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SOC stock and its distribution in the Republic of Ireland: Estimate based on geostatistics and GIS techniques

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Introduction



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- Global estimates of SOC 1500 Pg (Eswaran et al., 1995; Batjes, 1996); atmospheric pool of 750 Pg and biotic pool of 600 Pg (Schimel, 1995; Houghton, 1995; Lal, 2002). Minor changes of SOC storage can impact atmospheric carbon composition (Johnston *et al.*, 2004).
- Accurate estimates of SOC stock are required to assess the role of soil in the global carbon cycle.

Introduction



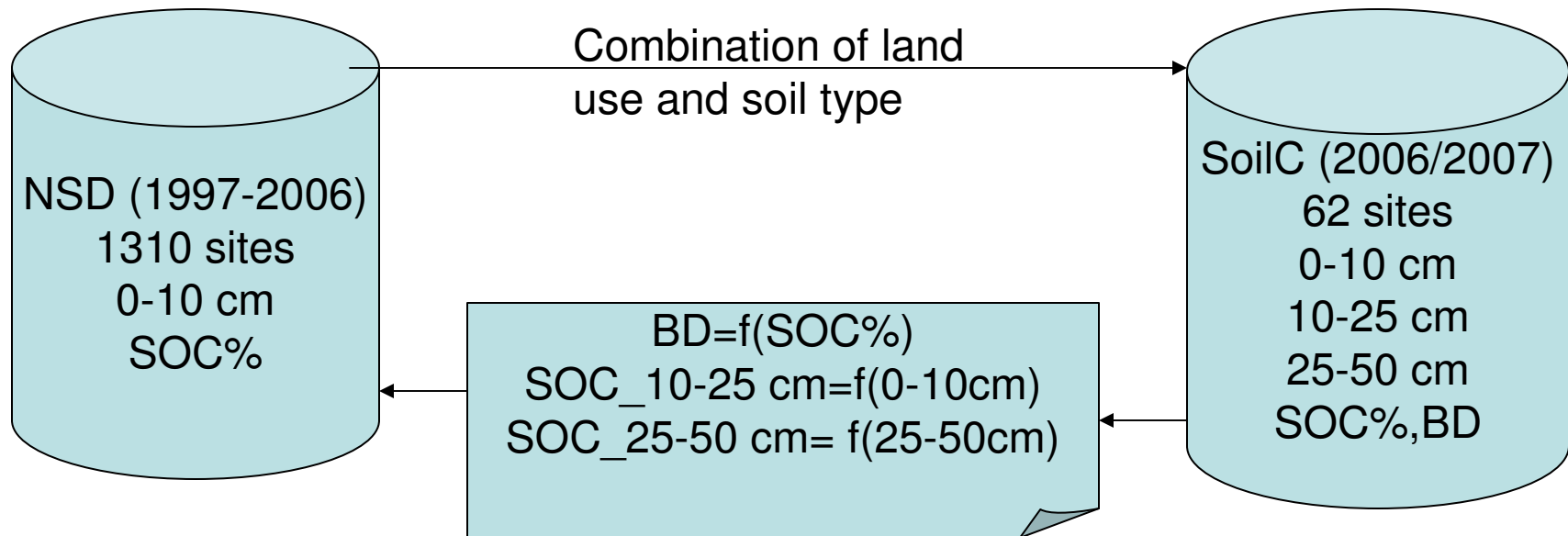
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- In Ireland, two estimates existed. One was dependent on limited and very old datasets (the study by Tomlinson, 2005) ; the other just directly cited datasets from the UK and no spatial distribution (the study by Eaton *et al.*, 2008).
- Update information especially spatial distribution of SOCD is needed for Ireland.
- McGrath & Zhang (2003) and Zhang & McGrath (2004) had successfully interpolated surface SOC (0-10cm) values to map the SOC distribution at a fine resolution with geostatistics together with GIS techniques in Ireland. Could we use this method for SOCD est.?

