Supporting Information

Combining continuous data on soil properties and land use to explore soil carbon changes and soil structure indicators

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Supplementary tables

SI – 1. SOC stock estimations based on linear models of bulk density

Table SI 1. Results from the Gaussian Error Propagation analysis concerning uncertainties associated with SOC stock estimations using the two bulk density equations for S1 and S2 samples, respectively.

		Mean SOC % S1 and S2	Mean Variance S1 and S2	Standard deviation (std)
Equation 1	S1	2.57	1.15	19%
	S2	2.64	1.04	18%
Equation 2	S1	2.57	1.15	19%
	S2	2.64	1.04	18%

Table SI 2. Grouped statistics for SOC stock calculations.

Ley frequency group	SASI group	mean	std	min	max
0%	S1	63.6	20.0	23.3	136.8
	S2	65.2	21.1	27.5	166.4
1-20%	S1	64.7	23.0	6.5	136.1
	S2	67.7	21.2	15.2	143.4
21-40%	S1	64.0	19.5	25.0	124.2
	S2	69.0	21.6	21.7	134.5
41-60%	S1	71.0	22.9	30.9	133.9
	S2	74.4	23.1	23.8	137.1
61-80%	S1	73.2	22.1	22.0	132.3
	S2	75.4	22.6	19.8	160.0
81-100%	S1	76.9	23.3	23.3	136.8
	S2	81.4	22.7	34.0	143.9

SI – 2. Impact factors for soil organic carbon

Table SI 3. Table with results from the Regression analysis on the field dataset. Eq 1 shows the regression analysis for SOC as the dependent variable. Bold value is the Intercept of the equation, and predictors in cursive and bold are statistically significant. Below the equations, additional regression for the two dependent variables is found. VIF = Variance Inflation Factor

Dependent	**Intercept**			***Statistically Significant Predictors in cursive and bold***	
	Eq 1				
	SOC (S2) = **0.8512** + ***0.0575*Ley Frequency*** + ***8.46*N*** ***-0.011*Clay***			R^2 0.47	RMSE 0.69

SOC Regression statistics		**VIF**	**Shapiro Wilks**
R^2: 0.47		Ley Frequency = 1.61	Statistic = 0.94
F-statistic: 506.79		Nitrogen = 3.86	p-value = 0.00
Degrees of Freedom: 3.0, 1607		Clay = 3.37	
p-value (F-statistic): 0.0000			

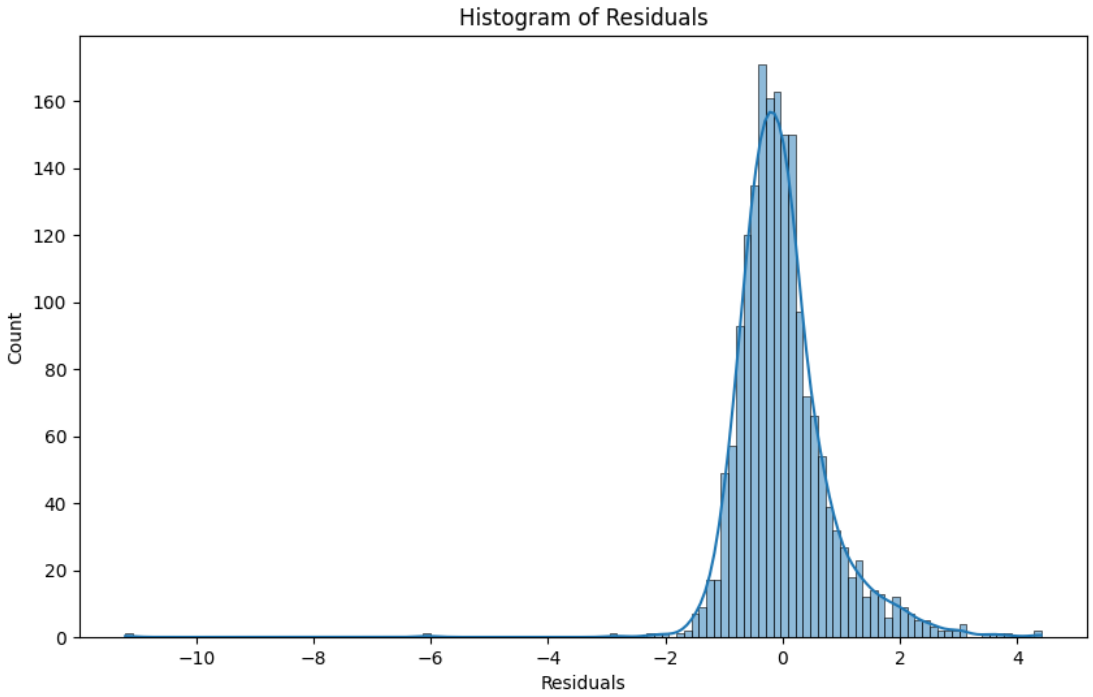


Figure SI 1. Histogram of residuals of SOC samples. This figure displays the histogram of residuals from the linear regression model, overlaid with a kernel density estimate to illustrate the distribution's shape

