THEME 1

Estimation of soil organic carbon stock in Estonian agricultural land

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INTRODUCTION

Last years' several local applied projects have focused to digitize and use jointly legacy soil data and new monitoring and agrochemical soil survey data for spatio-temporal SOC estimations and modelling.

OBJECTIVES

To assess soil organic carbon (SOC) changes and its current status in agricultural land. To highlight challenges and perspectives with spatio-temporal estimation of SOC data.

SOC stock change

In stationary soil monitoring sites, SOC stock has increased in mid-term perspective (~30 years) probably due to deep ploughing in 1980-90s. According to latest agrochemical soil surveys (2003-14), within 5-year resampling, SOC stock decreased by -1.04 and -2.04 t ha^{-1} y^{-1} in automorphic and hydromorphicsoils, respectively. Change rate varied across soil texture classes with largest decrease for sands.

Tab. 1: Temporal changes in SOC status at soil monitoring sites (average of 28 sites)

Period (sample size)	A horizon (cm)	SOC** (%)	SOC stock (t ha^{-1})
1983–87 (n=1015)	27.3^{a*}	1.79^{a}	66.3^{a}
2013–16 (n=360)	32.1^{b}	1.81^{a}	79.4^{b}

*different small letter within column indicate significant influence ($p<0.05$)
** determined by Tjurin method

Tab. 2: SOC stock change rate (t ha^{-1} y^{-1}) of arable soils in short-term (5-year) period

Texture class	Automorphic soils	Hydromorphic soils
Sand	-2.1 (n=110)	-2.2 (n=29)
Loamy sand	-0.7 (n=713)	-2.0 (n=58)
Loam	-1.1 (n=822)	-2.1 (n=157)
Clay	+2.5 (n=15)	+0.4 (n=37)

* SOC concentration determined by NIRS method

METHODOLOGY

Soil data

Estonian soils have been well studied and mapped at a scale 1:10,000.
Large-scale map was composed mainly in 1960-80s and digitized by 2001.
In 1983 stationary arable soil monitoring network was established (initially 79 and currently 28 sites).

Agrochemical soil survey provides most up-to-date data for SOC % at the field scale.

Limitation and perspectives

Areas, scale and also methods for SOC monitoring/survey have differed for decades, and this complicates the study of long-term changes.

MAIN RESULTS

According to agrochemical soil surveys, median SOC concentration of agricultural land is 2.36% (mean 3.69, min 0.43, max 52). Agricultural producers applying EU CAP subsidies for environment-friendly management & organic farming are obligated to take part in agrochemical soil survey, and SOC % must be analysed for at least every 20 ha.

Modelling of SOC spatial patterns

We developed a framework (incl. pedotransfer functions & rules, mixed model approach, legacy soil data etc.) for SOC stock prediction which could be integrated to existing digitized large-scale soil maps (1:10,000).

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Spatial SOC predictions can be used for practical farming purposes - e.g. for optimizing N-fertilizer rates between fields or for precision farming.
Predictions can be up-scaled to regional or country level for policy making.

CONCLUSION

~30% of previous Histosols have been mineralized due to intensive drainage and tillage since the 1960s, and this is not reflected on existing soil maps. There is an urgent need to update existing soil maps using digital soil mapping techniques before SOC prediction can be extrapolated across all soil types.