Databases and methods



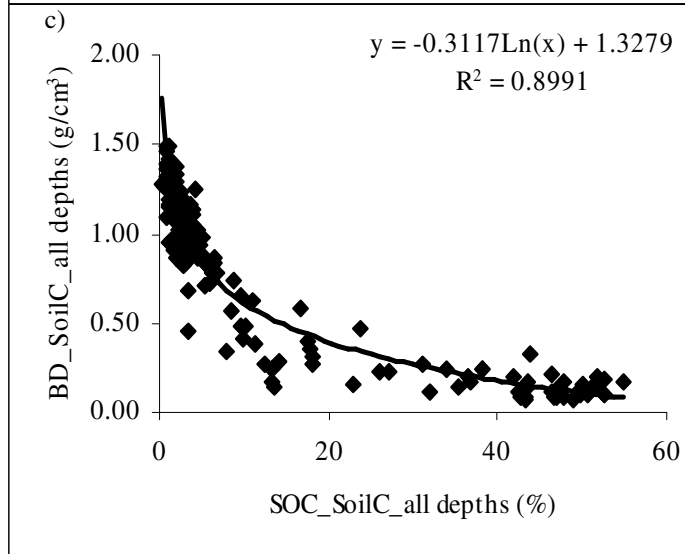
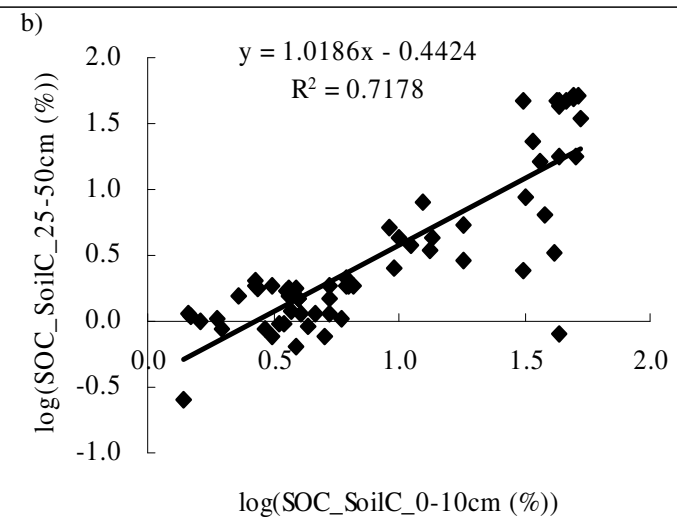
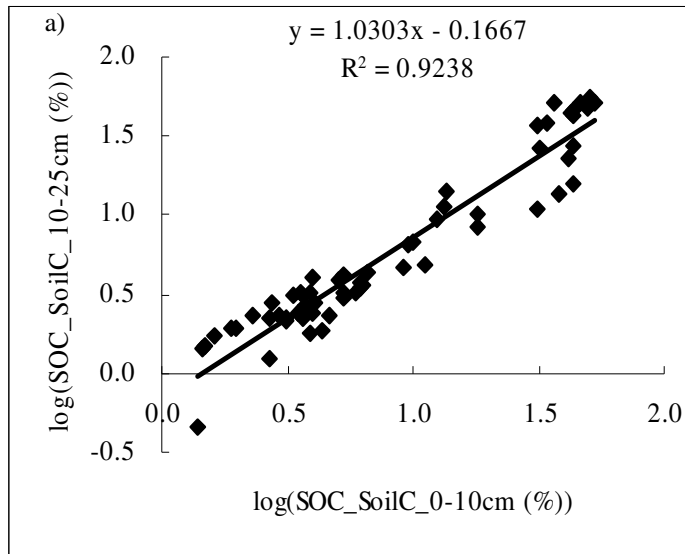
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Databases and method



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Calculation of the SOCD of 0-10 cm, 0-30 cm (sum of values of 0-10 , 10-25 and 25-30 cm) and 0-50 cm (sum of values of 0-30, and 30-50 cm) with the corresponding SOC and BD.

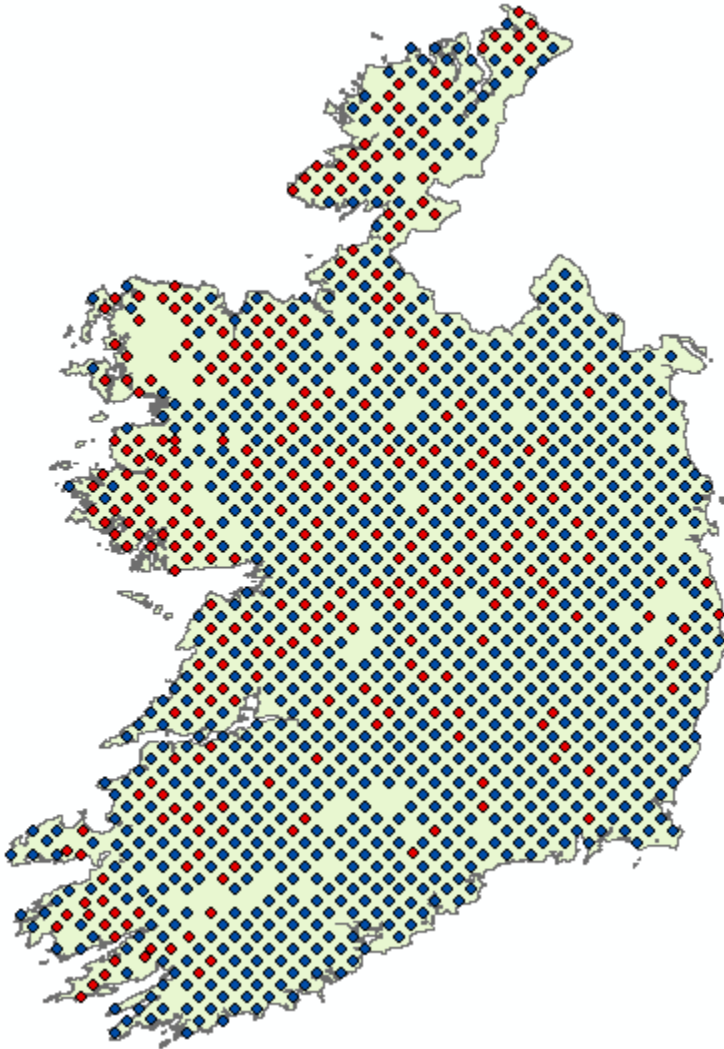
$$\text{SOCD}_h = \text{SOC}_h \times \text{BD}_h \times h \times 10000$$

