Digital mapping of soil properties in Zala County, Hungary for the support of county-level spatial planning and land management

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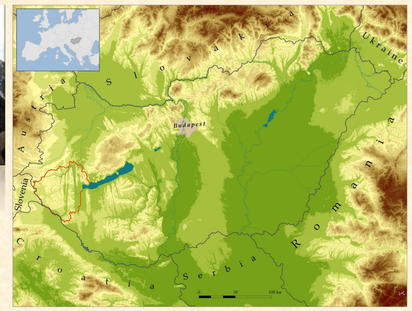

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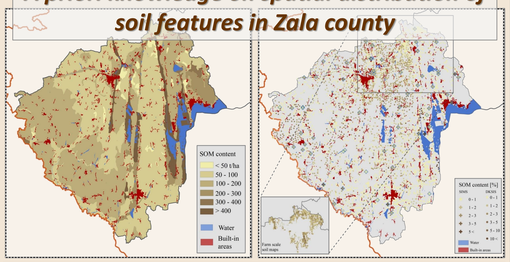
The main objective of the DOSoReMI.hu (Digital, Optimized, Soil Related Maps and Information in Hungary) project is to significantly extend the potential, how demands on spatial soil related information could be satisfied in Hungary. Although a great amount of soil information is available due to former mappings and surveys, there are more and more frequently emerging discrepancies between the available and the expected data. The gaps are planned to be filled with optimized DSM products heavily based on legacy soil data, which still represent a valuable treasure of soil information at the present time. Impact assessment of the forecasted climate change and the analysis of the possibilities of the adaptation in the agriculture and forestry can be supported by scenario based land management modelling, whose results can be incorporated in spatial planning. This framework requires adequate, preferably timely and spatially detailed knowledge of the soil cover. For the satisfaction of these demands in Zala County (3784 km²; one of the nineteen counties of Hungary), the soil conditions of the agricultural areas were digitally mapped based on the most detailed, available recent and legacy soil data. Various soil related information were mapped in three distinct sets: (i) basic soil properties determining agri-environmental conditions (soil type according to the Hungarian genetic classification, rootable depth, sand and clay content for the 1st and 2nd soil layers, pH, OM and carbonate content for the plough layer); (ii) biophysical criteria of natural handicaps defined by common European system and (iii) agro-meteorologically modelled yield values for different crops, meteorological and management scenarios. The applied method(s) for the spatial inference of specific themes was/were suitably selected: regression and classification trees for categorical data, indicator kriging for probabilistic management of criterion information; and typically regression kriging for quantitative data. The appropriate derivatives of a 20m digital elevation model were used in the analysis. Multitemporal MODIS products were selected from the period of 2009-2011 representing different parts of the growing season and years with various climatic conditions. Additionally two climatic data layers, the 1:100.000 Geological Map of Hungary and the map of groundwater depth were used as auxiliary environmental covariables. Our paper presents the mapping processes themselves, the resulted maps and some conclusions drawn from the experiences.

A priori knowledge on spatial distribution of soil features in Zala county



AGROTOPO Spatial Soil Information System — countrywide spatial soil information system (1:100,000)

1:10,000 scale genetic soil maps — do not cover totally even the agricultural areas of the country; partly processed digitally and not managed properly

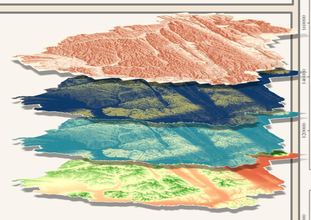
Hungarian Soil Information and Monitoring System (SIMS) — provides up-to-date and reliable data; 59 profiles within the county; locations not selected to be spatially representative

Soil Fertility Monitoring System (SFMS) — topsoil properties of ~100,000 agricultural plots; merely fragments are available of suitable for verification purposes

Digital Kreybig Soil Information System (DKSIS) — SMUs delineated based on overall chemical and physical soil properties of the soil root zone; detailed soil properties determined in soil profiles

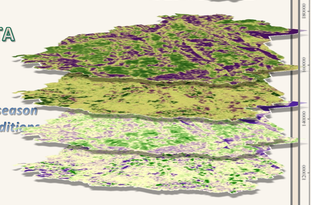
DIGITAL ELEVATION MODEL 20 m

- altitude,
- slope,
- topographic wetness index,
- LS factor,
- mass balance index,
- catchment area,
- profile and plan curvature,
- stream power index,
- tpi500



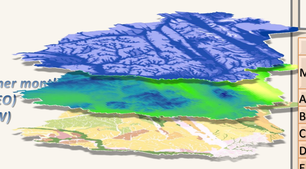
REMOTELY SENSED DATA

MODIS scenes (RS)
18 NDVI and EVI
- period of 2009-2011
- different parts of the growing season
- years with various climatic conditions



