
Organic matter content of Croatian soils: Regional differences and effect of agricultural management

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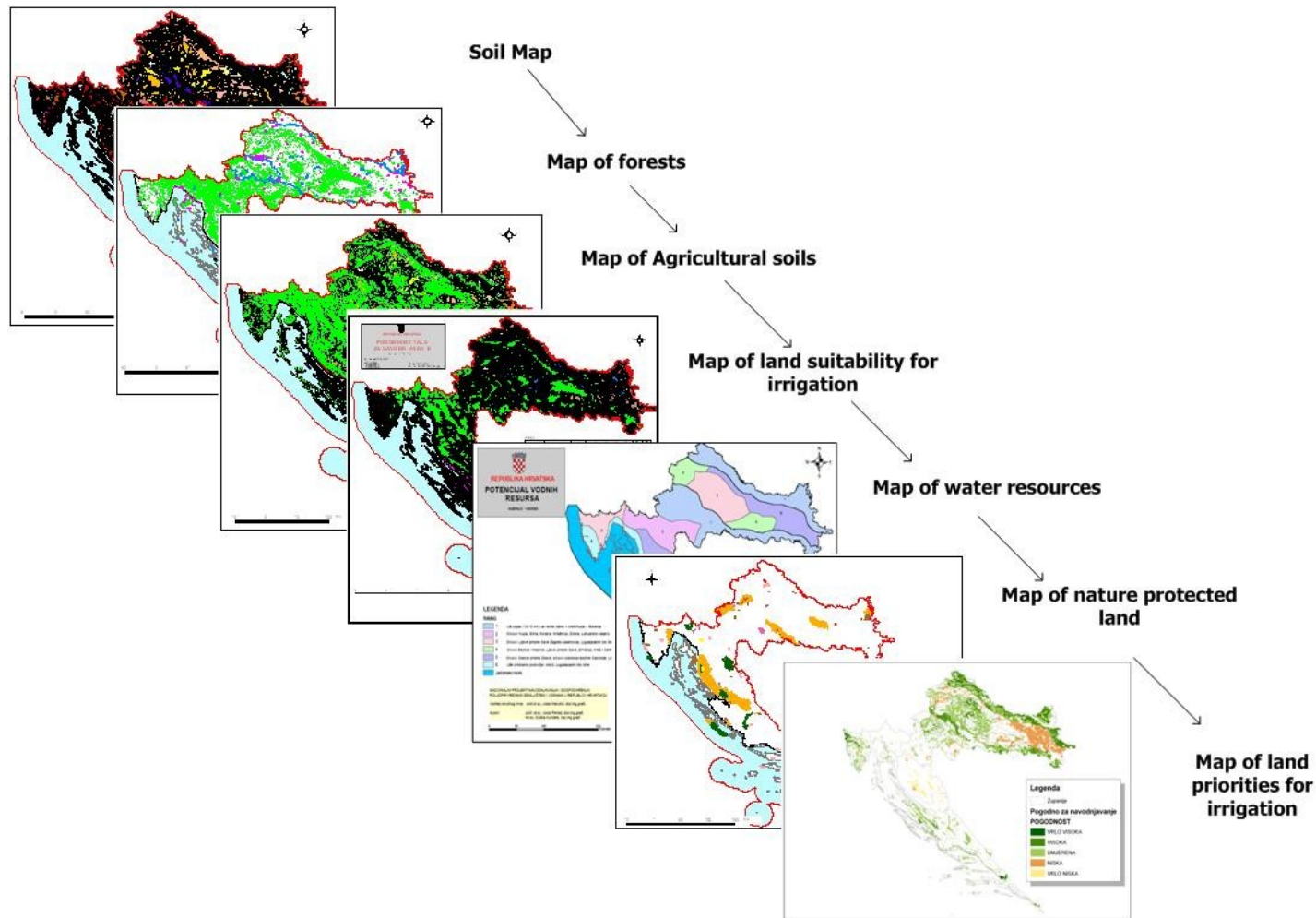
Soil survey and soil protection policy in Croatia

state-of-the-art

- **Soil survey** is carried out by numerous institutions, often as part of applied programmes with objectives that vary from basic soil mapping to farming systems research;
 - **Soil protection legislation** have not been consistently adopted so far, though the **EU Framework directive for soil protection** is a priority action
 - **Soil monitoring programme** was prepared but not applied, so far
 - Theoretical structure of the **national soil database** has also been established
- HIST is waiting to be financed

Applications

- › Soil survey information is widely applied in Croatia, so that almost all soil surveys have a practical purpose
- › In recent years there has been an increase in the range of suitability maps, reflecting the spread of environmental and agricultural interest



Research on OM content of Croatian soils

- One of the threats identified in the process of harmonizing the soil protection legislation with the EU demands is **a decline in organic matter in soils**
- A thematic digital database on **SOM** doesn't exist in spite of the comprehensive information available
 - most of the data were collected by the project of **Basic Soil Map of Croatia** (scale 1:50000) being carried out from 1964 to 1987
- In general, all the historical data on **SOM** from different databases should be judged for the possible disparities within the data, compared and harmonized before being entered into the new digital database
- Future data collection

Research on OM content of Croatian soils

- Future data collection have to be standardized, in terms of
 - sampling procedure
 - laboratory analysis
 - data management and long-term quality control
 - statistical methods and spatial data representativeness
- Ongoing project “**Geochemical mapping of agricultural soils of Croatia**” (Romic, M.) deals with spatial distribution of
 - **trace elements levels** and
 - **soil organic matter content**

Project structure

- **datasets:** actual measurements of the number of environmental variables captured in the field and lab analysis
- **reports:** user manual for the sampling, standard operating procedures (lab), data quality reports, literature reviews, discussion documents and scientific articles
- **software for analysing environmental research data:** statistical and geostatistical software; geostatistical models development
- **imageries:** photographs, remotely sensed images, aerial photography, topography maps, cadastre etc.
- **cartographical output or GIS output:** GIS map layers, datasets with geographical objects and geographical coordinates

Datasets

Main variables:

‣ **organic matter content**

‣ pH

Ni,

‣ Al, Ba, Ca, Cd, Co, Cr, Cu, Fe, Hg, Mg, Mn,
P, Pb, S, Sr, V, Zn

‣ texture

Top-soil:

