European Commission

Joint Research Centre (JRC)

Soil Organic Carbon preservation and sequestration in European agricultural soils: an overview.

Bampa F., Aksoy E., Guicharnaud R.A., Hiederer R., Montanarella L., Nocita M., Panagos P.

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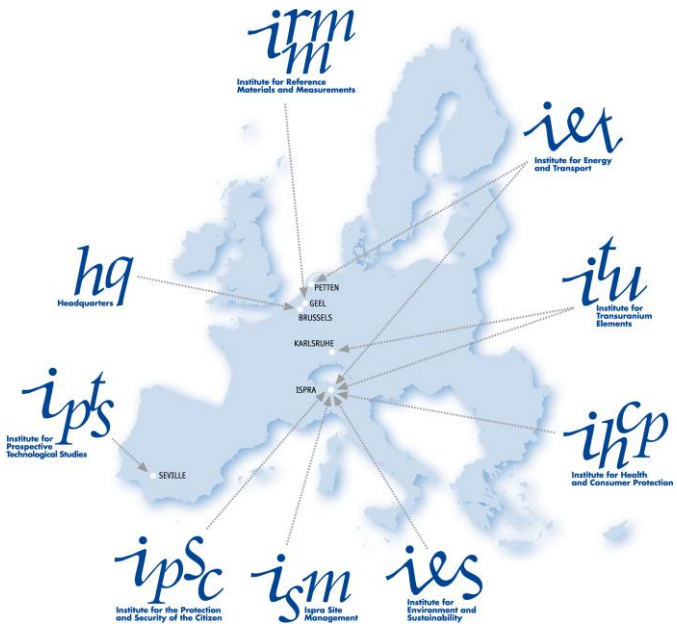
Joint Research Centre

JRC: who are we and what do we do?

European Commission

Established 1957

- 7 institutes in 5 countries:
  Italy, Belgium, Germany, The Netherlands, Spain
- 2,845 permanent and temporary staff in 2010
- 1,398 scientific publications in 2010
- 125 instances of support to the EU policy-maker annually



Where you can find us

- **Corporate Services** – *Brussels*
- **IRMM** – *Geel, Belgium*
  Institute for Reference Materials and Measurements
- **ITU** – *Karlsruhe, Germany and Ispra, Italy*
  Institute for Transuranium Elements
- **IE** – *Petten, The Netherlands and Ispra, Italy*
  Institute for Energy
- **IPSC** – *Ispra, Italy*
  Institute for the Protection and Security of the Citizen
- **IES** – *Ispra, Italy*
  Institute for Environment and Sustainability
- **IHCP** – *Ispra, Italy*
  Institute for Health and Consumer Protection
- **IPTS** – *Seville, Spain*
  Institute for Prospective Technological Studies

SOIL protection: where we stand?

THEMATIC STRATEGY FOR SOIL PROTECTION

- COMMUNICATION COM(2006) 231 on the Thematic Strategy for Soil Protection
- DIRECTIVE COM(2006) 232 establishing a framework for the protection of soil and amending Directive 2004/35/EC

*"**decline SOM**"*

- IMPACT ASSESSMENT SEC(2006) 620 of the Thematic Strategy for Soil Protection
- REPORT **COM(2012)46 final** on The implementation of the Soil Thematic Strategy and ongoing activities

*"...with appropriate **management practices**, SOM can be maintained and even increased… Keeping **C stocks** is thus essential for the fulfillment of present and future emission reduction commitments of the EU"*

- COMMUNICATION COM(2012)94final on Accounting for land use, land use change and forestry (LULUCF) in the Union's climate change commitments
- Proposal COM(2012)93final on accounting rules and action plans on greenhouse gas emissions and removals resulting from activities related to land use, land use change and forestry.

*"appropriate land uses and **management practices** in forestry and **agriculture** can limit emissions of C and enhance removals from atmosphere"*

- IMPACT ASSESSMENT SWD(2012)41final on the role of land use, land use change and forestry (LULUCF) in the EU's climate change commitments.

SOIL & Organic Matter

Sealing

Soil Biodiversity loss

Decline of
Soil Organic Matter

Erosion

Soil Threats

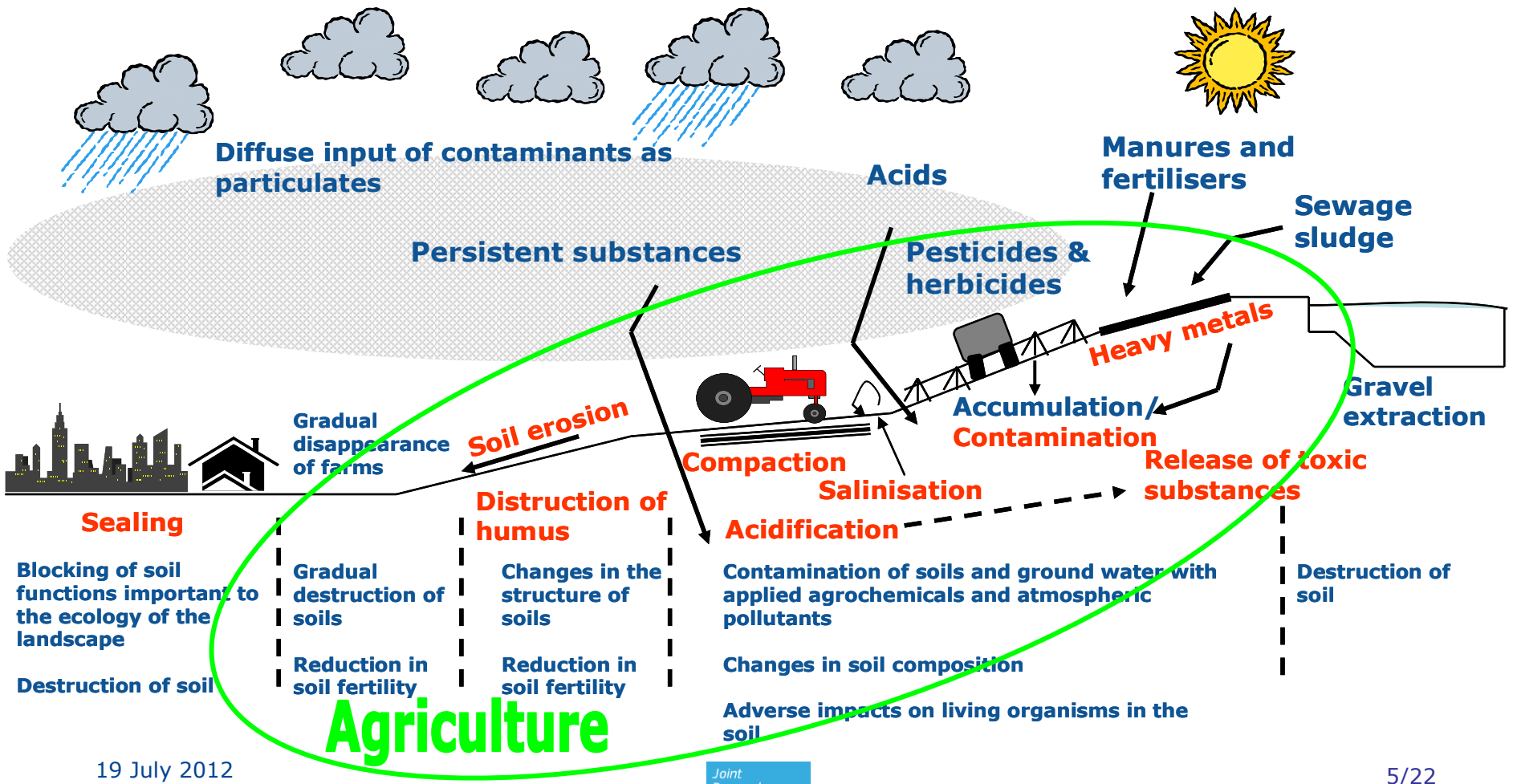
Salinization

Compaction

Contamination

Landslides

Human impacts & Soil



Agriculture,soils & Climate Change

- **White Paper** COM(2009)147 final on Adapting to climate change: Towards a European framework for action
  - WORKING DOCUMENT SEC(2009)417 on accompanying the White Paper on adapting to climate change: towards a European framework for action. Adapting to climate change: the challenge for European agriculture and rural areas.