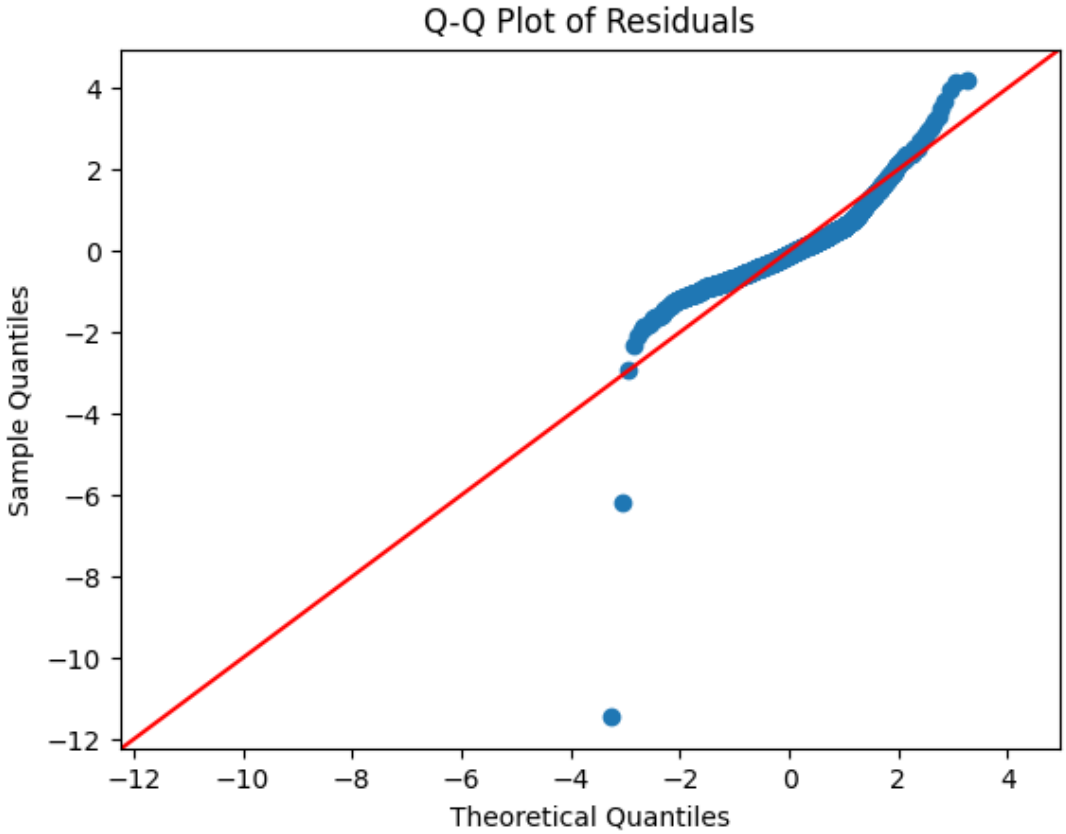


Figure SI 2. Quantile-Quantile (Q-Q) plot of Residuals of SOC samples. The QQ plot of the residuals against a theoretical normal distribution, with the 45-degree reference line indicating perfect normality.

SI – 3. Region-specific information about SOC/clay ratio and soil texture

Table SI 5. Average clay content and carbon value for each production region, subcategorized into soil structure quality classes.