‣ 0 – 30 cm

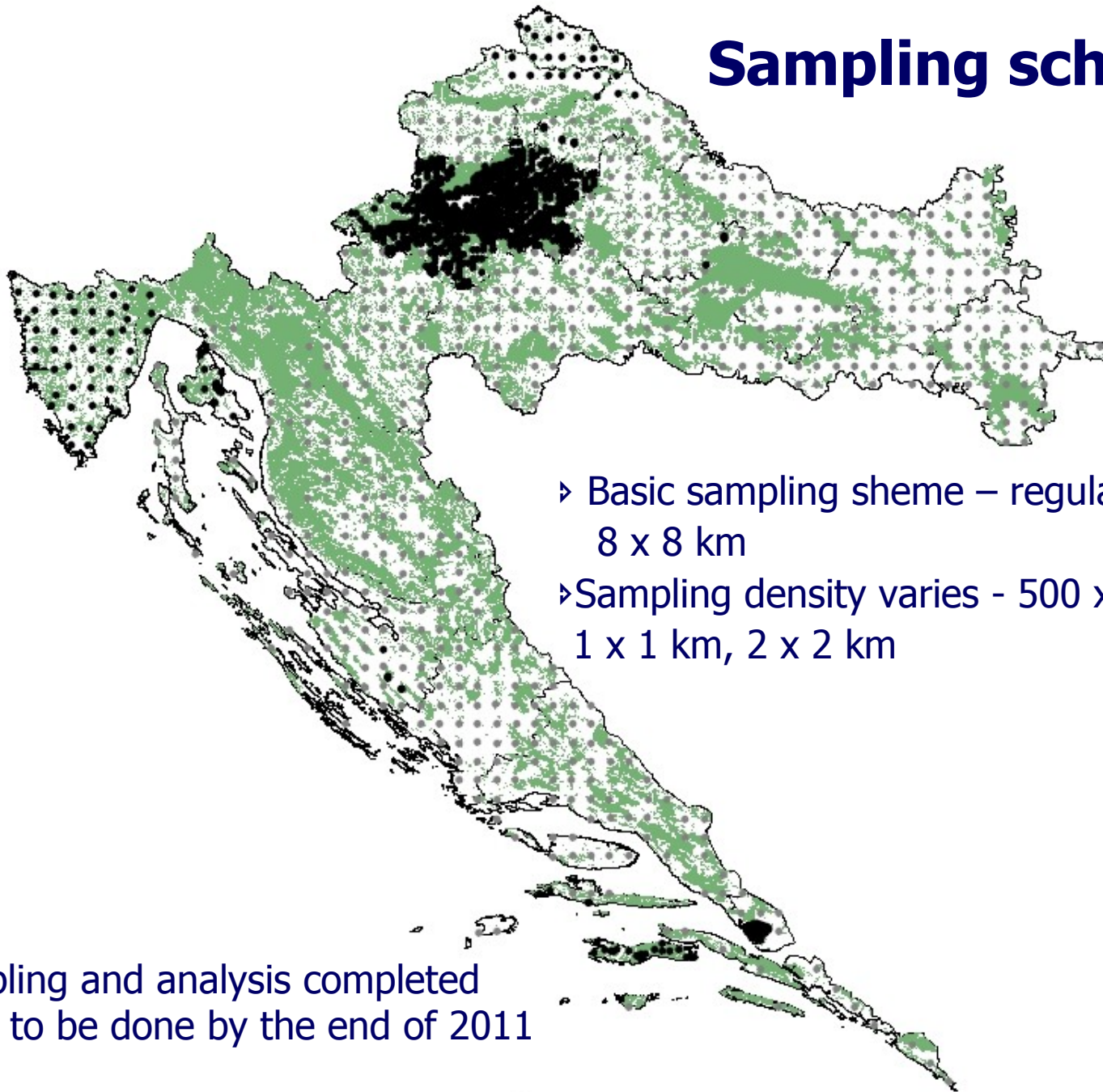
Sub-soil:

‣ 30 – 60 cm

Soil profiles:

‣ representative for soil type and land use

Sampling scheme

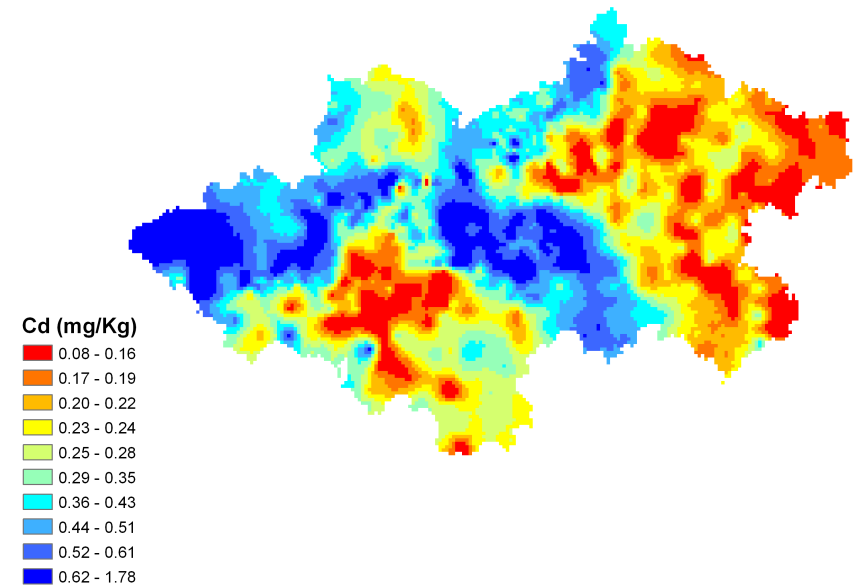
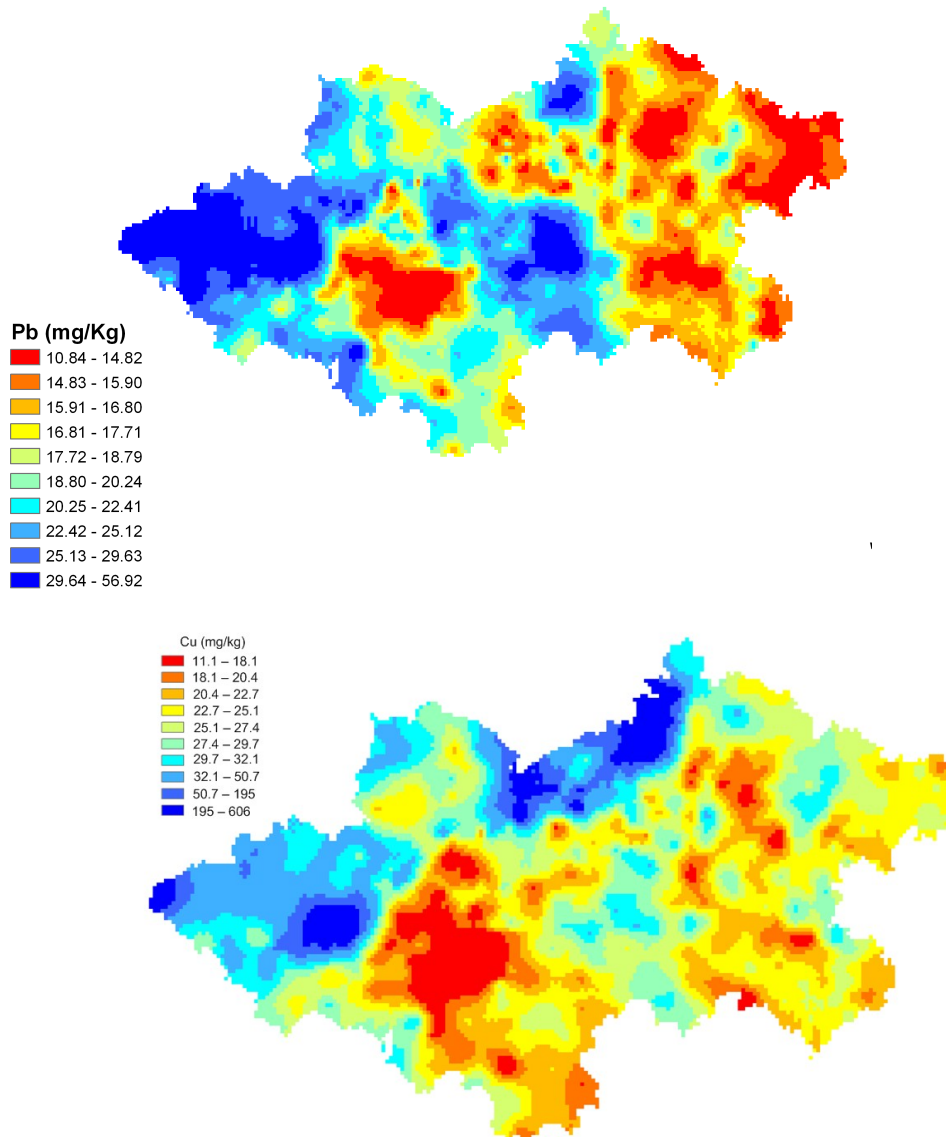


