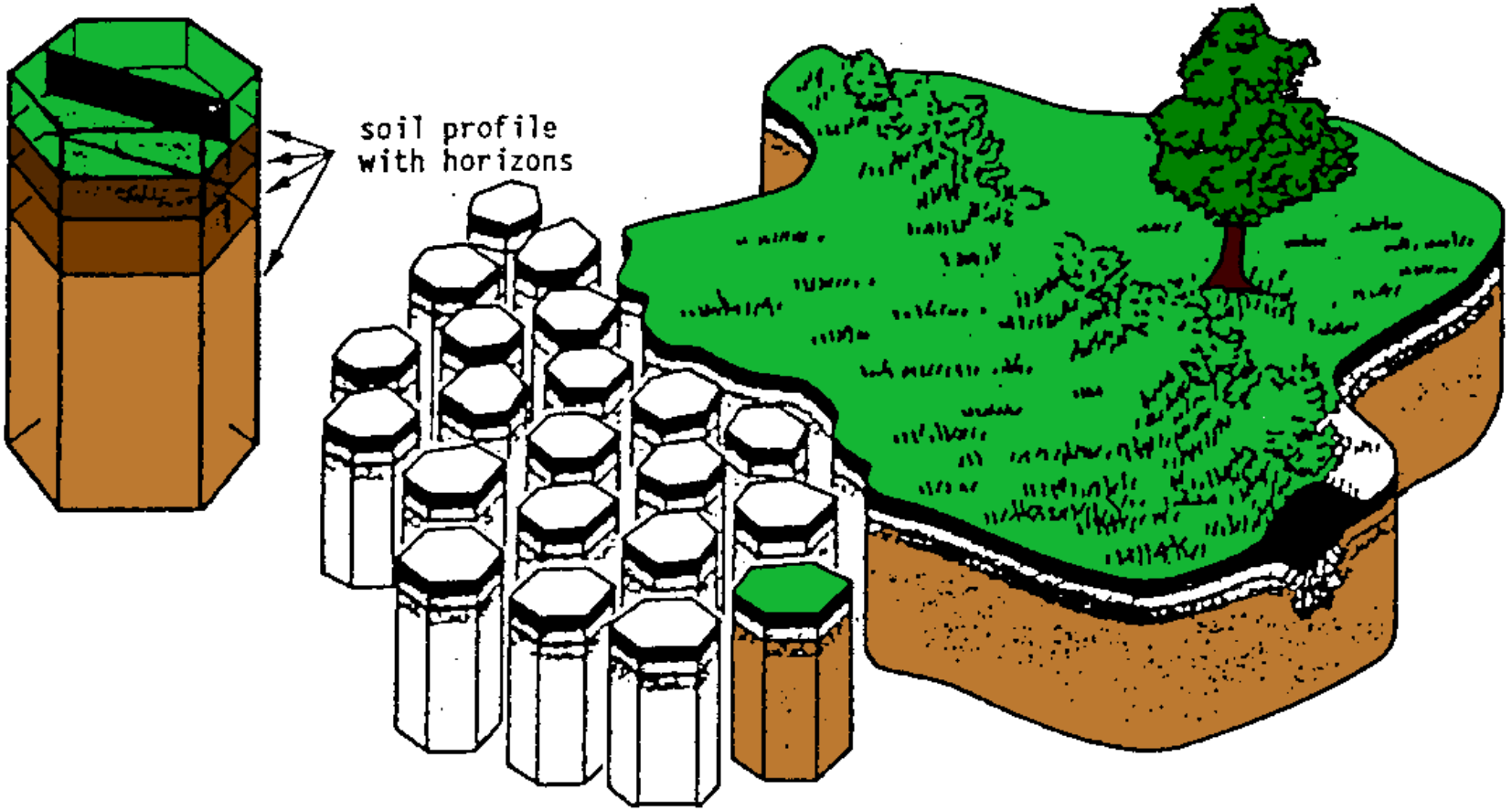
and the RISE Foundation for financial support.

THANK YOU FOR YOUR ATTENTION!



SOIL DEPTH

Soil depth controls:

- filter, buffer and transformation capacities
- nutrient and pollutant storage

Influencing

- Soil fertility
- Protection of groundwater and food chain

CLAY+ SILT CONTENT

- Basis of stable mineral- organic compounds,
- retains nutrients and further chemical compounds, reducing or avoiding the contamination of groundwater and surface water resources,
- improves water storage and reduces impacts through climate change.

SOIL ORGANIC CARBON (SOC)

- Derives from plant and animal residues
- Controls physical, chemical and biological soil functions:
  - *water holding capacity*
  - *source of plant nutrients*
  - *source of energy for soil organisms (biodiversity)*
  - *filter, transformation and buffer capacity (against adverse chemical impacts)*
  - *resistance against compaction and erosion*

pH and Cation Exchange Capacity (CEC)

- Control the mobility of elements, e.g. plant availability and danger of leaching,
- pH and CEC can be controlled by specific measures (e.g. liming).