> *"..in **agriculture** projected climatic changes will affect crop yields, livestock management and the location of production …climate change will also affect soil by **depleting organic matter** …examples of **mitigation** include improving the **soil's carbon capacity**".*"

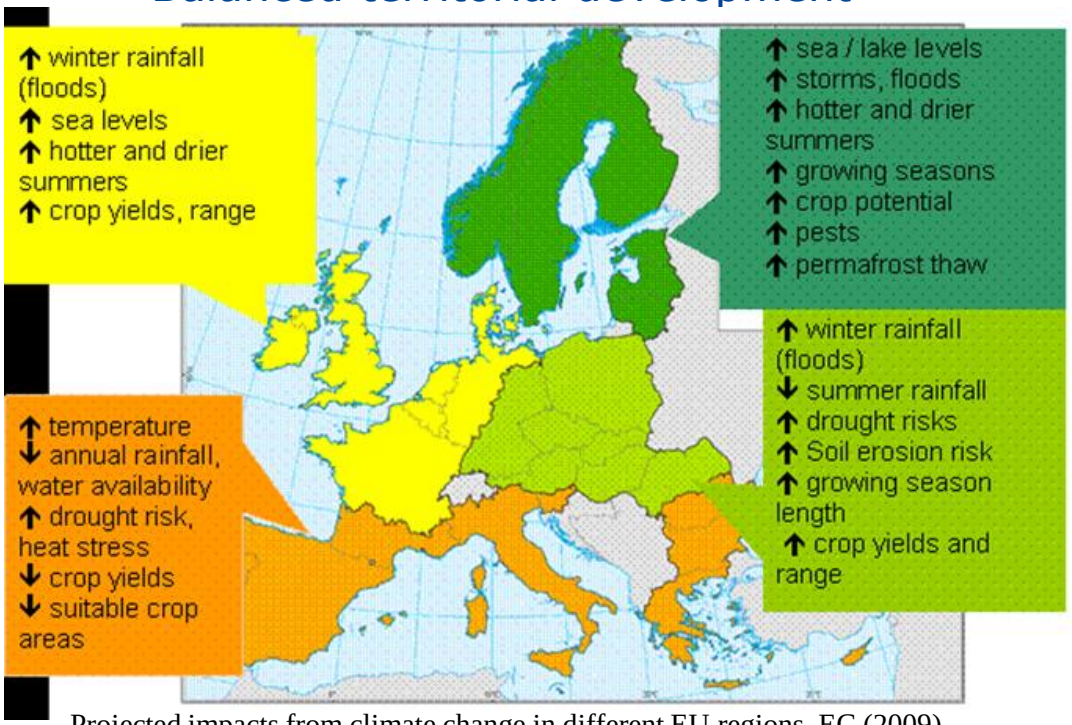
- WORKING DOCUMENT SEC(2009) 1093 final on The role of the European agriculture in climate change mitigation.

> *"..In the EU, agriculture can contribute to climate change mitigation by …storing C in farmland soils..to address the double challenge of reducing GHG emissions while at the same time coping with the changing climate, it will be necessary to ensure **synergies between adaptation and mitigation** as much as possible. Measures that provide co-benefits in terms of reducing emissions and increasing resilience of farming need to be identified and promoted (..soil and tillage practices…and protection and management of pastures..organic farming…)."*

The CAP towards 2020

COMMUNICATION COM(2010)672 final on
The CAP towards 2020:Meeting the food, natural resources and territorial challenges of the future.

- Viable food production
- Sustainable management of natural resources and climate action
- Balanced territorial development



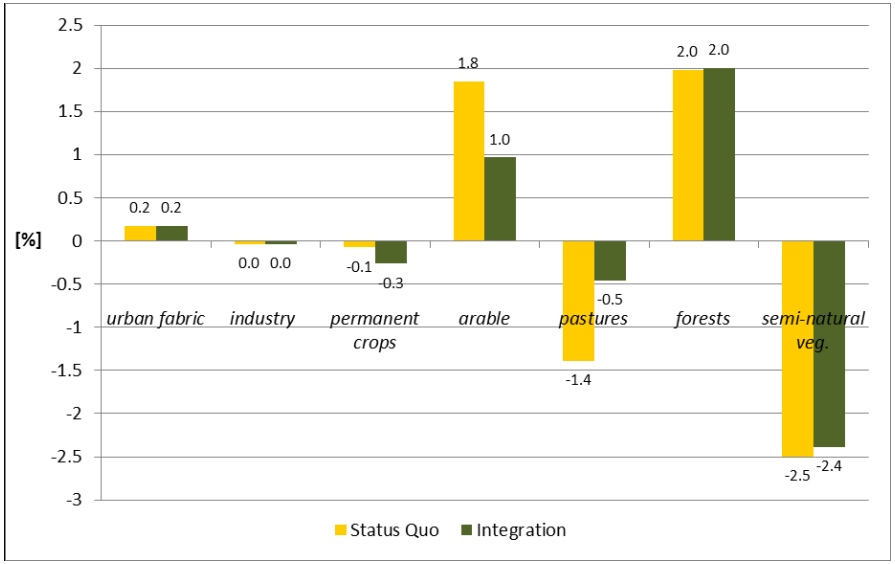
Projected impacts from climate change in different EU regions. EC (2009)

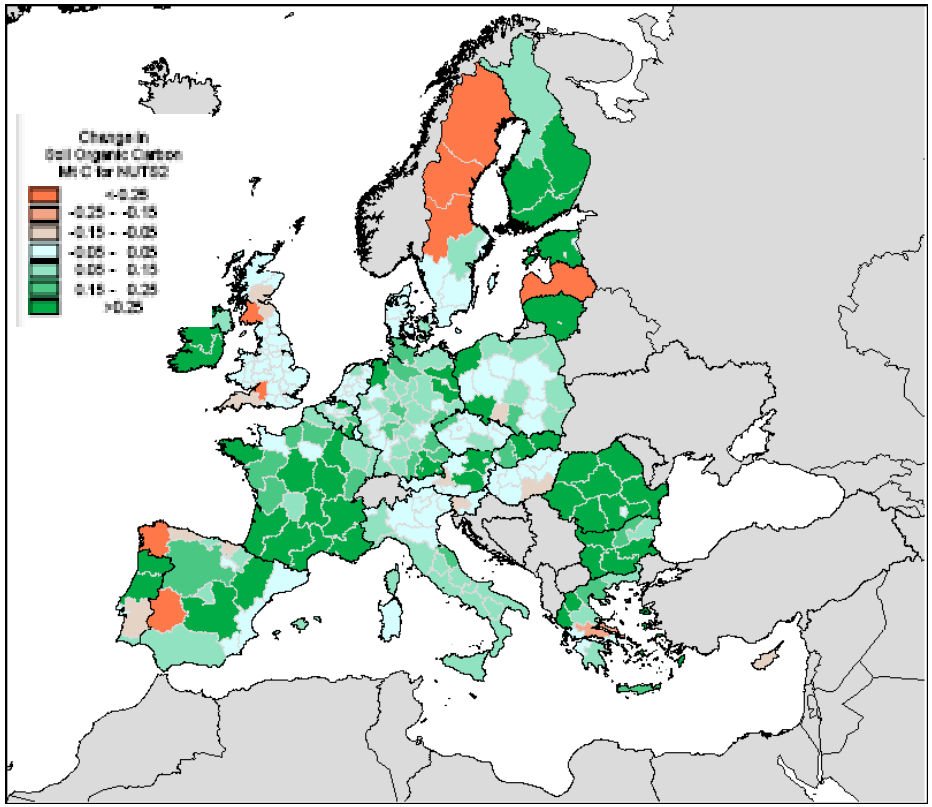
".. Agriculture …plays a key role in producing public goods, notably environmental such as landscapes, farmland biodiversity, climate stability and greater resilience to natural disasters ... At the same time, many ***farming practices*** *have the potential to put pressure on the environment, leading to soil depletion, water shortages and pollution, and loss of ..biodiversity. It is important to further unlock the agricultural sector's potential to mitigate, adapt and make a positive contribution through GHG emission reduction, production efficiency measures including …carbon sequestration and protection of carbon in soils based on innovation."*

Implementation of the CAP Policy Options with the Land Use Modeling Platform

EU-27 changes in LU-LC (2006-2020):

Net change(%)