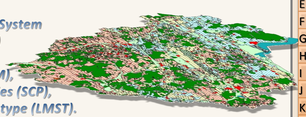
FURTHER THEMATIC AUXILIARY SPATIAL INFORMATION

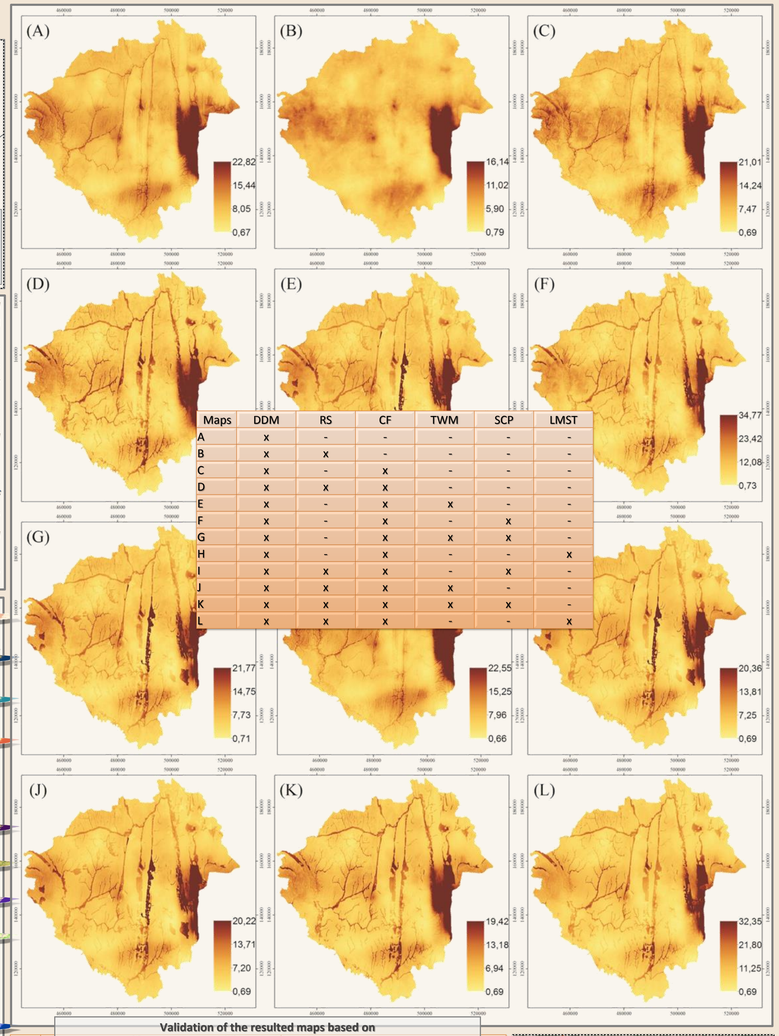
- Climatic data layers (CF):
  (i) mean annual precipitation
  (ii) mean temperature of summer months
- Geological Map of Hungary (GEO)
- Map of groundwater depth (GW)



SOIL DATA

Digital Kreybig Soil Information System Soil mapping units (DKSIS SMUs)
(i) combined texture and water management categories (TWM),
(ii) overall soil chemical properties (SCP),
(iii) landscape management soil type (LMST).

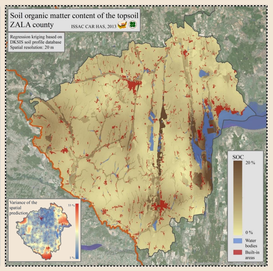




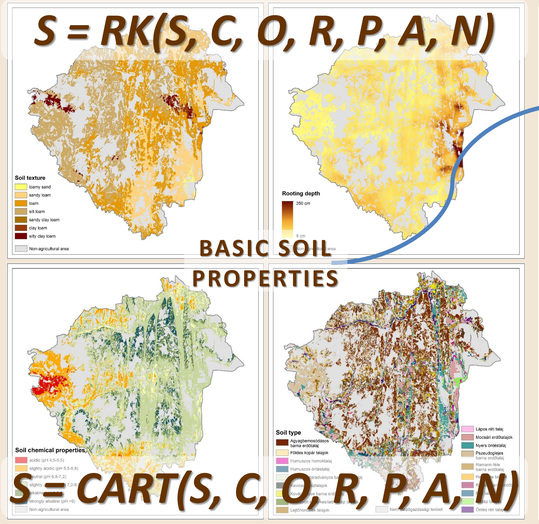
Maps	DDM	RS	CF	TWM	SCP	LMST
A	x	-	-	-	-	-
B	x	x	-	-	-	-
C	x	-	x	-	-	-
D	x	x	x	-	-	-
E	x	-	x	x	-	-
F	x	-	x	-	x	-
G	x	-	x	x	x	-
H	x	-	x	-	-	x
I	x	x	x	-	x	-
J	x	x	x	x	-	-
K	x	x	x	x	x	-
L	x	x	x	-	-	x

Validation of the resulted maps based on (i) test DKSIS and (ii) the independent SFMS data set