- › Basic sampling scheme – regular square grid 8 x 8 km
- › Sampling density varies - 500 x 500 m, 1 x 1 km, 2 x 2 km

- Sampling and analysis completed
- Have to be done by the end of 2011

Corregionalized model applied

Co-kriging maps of heavy metals



Castrignàno, A., Romić, M. 2007. Application of multivariate geostatistics to describe soil pollution by heavy metals in Northwestern Croatia. Computational Environmentrics, TIES2007



NW Croatia – Sava – Drava – Mura Rivers

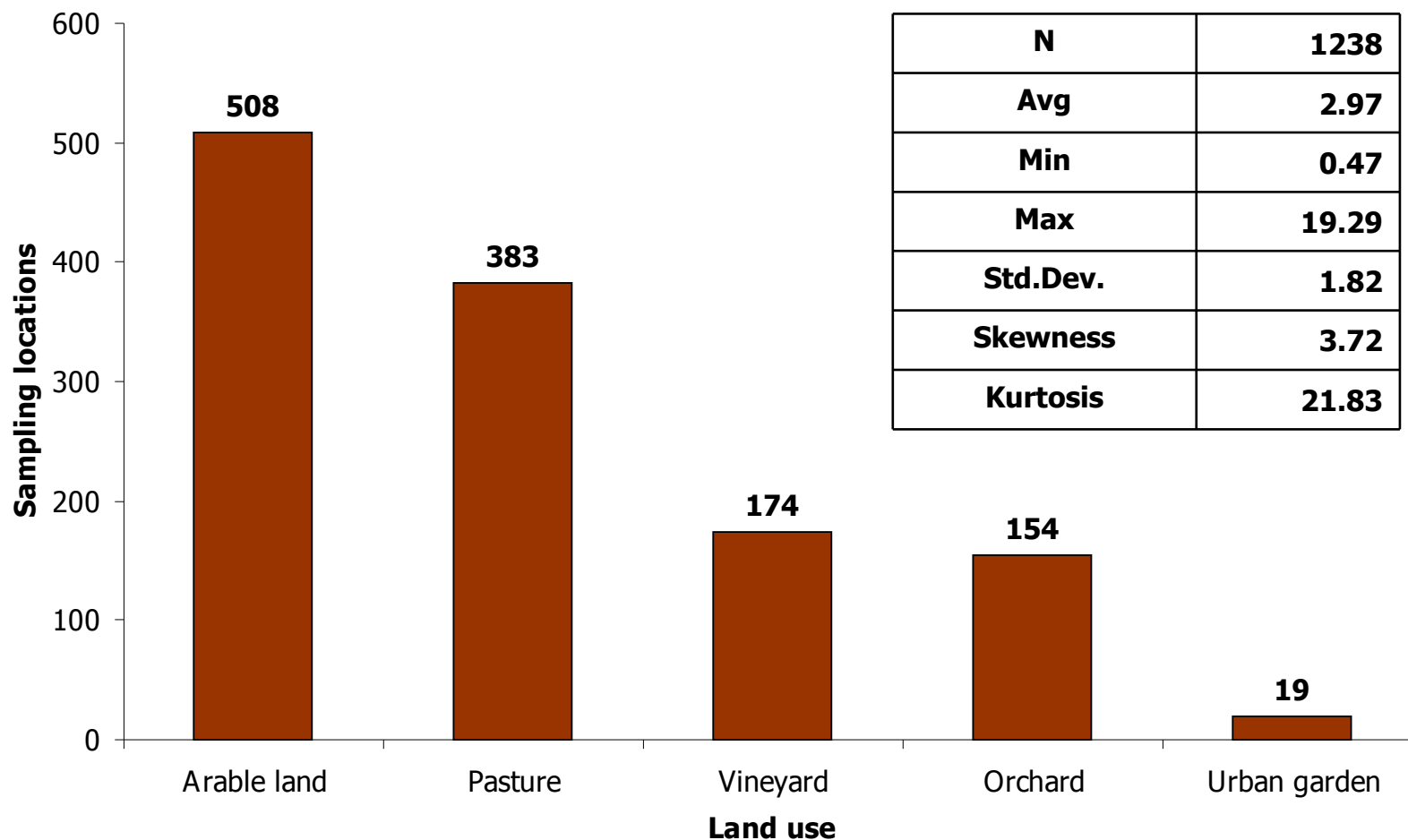
Istra and Kvarner islands

South Croatia Islands and Neretva River Valley

Different land use history influences soil properties and therefore soil functioning

- different types of agricultural land use may result in different soil condition even within one soil series
- **SOM** can be considered a suitable integrating soil parameter indicating soil quality within a given soil series
- the existing 1:25000 geochemical soil survey was used to select 4 regions studied to
 - **derive a quantitative relation between SOM content and management and cropping history**