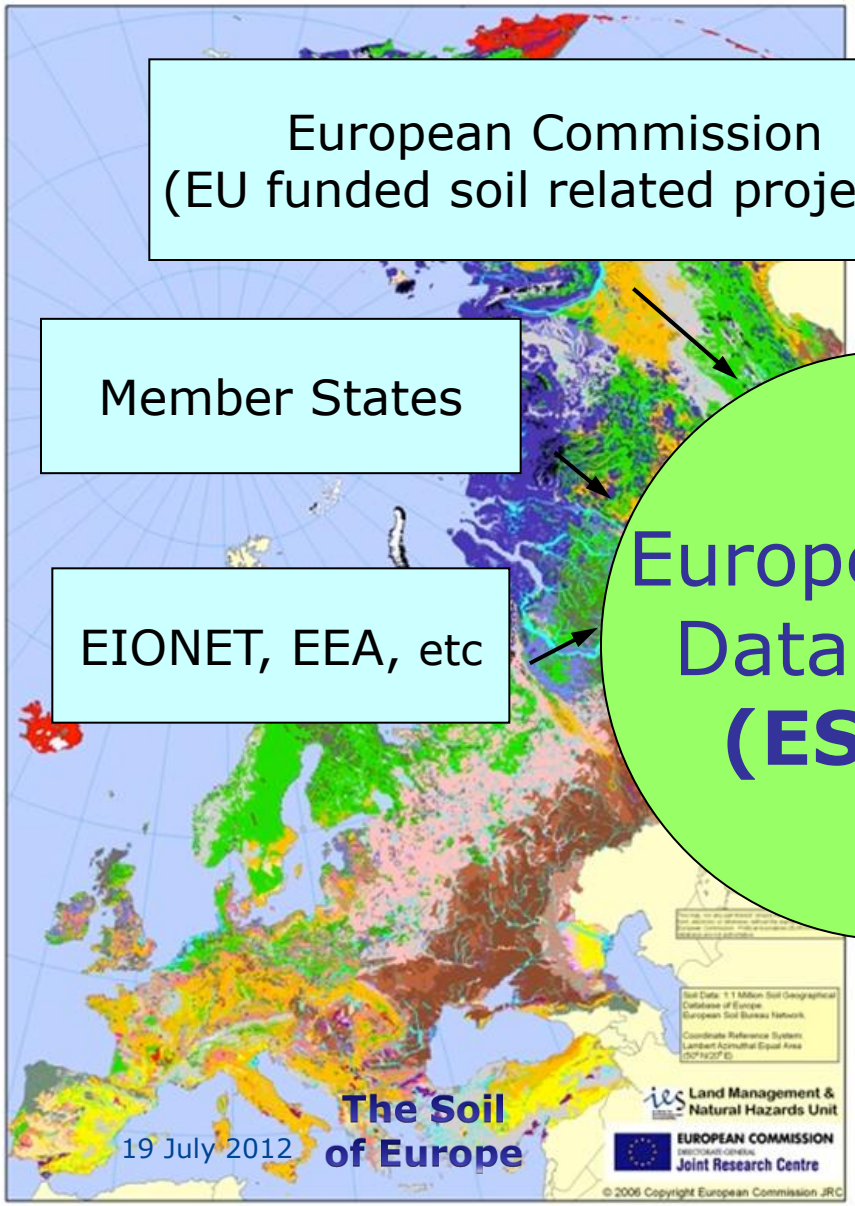




Estimated changes in SOC from Status Quo scenario to Integration policy option over 10 years (NUTS2)

Lavalle C., Baranzelli C., Mubareka S., Gomes C.R., Hiederer R., Batista e Silva F., Estreguil C. (2011)

Joint Research Centre



European Commission
(EU funded soil related projects)

Member States

EIONET, EEA, etc

European Soil Data Centre **(ESDAC)**

Data from specific in-house JRC actions (e.g. ESDB, SOTER)

Data from related JRC and EC actions (e.g. LUCAS, BIOSOIL)

Network of soil centres (e.g. ESBN)

Collaborative research (e.g. EuroGeoSurveys, FAO, ISRIC)

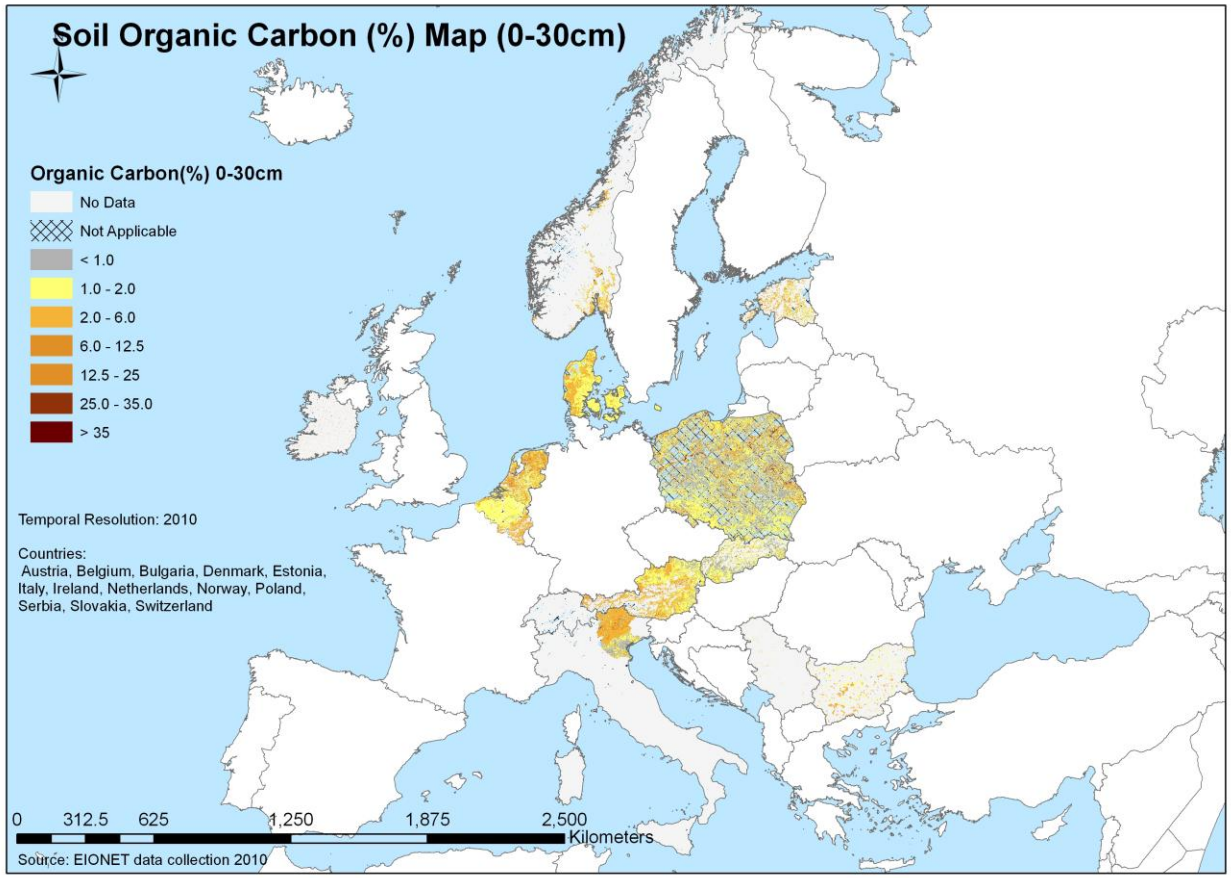
EIONET data collection: SOC

European Environment Information and Observation NETwork

Collection and organization of data, development and dissemination of information concerning Organic Carbon and Erosion in Europe.

Network for official reporting of Member States to EEA

8 countries provided datasets (Austria, Belgium, Bulgaria, Denmark, Italy, Netherlands, Poland, Slovakia) and 4 countries only points (Estonia, Norway, Serbia, Switzerland).