Maps	ME	MAE	MSE	RMSE	RMNSE	RI	ME	MAE	MSE	RMSE	RI
A	-0.43	0.86	6.73	2.59	1.21	5%	0.75	0.96	2.24	1.50	1%
B	-0.46	0.88	7.43	2.73	1.26	-	0.70	0.91	2.18	1.48	2%
C	-0.43	0.87	6.70	2.59	1.21	5%	0.75	0.96	2.27	1.51	-
D	-0.45	0.88	7.21	2.69	1.22	2%	0.77	0.96	2.04	1.43	5%
E	-0.29	0.75	4.69	2.17	1.11	21%	0.76	0.93	1.65	1.29	15%
F	-0.37	0.84	6.04	2.46	1.14	10%	0.84	1.01	2.04	1.43	5%
G	-0.29	0.75	4.69	2.17	1.11	21%	0.75	0.92	1.63	1.28	15%
H	-0.40	0.83	6.12	2.47	1.09	9%	0.82	0.99	1.87	1.37	9%
I	-0.41	0.88	6.76	2.60	1.12	5%	0.81	0.97	1.87	1.37	9%
J	-0.31	0.77	5.19	2.28	1.11	16%	0.77	0.92	1.60	1.26	16%
K	-0.31	0.78	5.20	2.28	1.11	16%	0.73	0.89	1.55	1.24	17%
L	-0.42	0.85	6.68	2.59	1.10	5%	0.87	1.01	1.87	1.37	9%

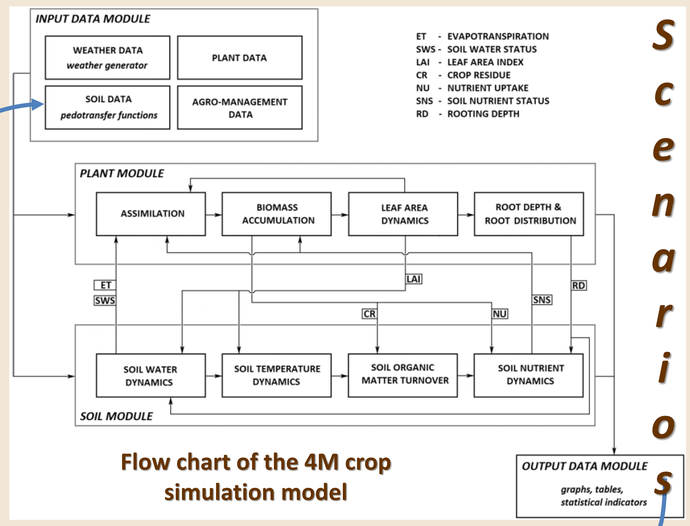


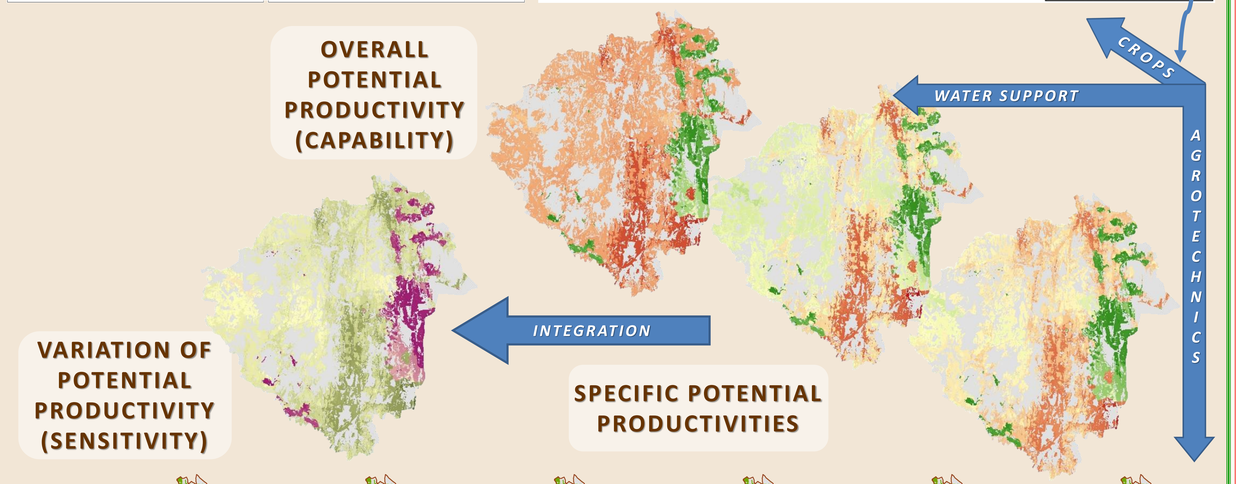
S = RK(S, C, O, R, P, A, N)



BASIC SOIL PROPERTIES

S = CART(S, C, O, R, P, A, N)



Flow chart of the 4M crop simulation model

S c e n a r i o s