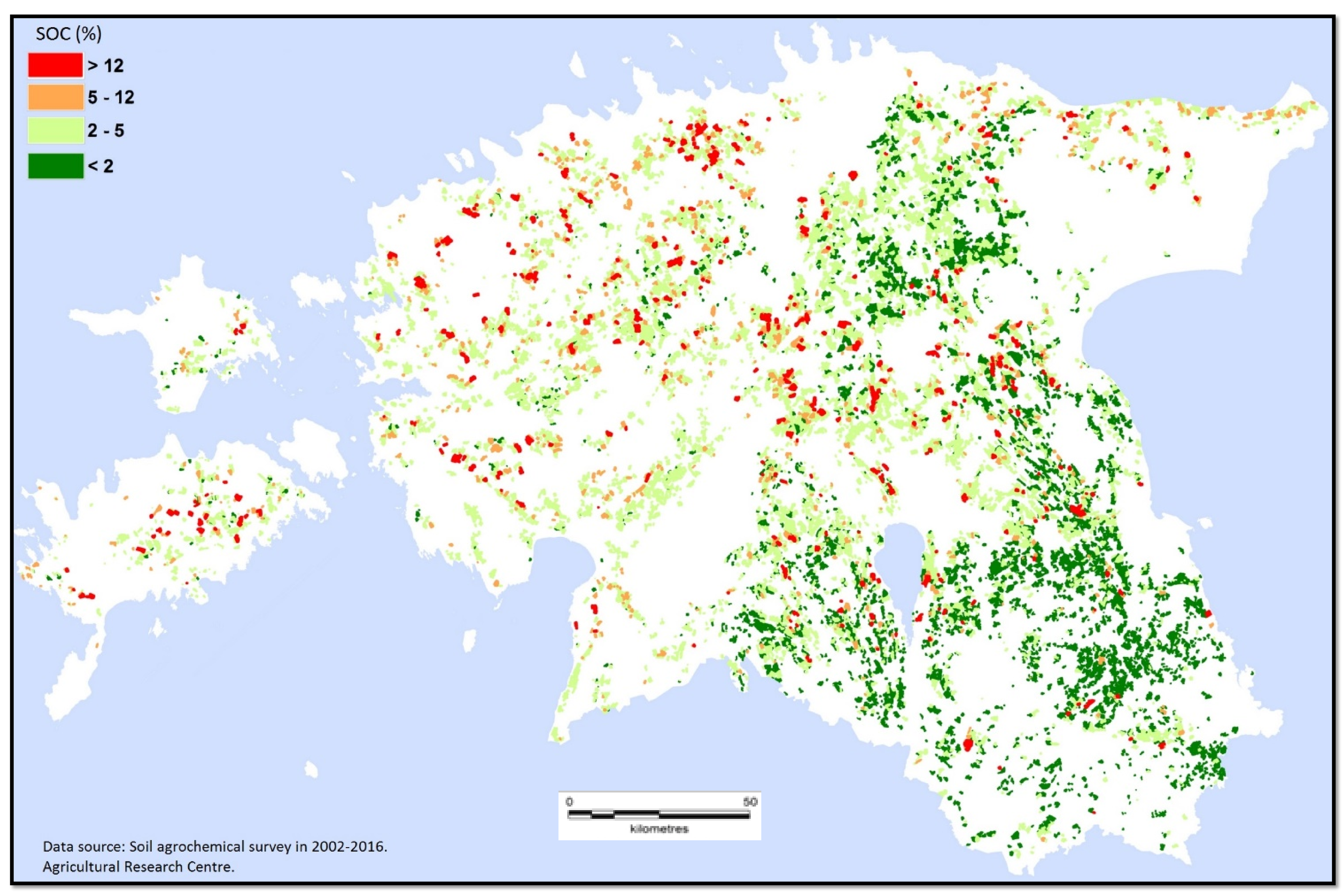

Fig. 1: SOC concentration (%) of Estonian agricultural land (n=23885)

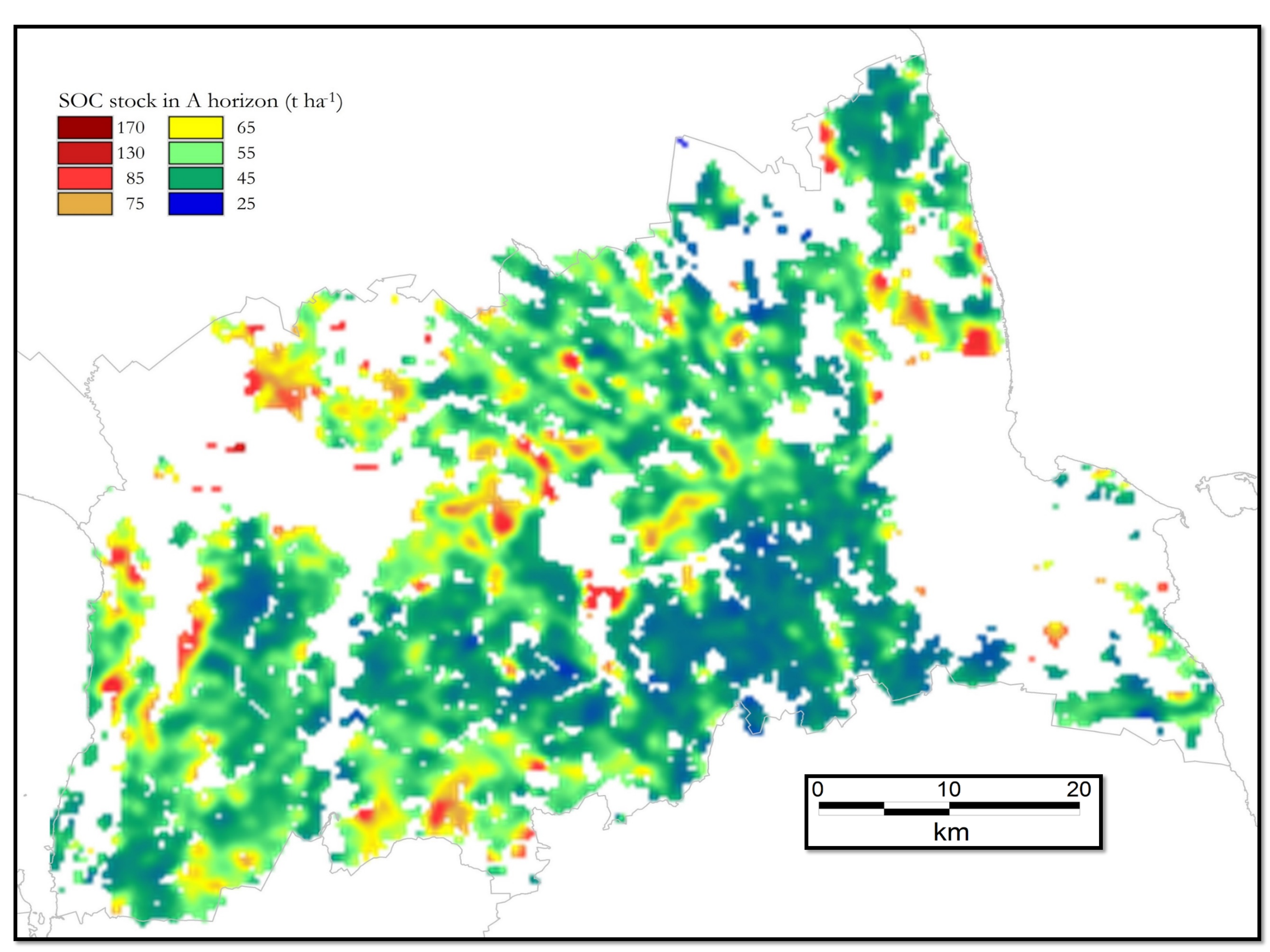

Fig. 2: Modelled SOC stock (t ha^{-1}) of agricultural land in Tartu County

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