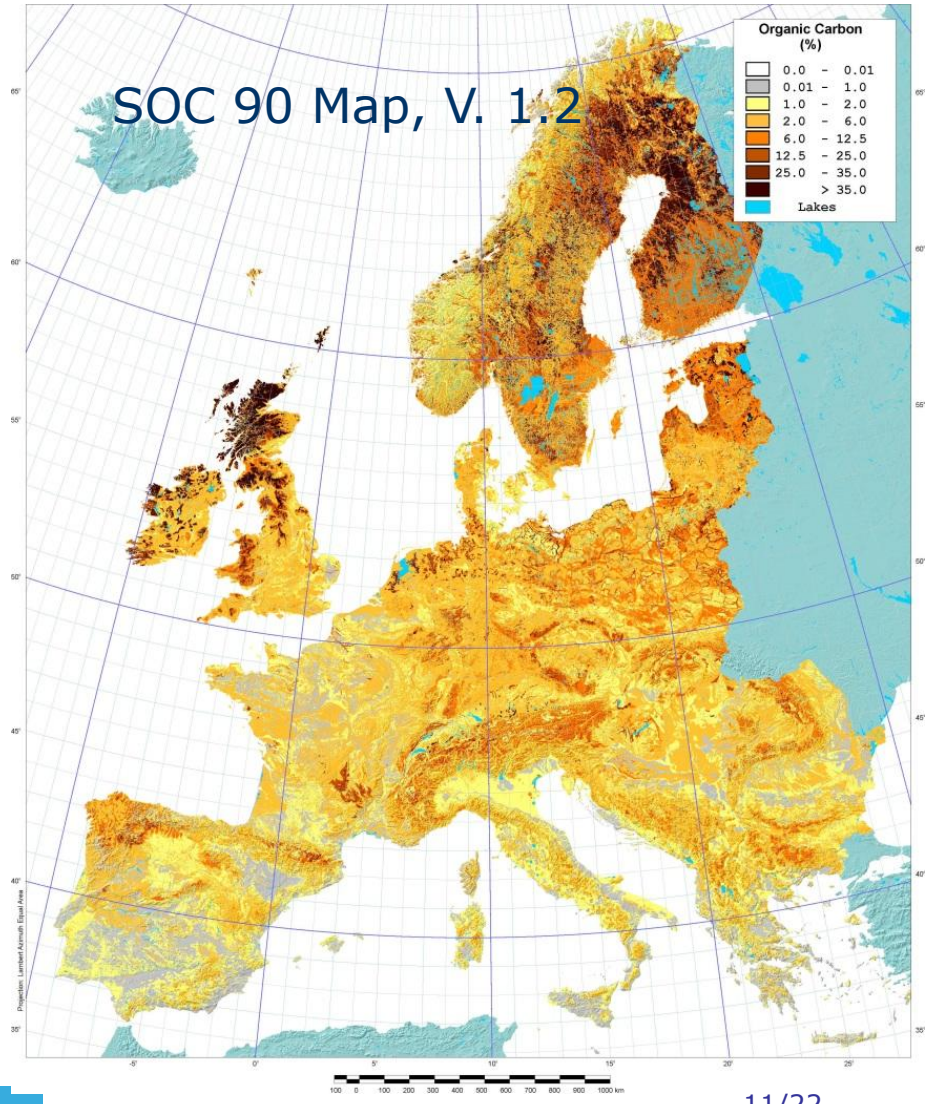
Panagos P. (2012)

European Topsoil SOC Content Map

European Commission

Spatial data layer of estimated OC contents in the upper 30cm of the surface horizon of soils in Europe.

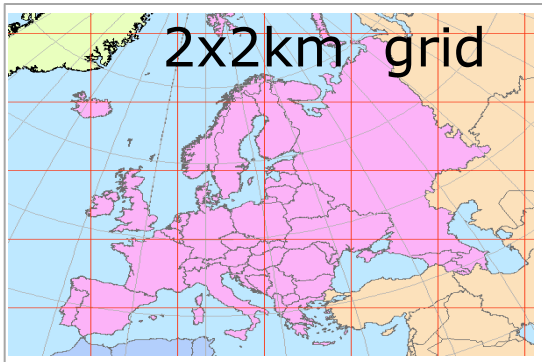
Produced by applying the revised PTR and temperature function to 1km spatial data layers of soil, land cover and climate.



Model output

Organic carbon content (%) in the surface horizon (0-30 cm) of soils: total 71 Gt C in EU
Jones et al., 2005

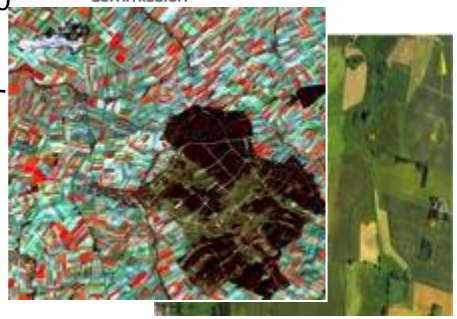
LUCAS project



A EUROPEAN
LAND USE / COVER
AREA FRAME
STATISTICAL SURVEY

1,000,000 points

Image 2000



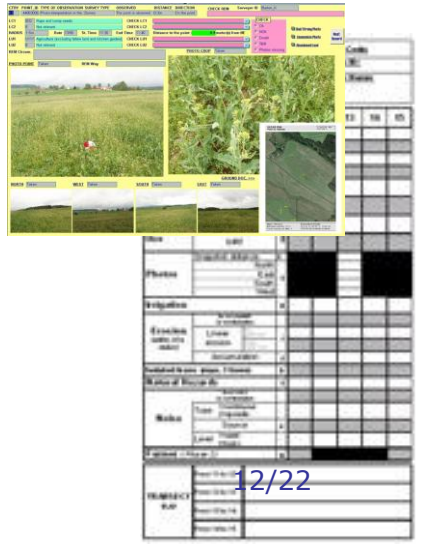
Ortho-Photos

Photo-Interpretation

Stratum	Points
Arable	uuuuu
Water	xxxxxx
Artificial	yyyyyy
Woodland	zzzzz

Sampling

235,000 points



Compute statistics

LUCAS soil survey 2009

Selection of point, based on LUCAS master grid (2 x 2 km), as a function of:

- country
- land use
- physiography
  - slope
  - aspect
  - elevation
  - slope
  - curvature, etc.

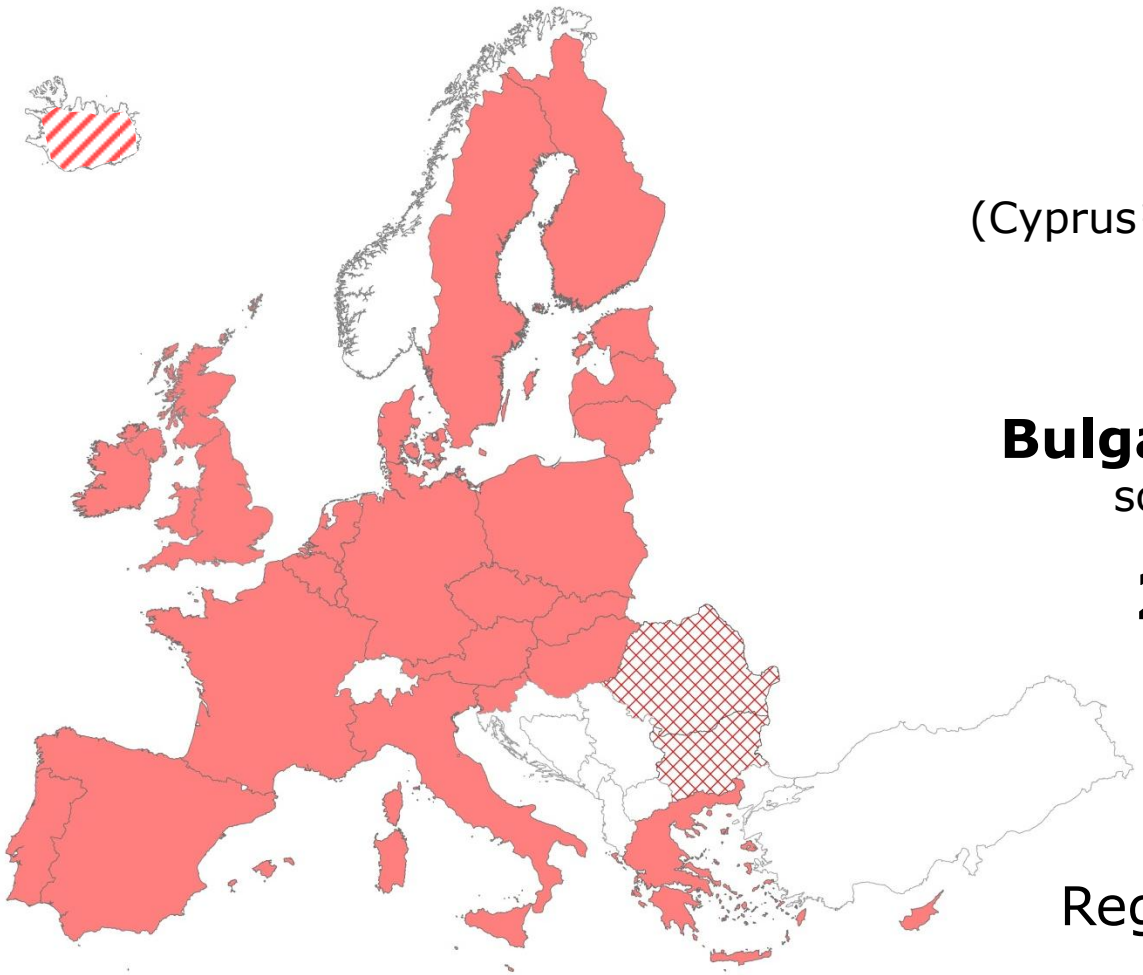
10 % = 22,000 ca sampling points (triplets)selected