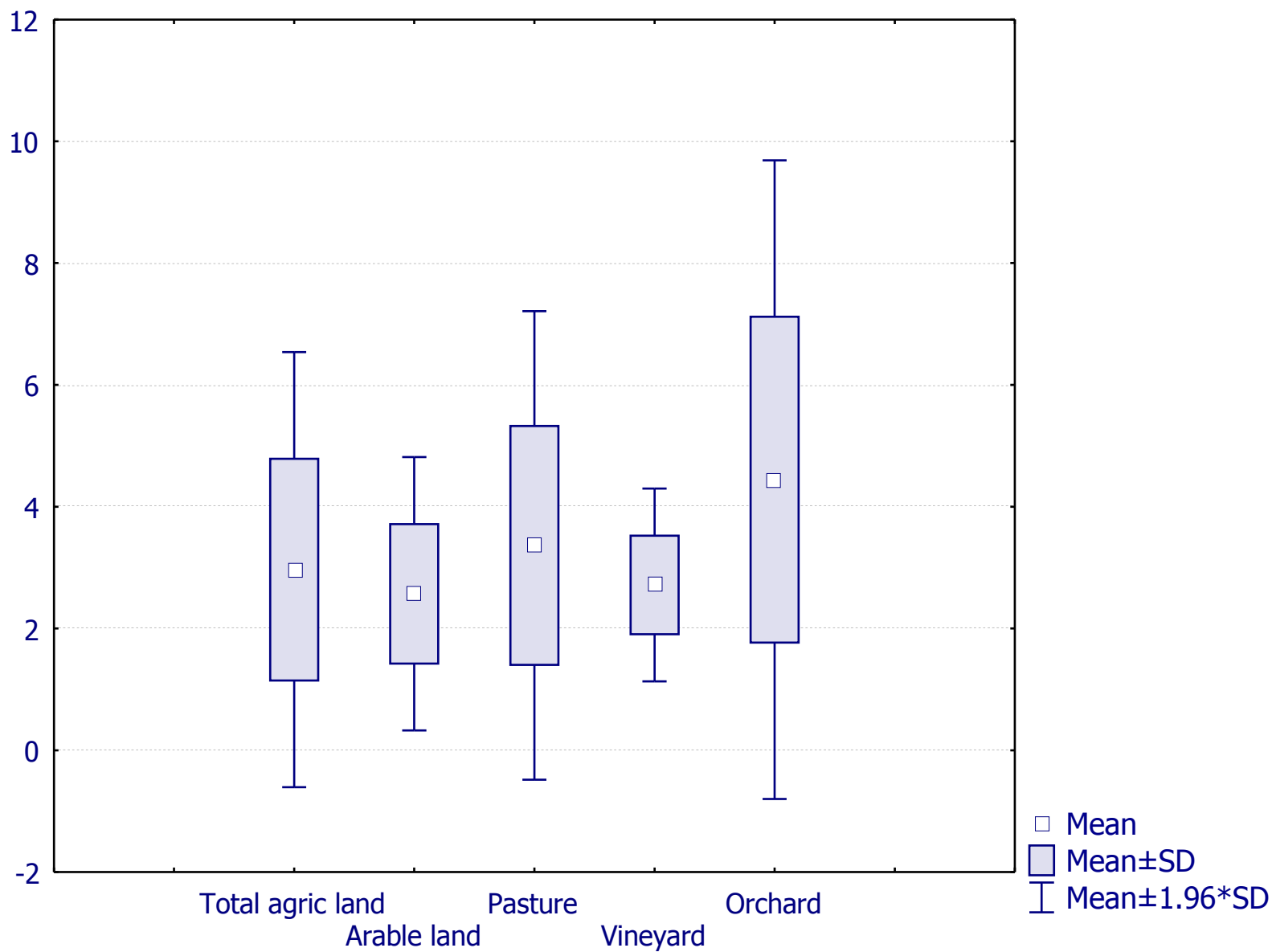
1238 sampling locations in totals (processed so far)



Statistical summary (SOM %)

Land use

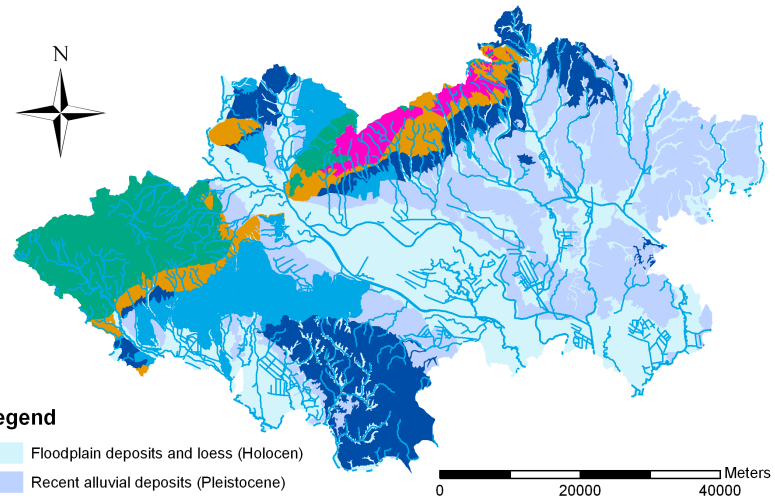
	Total agricultural land	Arable land – cereals and vegetables	Pasture	Vineyards	Orchards
N	1238	966	382	178	156
Mean	2.97	2.57	3.36	2.71	4.45
Median	2.54	2.30	2.96	2.62	3.82
Min	0.47	0.47	0.45	0.57	1.33
Max	19.29	11.2	16.1	5.86	19.3
St.Dev.	1.82	1.14	1.96	0.81	2.67
Skweness	3.72	1.66	2.72	0.71	3.48
Kurtosis	21.83	5.35	11.5	1.45	13.8



Geological and soil type heterogeneity

- ▶ **OM** - the most naturally occurring complex mixture on earth
- ▶ **SOM** reactivity depends on a number of factors
 - sources, structures, and stage of organic matter oxidation
 - depositional environments (terrestrial SOM, marine-derived OM, fluvial deposits ...)
 - spatial dynamics - erosion and redeposition
- **We tried to identify possible regional differences in SOM content regarding different natural features**

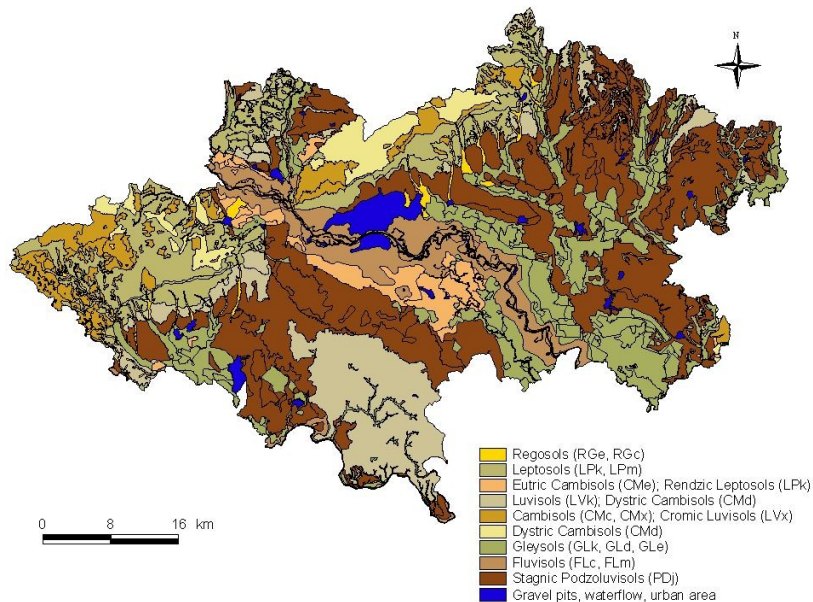
Geology and hydrology



Legend

- Floodplain deposits and loess (Holocen)
- Recent alluvial deposits (Pleistocene)
- Alluvial deposits (Plio-Pleistocene)
- Terraced alluvial deposits (Pliocene)
- Piedmont terraced deposits (Miocen)
- Limestones and dolomitic limestones (Mesozoik)
- Volcanic and metamorphic complex of the earth crust (Paleozoik)