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SLOPE

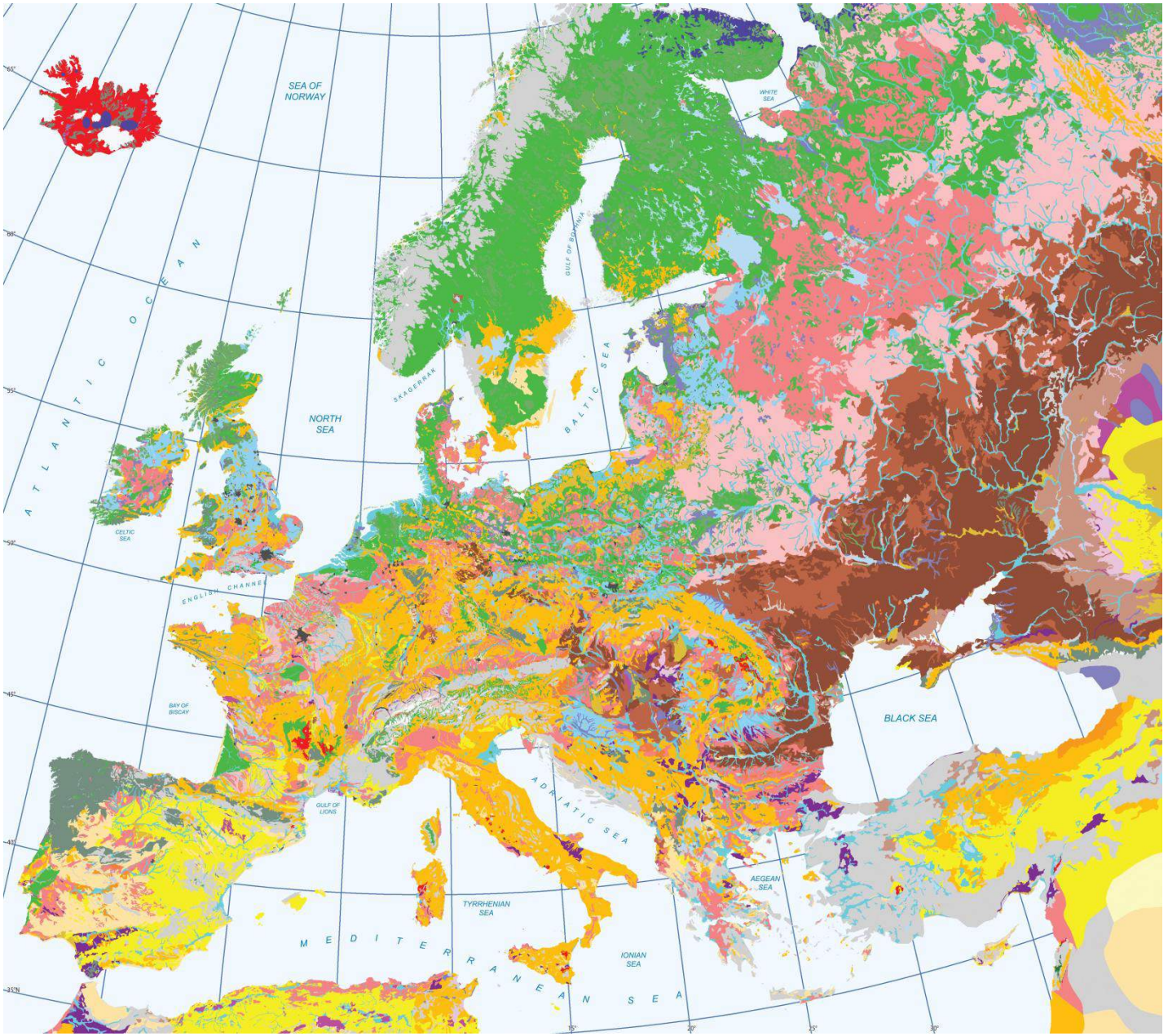
Intensification of crop production on slopes with a steepness more than 15% cannot be recommended because of SOIL EROSION.

Sustainable Intensification - Definition

Sustainable Intensification:

- Strategy to achieve global food security
- Means to improve the productivity and environmental management of agricultural land

The concept of SI should always be seen in a local context and should include different strategies and technologies.


SEA OF NORWAY
WHITE SEA
GULF OF BOTHNIA
ATLANTIC OCEAN
SKAGERRAK
BALTIC SEA
NORTH SEA
CELTIC SEA
ENGLISH CHANNEL
BAY OF BISCAY
BLACK SEA
GULF OF LIONS
ADRIATIC SEA
AEGEAN SEA
TYRRHENIAN SEA
IONIAN SEA
MEDITERRANEAN SEA

Arable land according to Corine Land Cover 2006 (CLC 2006)