SOIL PARAMETERS ANALYSED

Parameter	Unit	Decimals
Coarse fragments	%	0
Particle size distribution (FAO, 1990a)	-	-
Clay content	%	0
Silt Content	%	0
Sand Content	%	0
pH($CaCl_2$)	-	1
pH(H_2O)	-	2
Organic carbon	g/kg	1
Carbonate content	g/kg	0
Phosphorus content	mg/kg	1
Total nitrogen content	g/kg	0
Extractable potassium content	mg/kg	1
MULTISPECTRAL Properties (With diffuse reflectance measurements saturation)		
Cation exchange capacity	cmol(+)/kg	1

- 20,855 soil samples analysed
- Data stored in ESDAC and soil samples stored in JRC
- Processing of new soil information has started

LUCAS 2009: geographical coverage



2009
EU-27
(Cyprus[1], Malta[2], except Bulgaria and Romania)

2012
Bulgaria and Romania
soil survey on-going

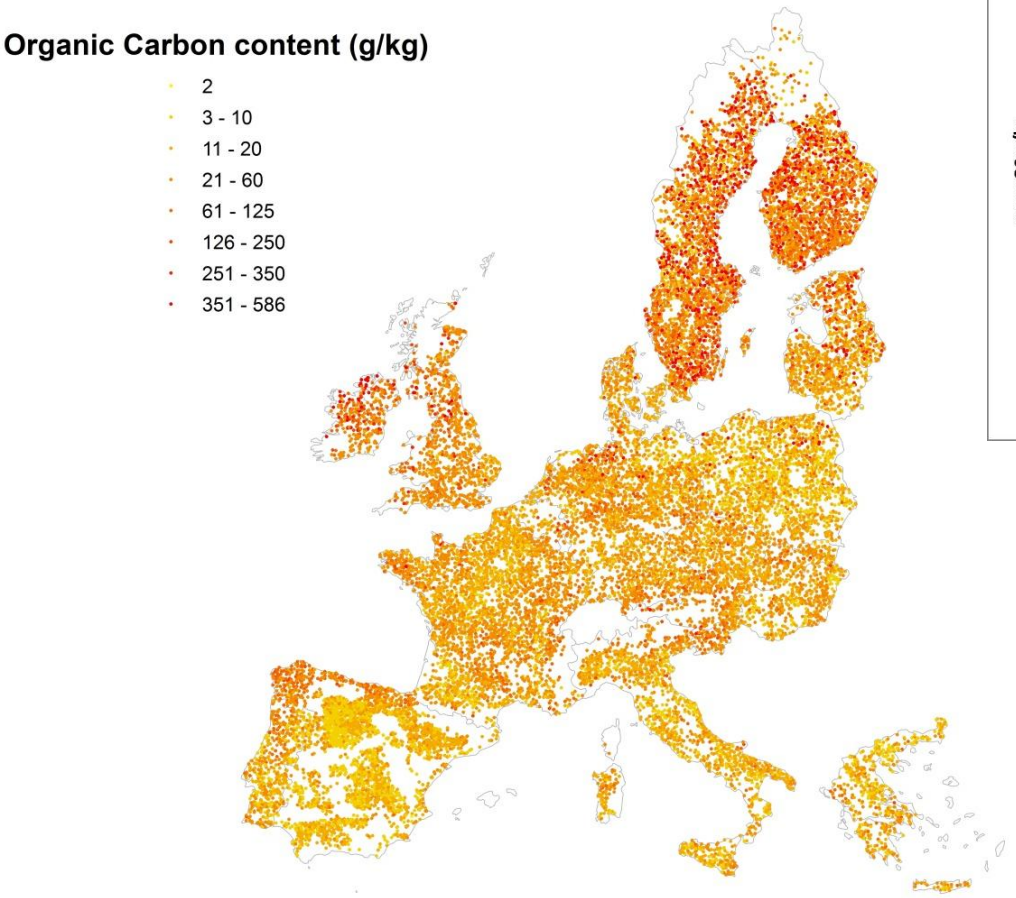
2012-2013
Iceland

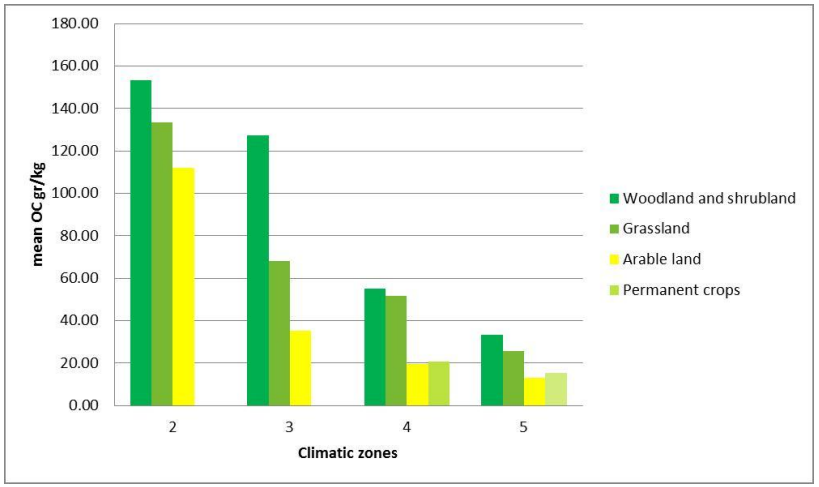
20xx
next[3]?
Regular monitoring?

[1] Cyprus has joined the survey on voluntary bases, adopted the same sampling methodology , but LUCAS LC-LU data are missing.
[2] Malta had difficulties to adjust the sampling grid for the LUCAS standards but samples are already included in LUCAS 2009.
[3]Next LUCAS soil surveys will include CANDIDATE COUNTRIES.