Soil types

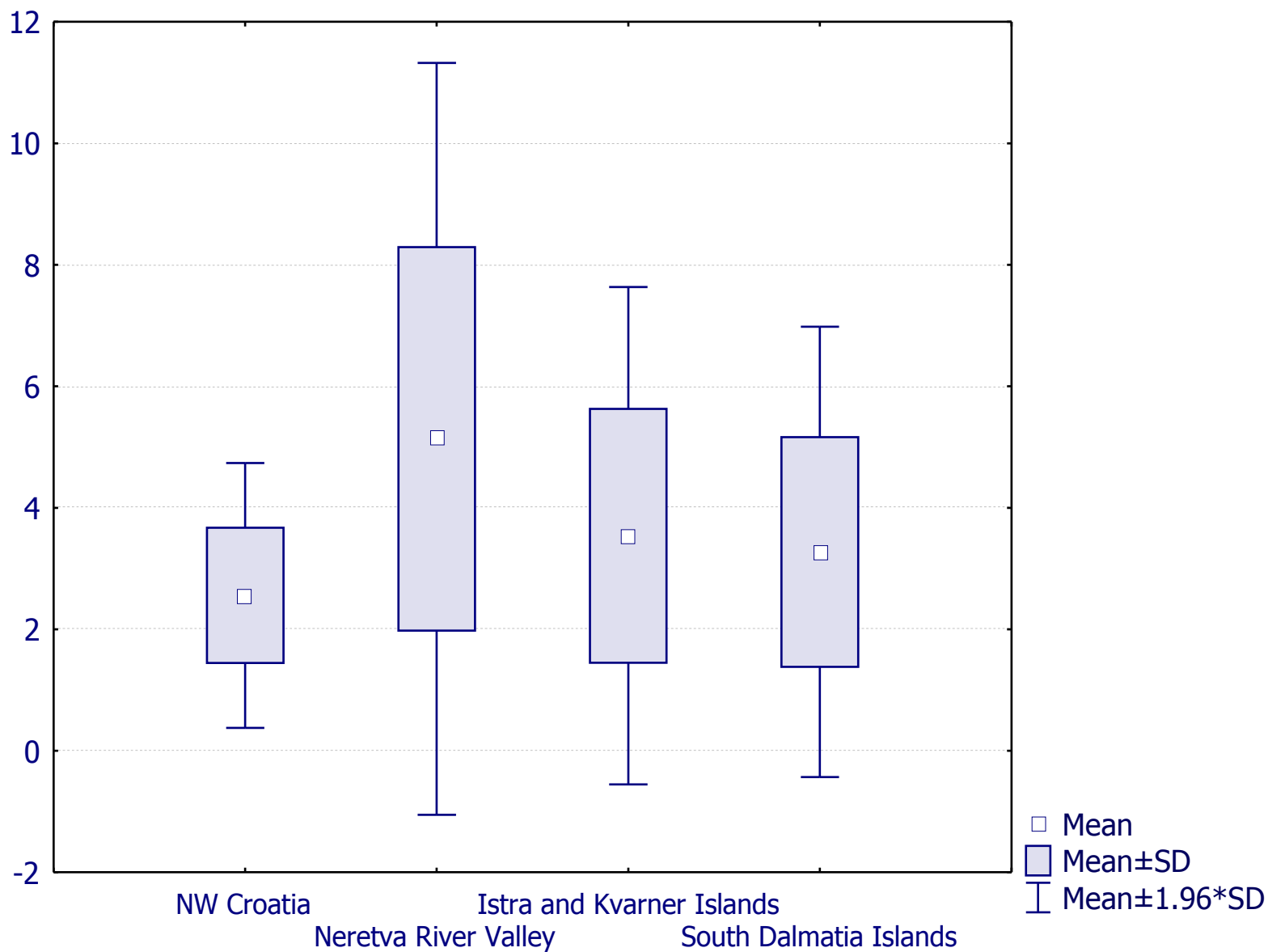


- Regosols (RGe, RGc)
- Leptosols (LPk, LPm)
- Eutric Cambisols (CMe); Rendzic Leptosols (LPk)
- Luvisols (LVk); Dystric Cambisols (CMd)
- Cambisols (CMc, CMx); Cromic Luvisols (LVx)
- Dystric Cambisols (CMd)
- Gleysols (GLk, GLd, GLe)
- Fluvisols (FLc, FLm)
- Stagnic Podzoluvisols (PDj)
- Gravel pits, waterflow, urban area

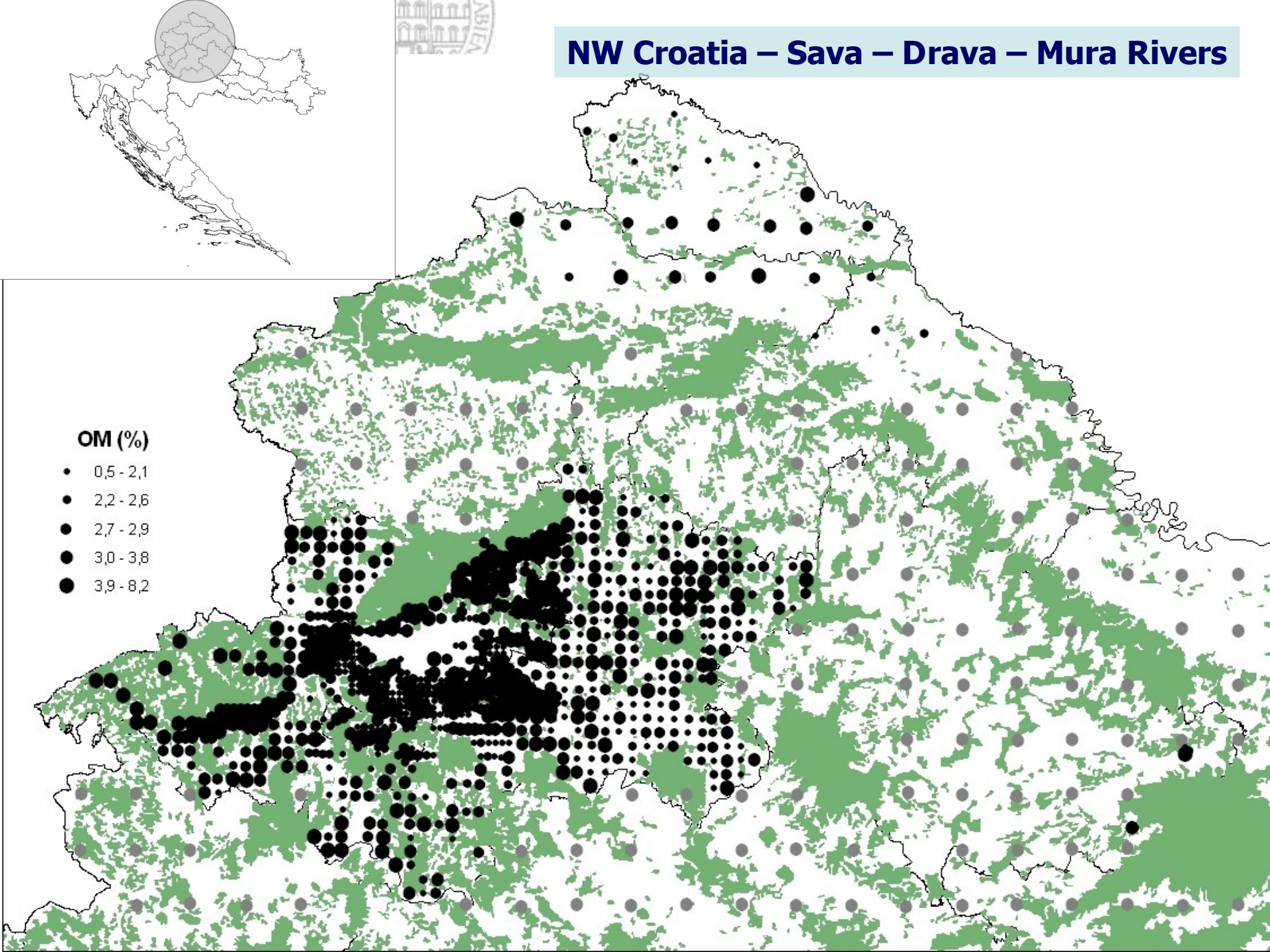
Statistical summary (SOM %)