Number of Fields Production region (PR)	Soil structure quality	Share (% of number)	Clay % DM Average	Carbon % DM Average
PR 1				
107	Very Good	52%	12.4	2.7
32	Good	15%	15.6	1.7
40	Suggested Improvement	19%	22.4	1.9
28	Poor	14%	27.3	1.8
PR 2				
144	Very Good	75%	10.3	2.7
15	Good	8%	18.9	2.1
25	Suggested Improvement	13%	20.5	1.8
9	Poor	5%	31.3	1.9
PR 3				
116	Very Good	35%	13.9	3.0
29	Good	9%	22.9	2.5
53	Suggested Improvement	16%	32.7	2.8
137	Poor	41%	41.7	2.2
PR 4				
58	Very Good	16%	16.0	3.0
21	Good	6%	31.7	3.5
58	Suggested Improvement	16%	32.4	2.8
227	Poor	62%	43.1	2.3
PR 5				
199	Very Good	78%	9.3	3.2
22	Good	9%	28.4	3.1
18	Suggested Improvement	7%	29.8	2.6
17	Poor	7%	48.3	3.0
PR 6				
68	Very Good	58%	12.8	2.9
14	Good	12%	27.9	3.1
14	Suggested Improvement	12%	27.6	2.5
22	Poor	19%	39.1	2.1
PR 7				
65	Very Good	77%	17.2	3.6
11	Good	13%	27.8	3.2
5	Suggested Improvement	6%	31.4	3.0
3	Poor	4%	34.0	2.4
PR 8				
47	Very Good	94%	7.8	3.1
2	Good	4%	20.5	2.3

1	Suggested Improvement	2%	15.0	1.3

Table SI 6. Significance of changes in SOC between S1 and S2 based on Wilcoxon non-parametrical test (95% confidence interval) for the eight production regions (P08) and the Ley Frequency groups. Bold values = statistically significant (p<0.05).

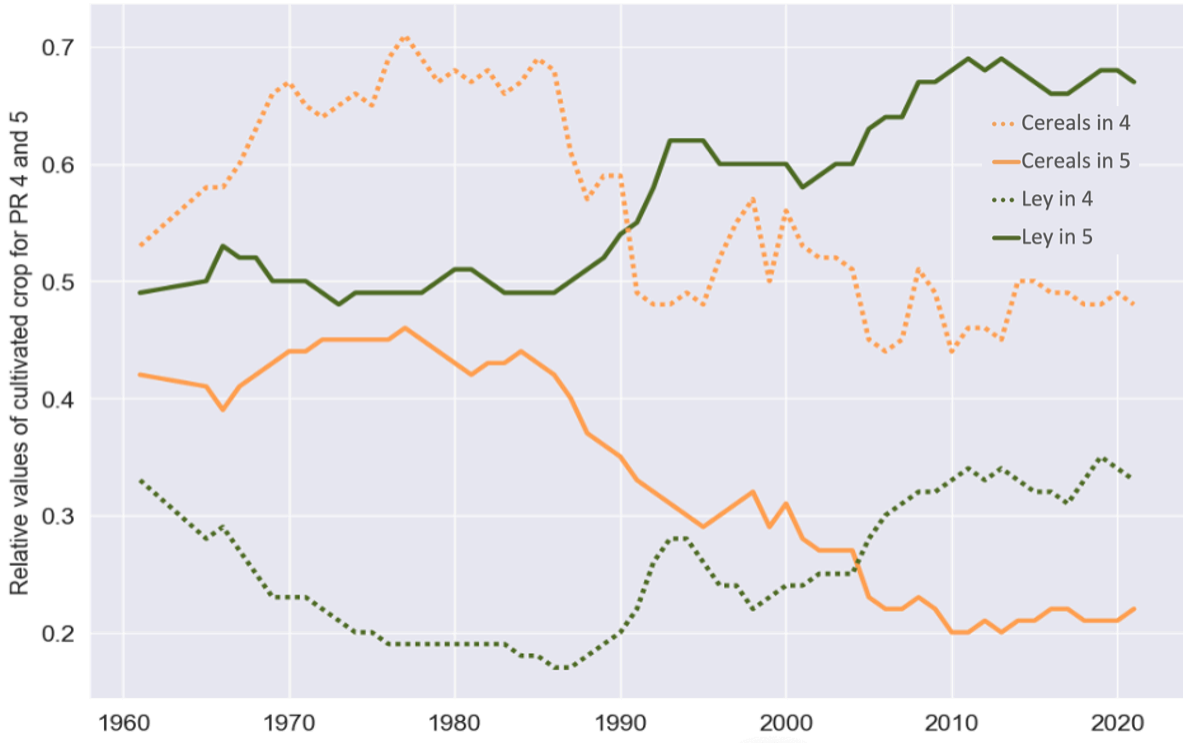
P08	Total samples	1	2	S	4	5	6	7	8
P value	**0.0064**	**0.01**	**0.037**	**4e-06**	**0.0034**	0.0648	**0.002**	0.40	0.79

Ley Frequency groups	Total Samples	0%	1-20 %	21-40%	41-60%	61-80%	81-100%
P value	**4e-05**	**8e-05**	0.057	**8e-05**	**4e-05**	**0.022**	**0.0011**

Supplementary figures

SI – 4. Historical land use for P08 4 and 5

Figure SI 3. Historical land use of two production regions - P04 and P05. Relative values of Perennial ley and Cereal production in the regions over time - 1960 to 2021.