LUCAS 2009: data analysis

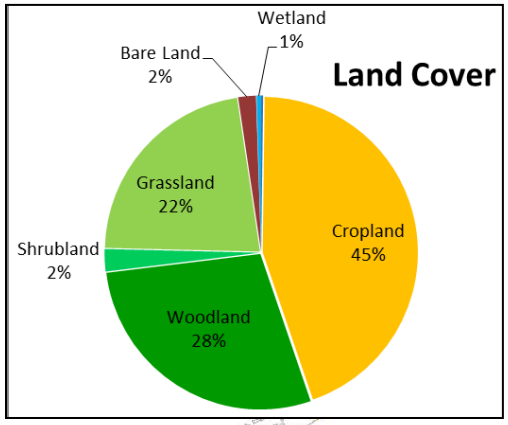
19,879 soil samples



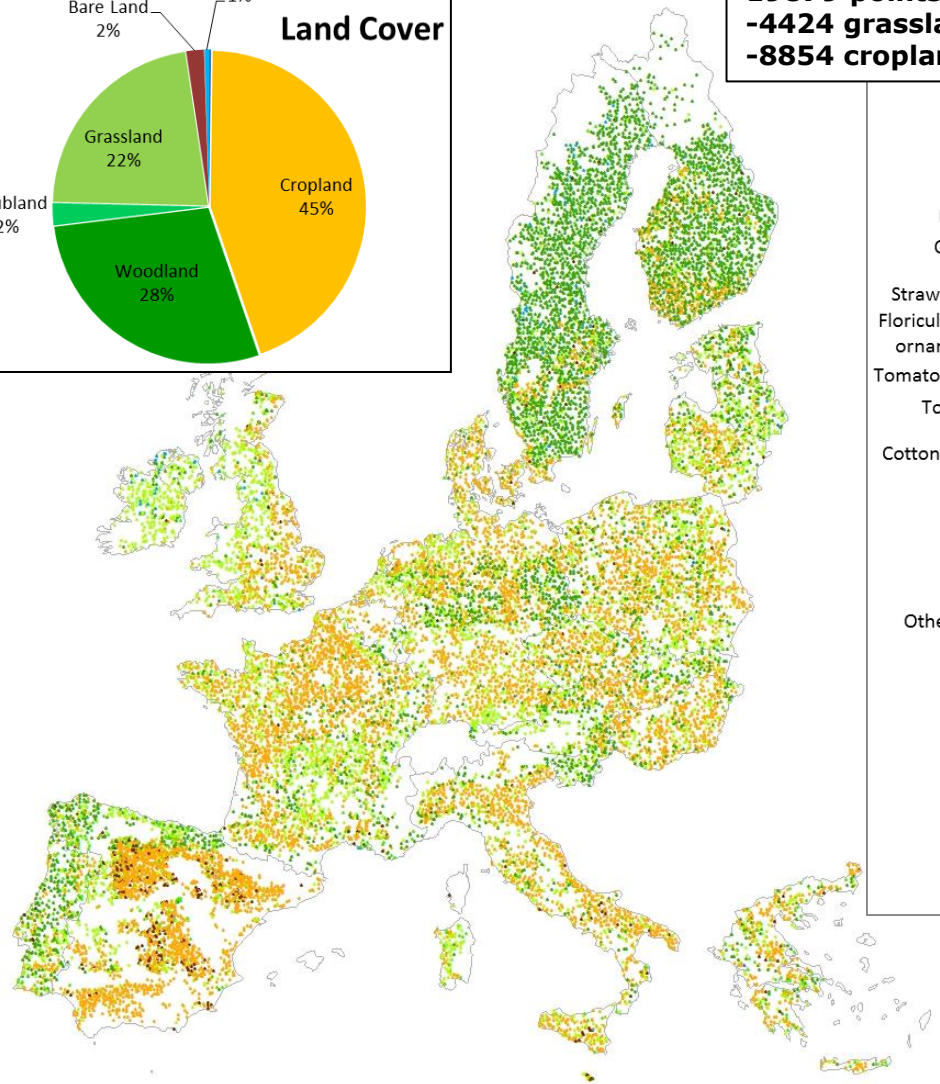


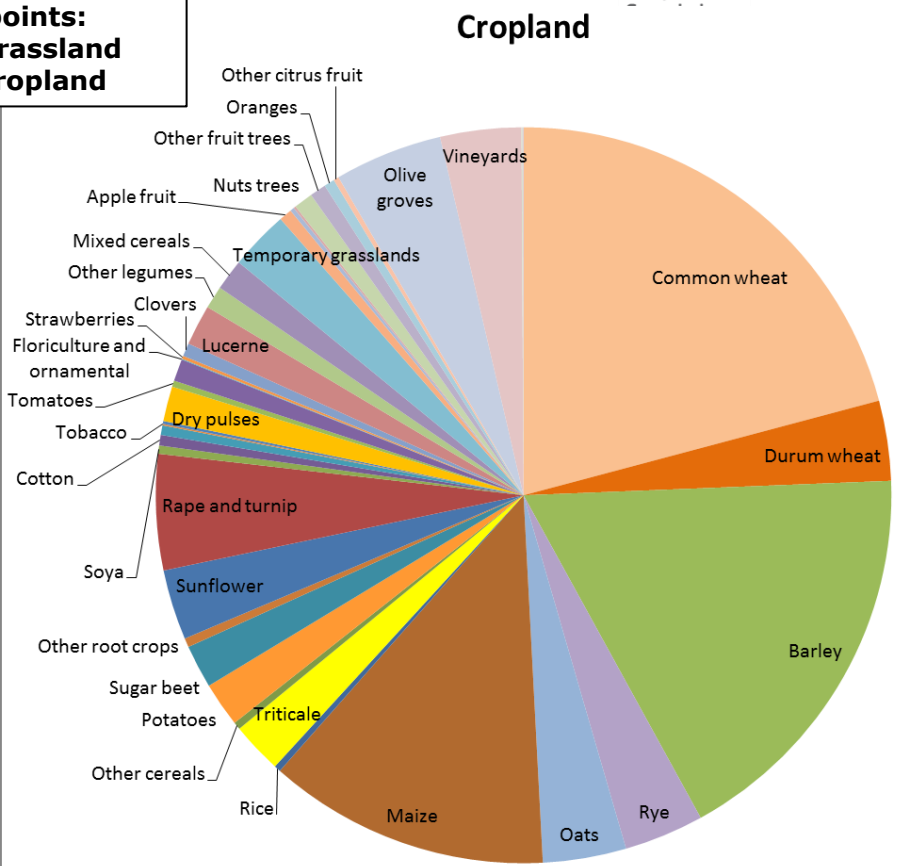
ON-GOING: interpolation of LUCAS Soil Organic Carbon points for creating a map using geostatistical method.