Regional differences

	Total agricultural land	NW Croatia Sava – Drava – Mura River plains	Istra and Kvarner Islands	South Dalmatia Islands	Neretva River Valley
N	1238	962	93	31	152
Mean	2.97	2.56	3.54	3.28	5.13
Median	2.54	2.29	2.91	2.91	4.20
Min	0.47	0.47	1.64	1.29	2.45
Max	19.3	8.19	13.6	11.2	19.3
St.Dev.	1.82	1.11	2.09	1.89	3.16
Skweness	3.72	1.35	2.66	2.88	2.70
Kurtosis	21.83	2.65	8.27	10.3	7.06

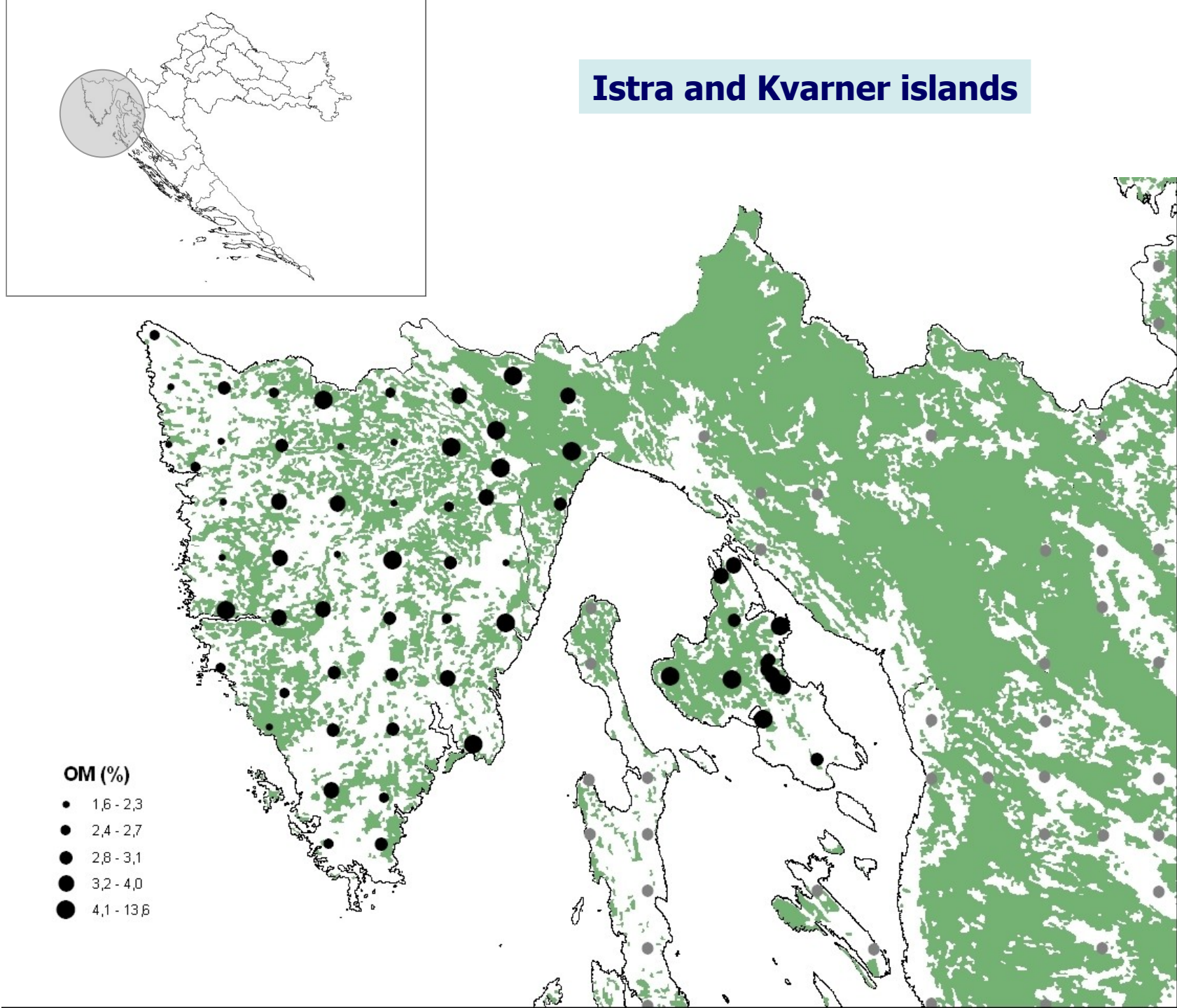


NW Croatia – Sava – Drava – Mura Rivers





Istra and Kvarner islands





Terra Rossa Poreč, Istra



Neretva River Valley

- south of the Croatian Adriatic coast
- Delta of the Neretva River - hydro-ameliorated area intensively used nowadays as a fertile agricultural land



Soil salinization: diagnostics, processes and effects on plants (Romić D.)



➤ **Agriculture mainly involves growing of citrus and other Mediterranean fruits**