SI – 5. Changes in winter wheat cultivation and production

Winter wheat cultivation area is increasing in Sweden at the expense of summer cereals, foremost oat. Between S1 and S2, winter wheat cultivation areas increased by roughly 6.2% in Sweden on average, with a higher increase in the three southern production regions (PR 1-3). A difficult and rainy autumn in 2012 resulted in a very low establishment of winter wheat in PR 4, causing a modest area increase. PR 1, PR 3, and PR 4 stand for over 80 % of the total acreage of winter wheat. (Jordbruksverket, 2023)

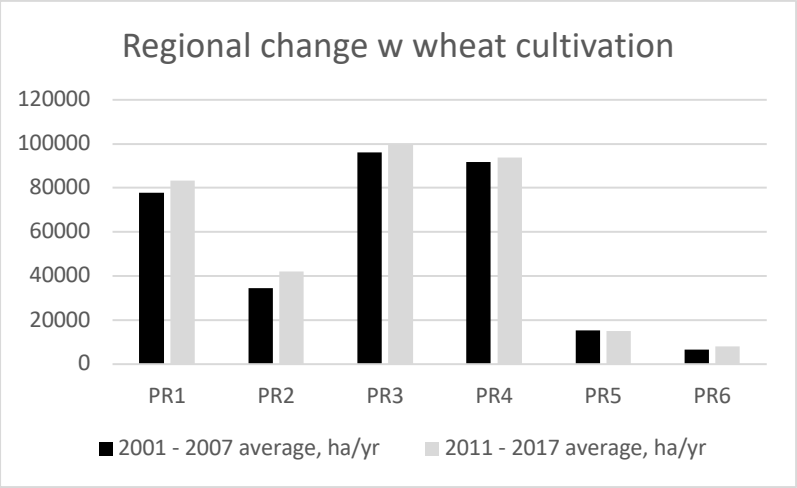


Figure SI 4. Changes in winter wheat cultivation (hectares) between S1 (black) and S2 (grey)

Average winter wheat yield increased by close to 12 % between S1 and S2 (Swedish average). The increase was more accentuated in the southern production regions (PR 1-3). As noted above, difficult weather conditions during the 2012/2013 season resulted in a small increase (4%) in PR 4 (Jordbruksverket, 2023)

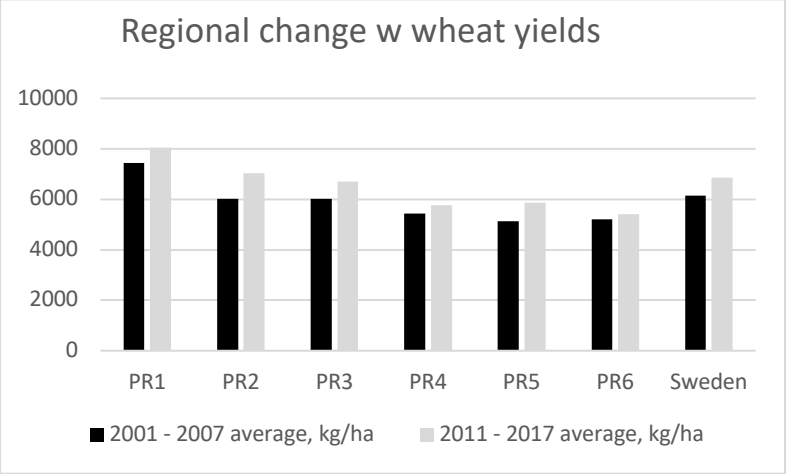


Figure SI 5 Changes in winter wheat yields (hectares) between S1 (black) and S2 (grey)

Jordbruksverket. (2023). Jordbruksverkets statistikdatabas. https://statistik.sjv.se/PXWeb/pxweb/sv/Jordbruksverkets%20statistikdatabas/?rxid=5adf4929-f548-4f27-9bc9-78e127837625 Access June 2023.

SI – 6. Code availability for statistics

In the Method section, several different statistical analyses were used.

These are all collected in an open repository on GitHub.

Link below to Repository on Github

https://github.com/Karlstefanrehn/statistics_SASI/tree/main

Code availability on method development and spatial operations are available on request.

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