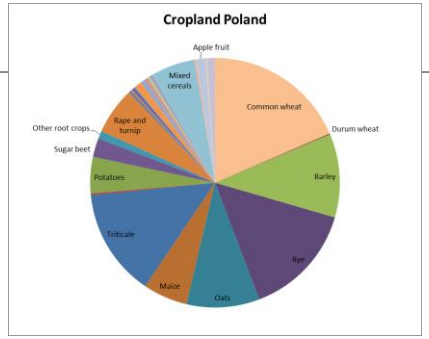
LUCAS 2009: Land Cover

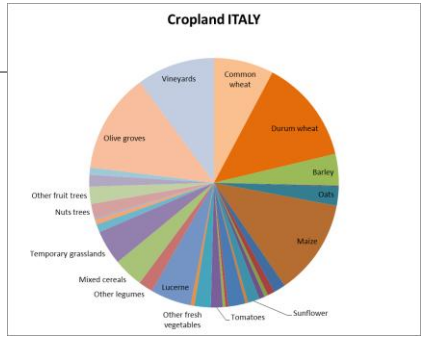


19879 points:
-4424 grassland
-8854 cropland







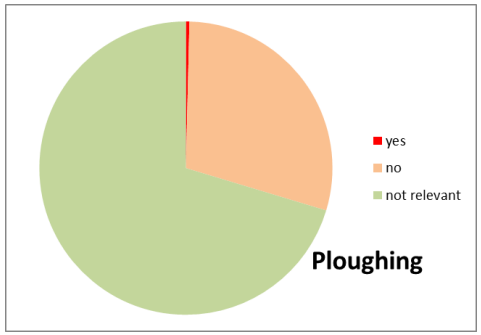


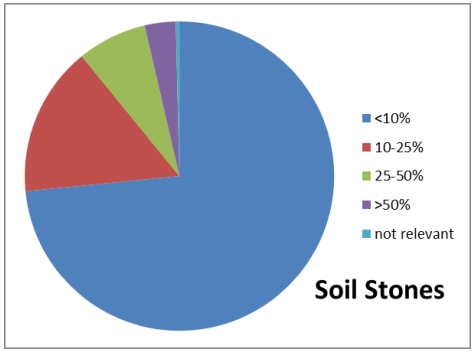
19 July 2012

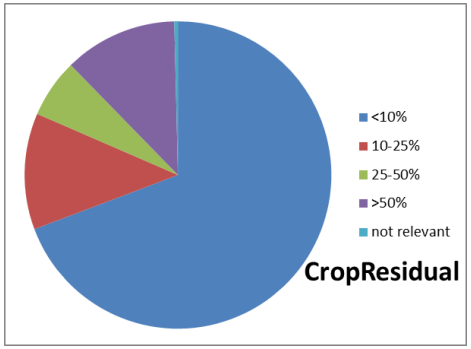
Joint Research Centre

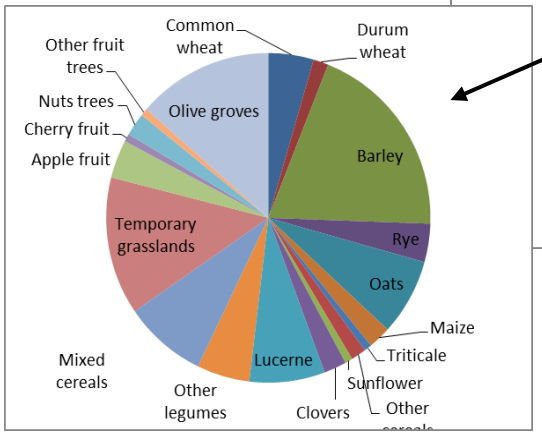
LUCAS 2009: Land management

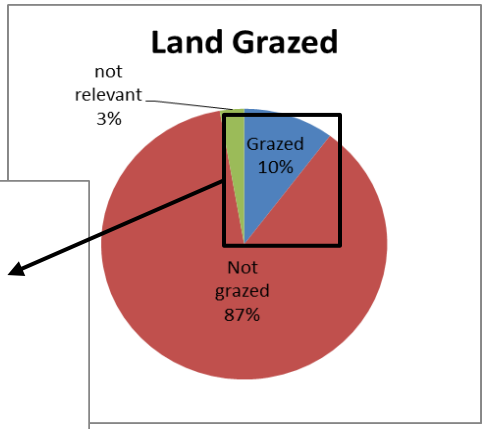
European Commission

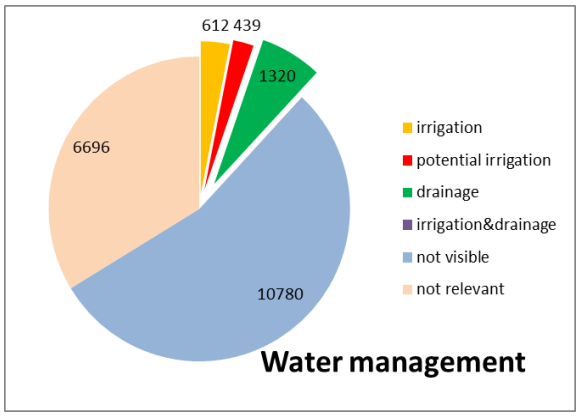


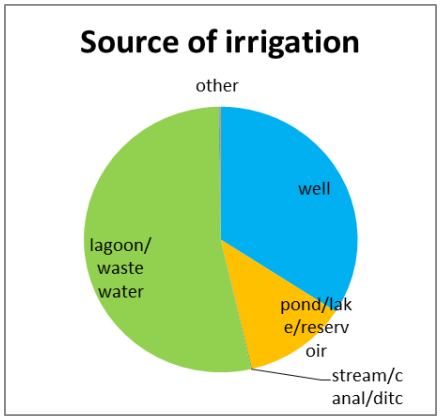


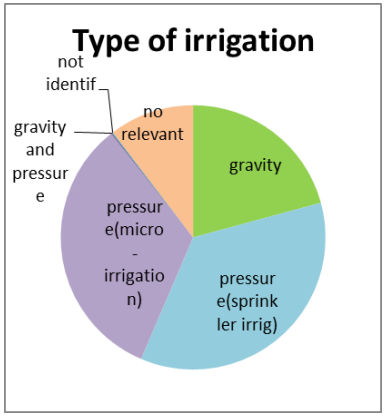


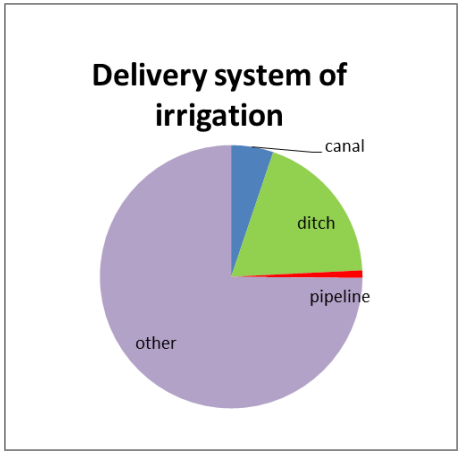












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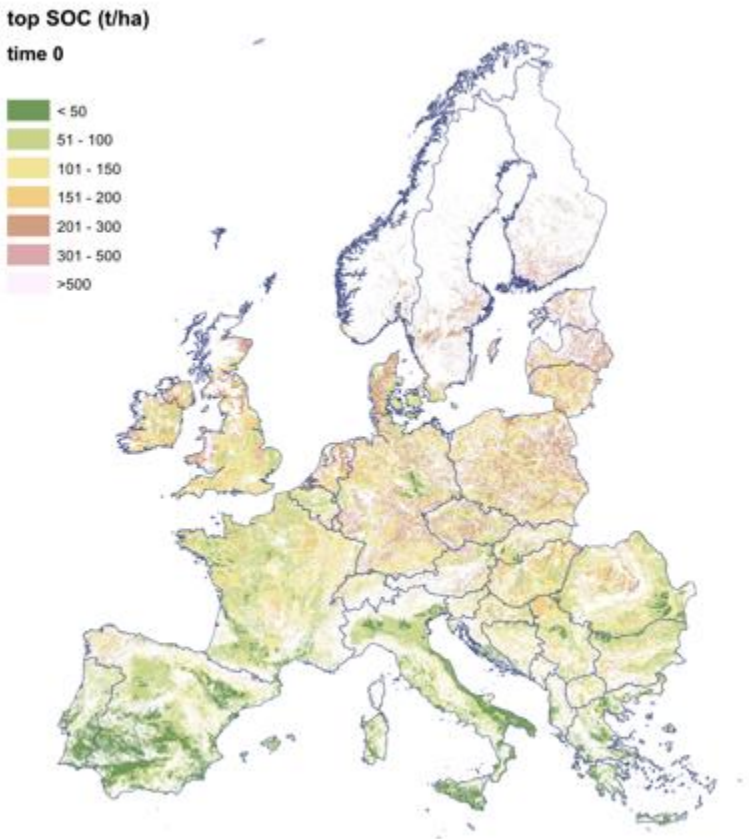
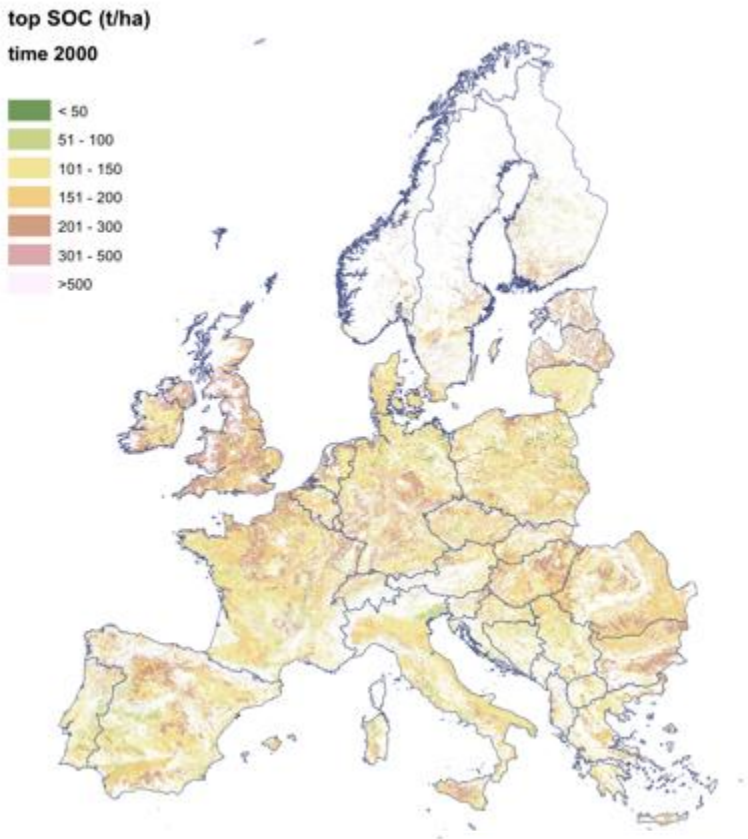
CAPRESE project