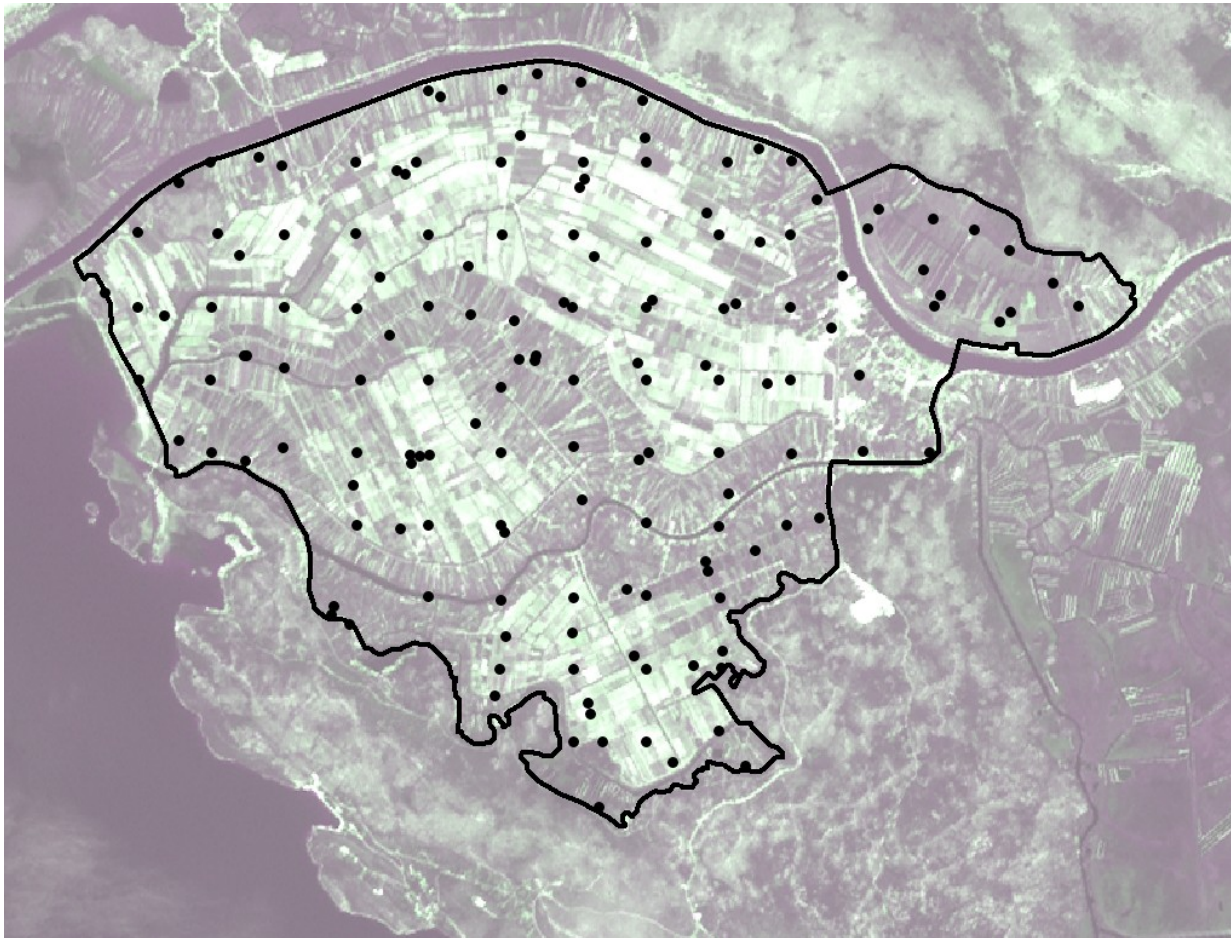


as well as early vegetables, regularly applying irrigation.



USING HYPERSPECTRAL REMOTE SENSING TO ESTIMATE SOM

- a rapid and efficient tool to quantify soil properties;
- we are aimed to examine the capacity of **hyperspectral reflectance** for mapping SOM
- ongoing activity



ASTER satellite imagery acquired in 2006

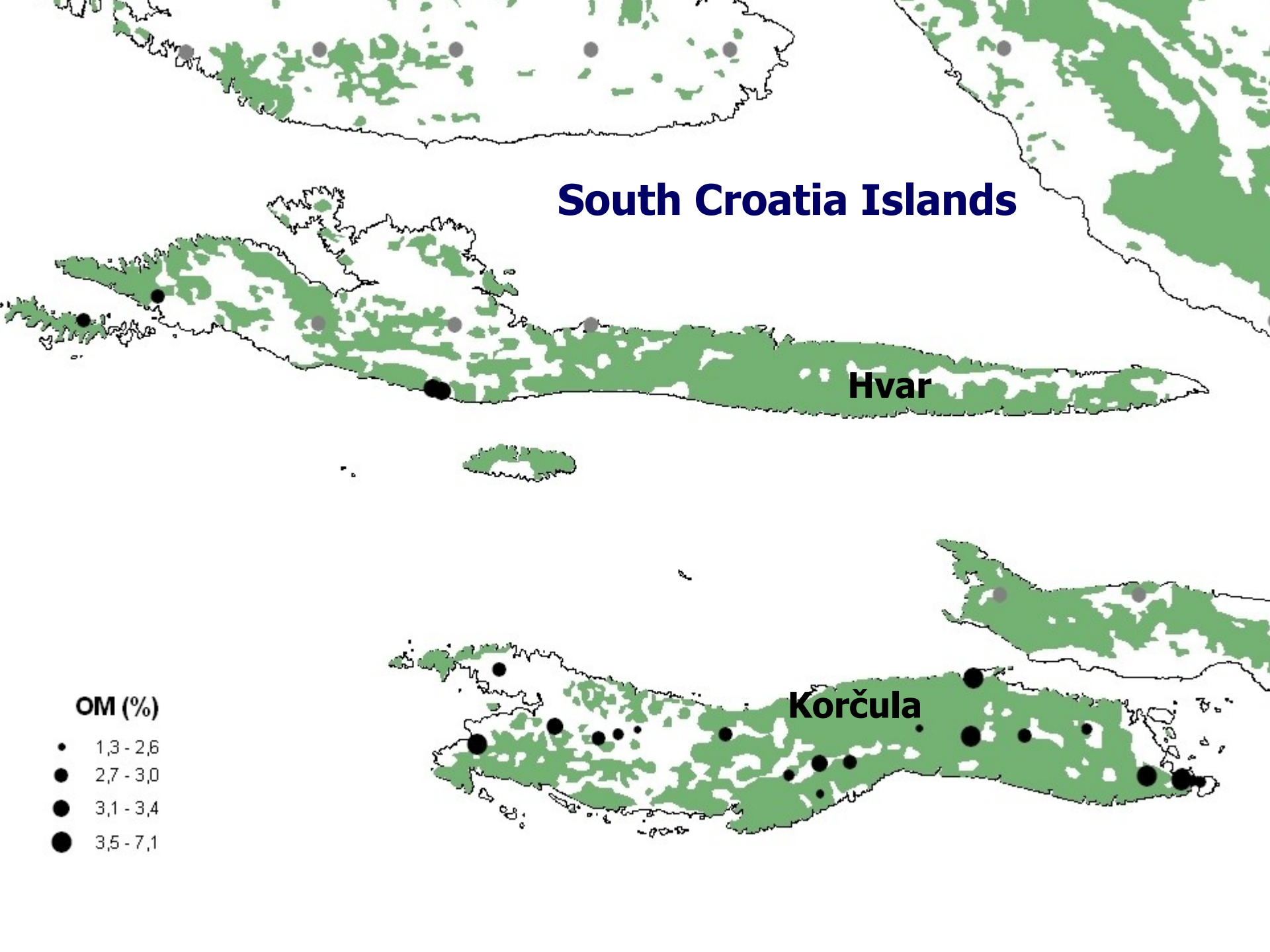
South Croatia Islands

Hvar

Korčula

OM (%)

- 1,3 - 2,6
- 2,7 - 3,0
- 3,1 - 3,4
- 3,5 - 7,1





- Croatia has three main regions lining the rocky coastline along the Northeast coast of the Adriatic Sea: Istria, Dalmatia, and the Northern Seacoast.
- The Croatian limestone found along this zone is considered the classical **karst**, belonging to the Cretaceous and Jurassic periods, with an average thicknesses of 2-3 kilometers thick and 1-2 kilometers thick, respectively.