European Commission

From Cropland to Permanent grassland

Century Model



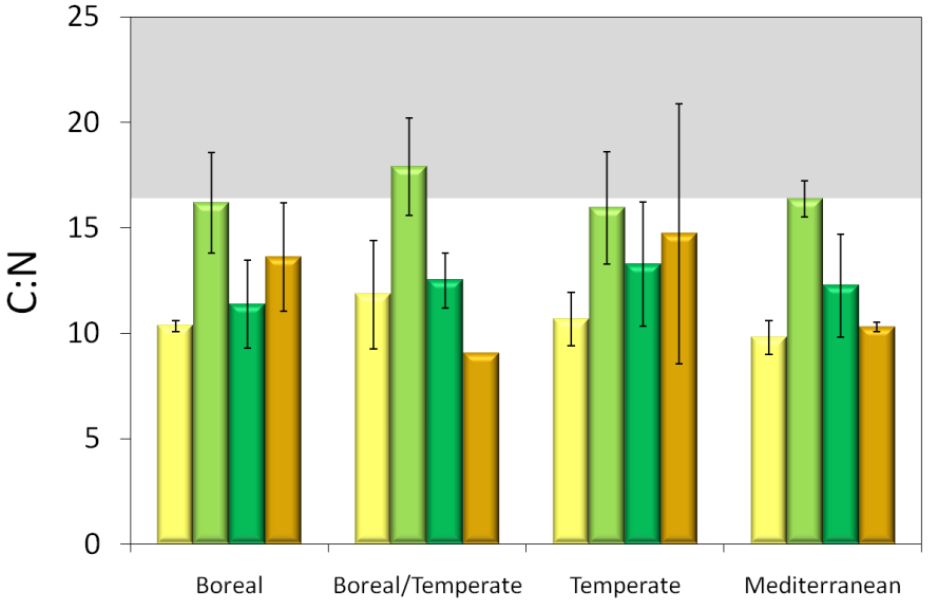


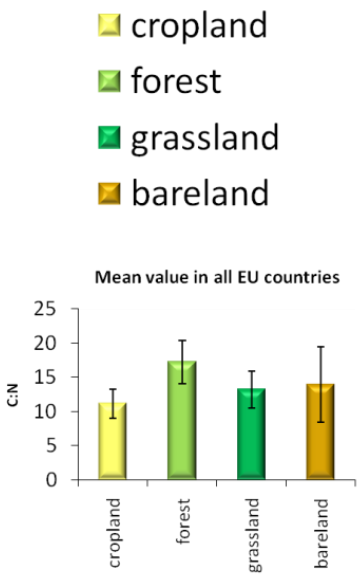
Lugato E. (2012)

Potential Sequestration

C and N limitation in LUCAS soils ?

A soil C:N <16 indicates C limitation – A soil C:N ratio of >16 indicates soil N limitation





Grey area demonstrates N limitation- White area C limitation

Guicharnaud R.A., (2012)

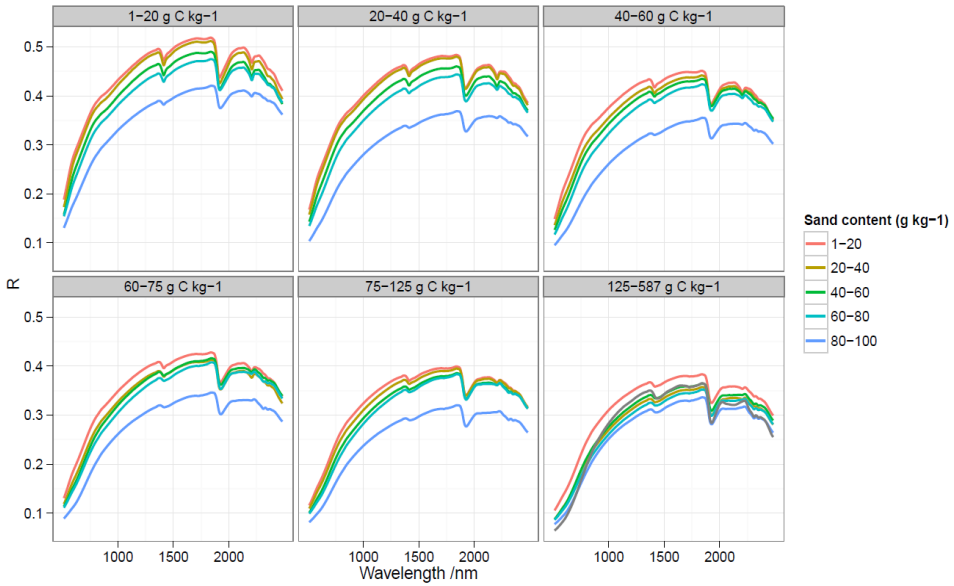
Premilinary results suggest:

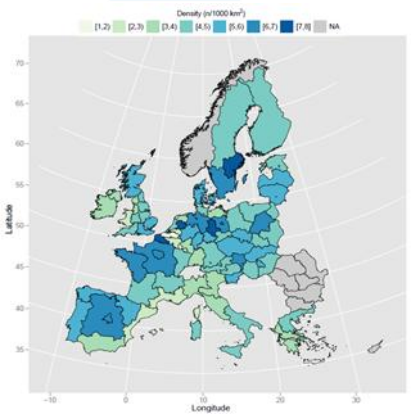
- **Soil C:N ratios** demonstrate that plant available C is rather a limiting factor in MS soils rather than N (cropland, grassland and bare land)
- Forested soils tend to be N limited
- No specific trend was observed between climatic regions

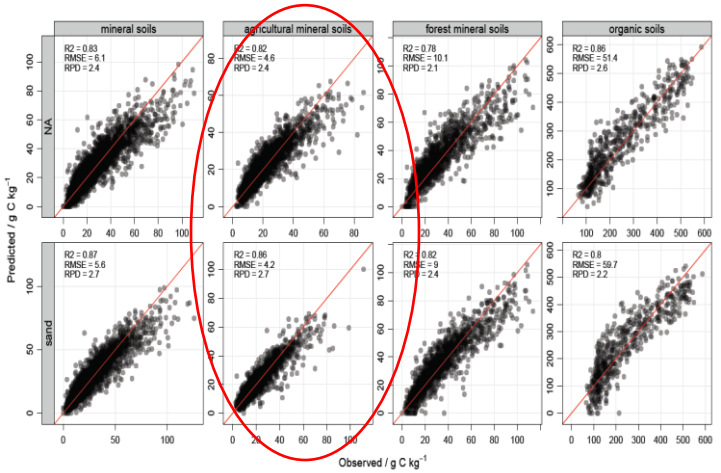
LUCAS spectral library for SOC prediction

European Commission

- 23 European countries
- ~20,000 spectral readings in the Vis-NIR region (400-2500 nm)
- Metadata:
  - Clay, silt, sand, OC, pH, CEC, CaCO3 content
  - Geographical coordinates, land use, etc







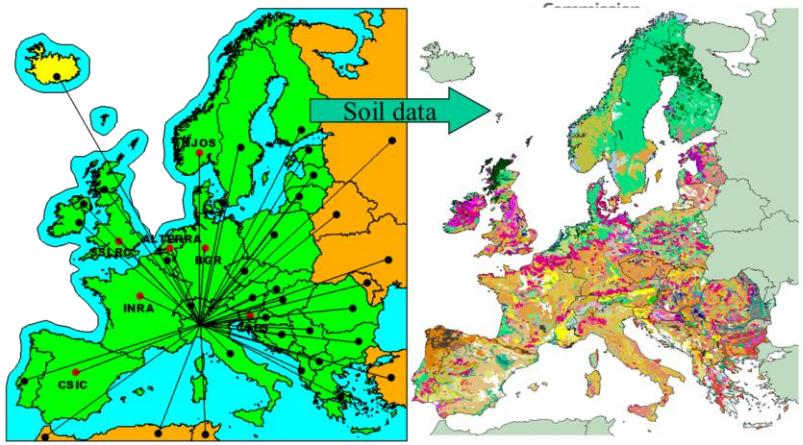
The low bias and the reasonable accuracy indicate that Vis-NIR spectroscopy can be used for national/sub-national scale (NUTS0, NUTS1) monitoring of SOC

Nocita M. (2012)

NETWORKS

- **ESBN**

European Soil Bureau Network



- **EIONET**

European Environment Information and Observation Network

- **HWSD Harmonized World Soil Database**
- **IPCC (Intergovernmental panel on Climate Change)**
- **Global Soil Partnership**

GLOBAL SOIL PARTNERSHIP

- **Global Soil Map.net** www.globalsoilmap.net

Thank you for your attention

Francesca Bampa

European Commission, JRC - Institute for Environment and Sustainability - Land Resource Management

EU SOIL PORTAL http://eusoils.jrc.ec.europa.eu/

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