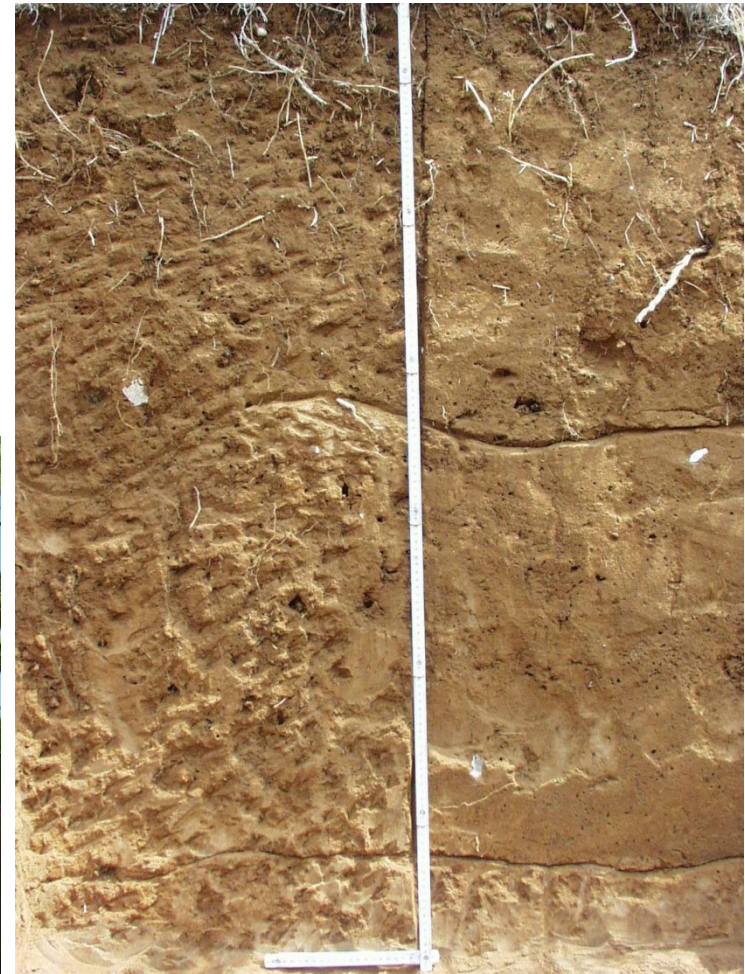


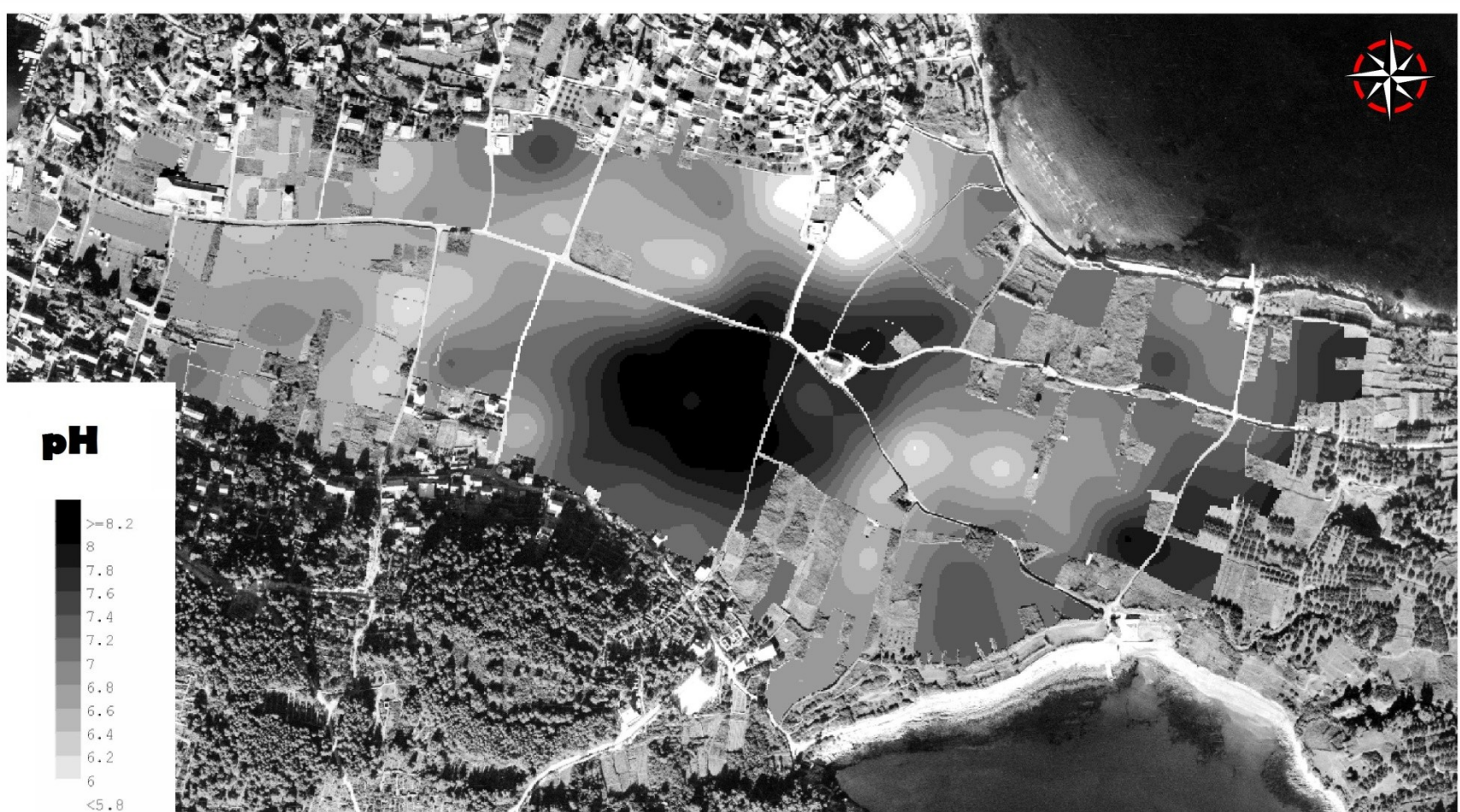
Soil variation in Lumbarda polje (Korčula Island)



- a very thin grid of coordinates was extracted from the raster image of aerial photographs,
- sampling coordinates were selected using the standard *k*-means approach to non-hierarchical cluster analysis

- an area of about 40 hectares of vineyards
- costal palaeodunes





Lumbarda - Island of Korcula

0 100 200 300 400 500 m

Scale
1 : 5000



- The multivariate set of data was in processed to calculate the probabilistic pairwise dissimilarity of Goodall
- delineated the soil units present in the area, and the spatial distribution shown in 1:5000 scale maps.

Options for further development

- for the **legislation needs**, HR Government has series of adequate quality datasets available
- most of the actual legislation regulates the agricultural land management
 - **assess the performance of the existing programmes and identify any gaps required to (i) monitor the legislation impact and (ii) meet EU requirements**

Thank you