Note that in order to calculate the SOCD of 25-30 cm and 30-50 cm, we used the same SOC and BD values as those of 25-50 cm layer.

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We separated the 1310 *NSD* points into two groups of mineral (SOC <15%, 992 sites in blue) and peat (SOC >15%, 318 sites in red) soils.

For peat group, SOCD values assigned to each peat type on peat map (Hammond, 1979) . Overlaid with mineral soil map to form the SOCD distribution for the country.

$$\gamma(h) = \frac{1}{2N(h)} \sum_{i=1}^{N(h)} [z(x) - z(x+h)]^2$$

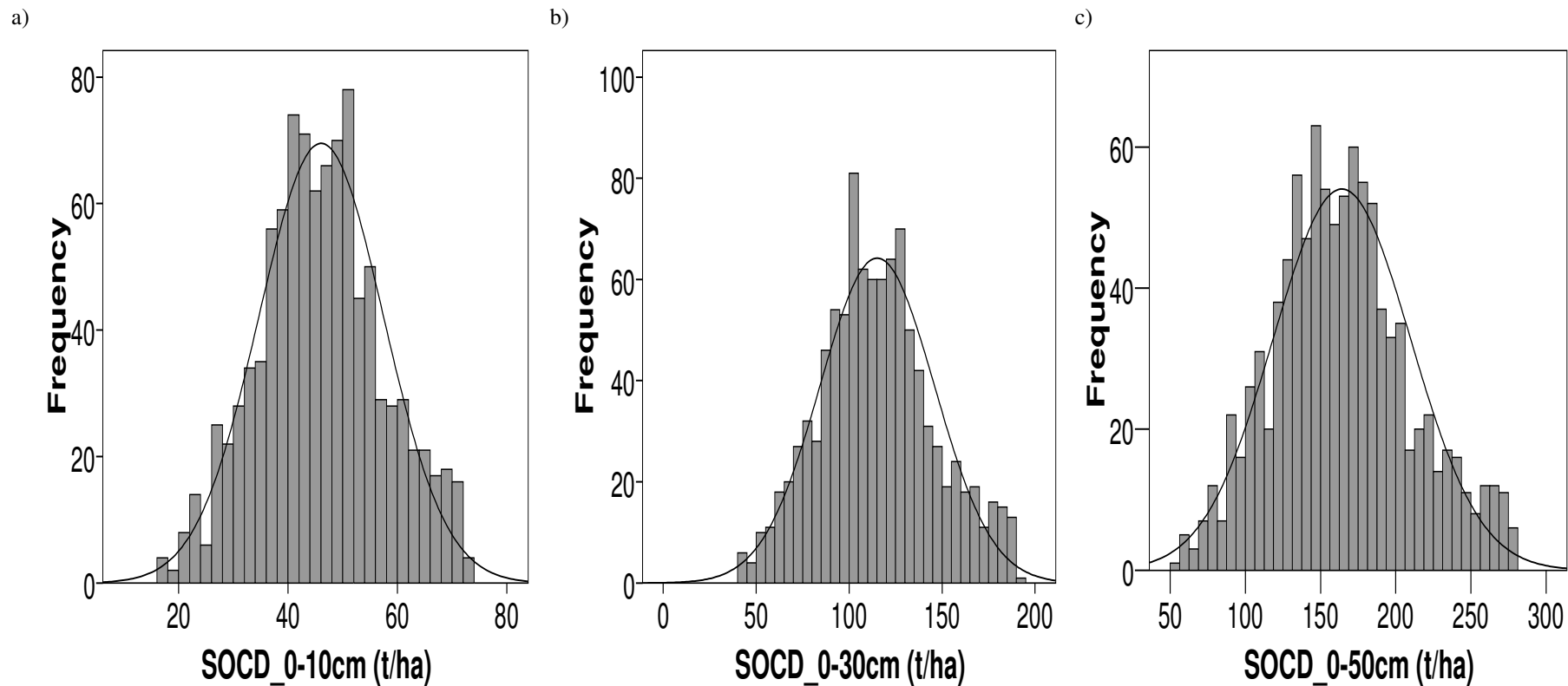
These models provide information about the structure of the spatial variation as well as the input parameters for kriging.

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- Normality distribution (K-S $p=0.70, 0.32, 0.17$)

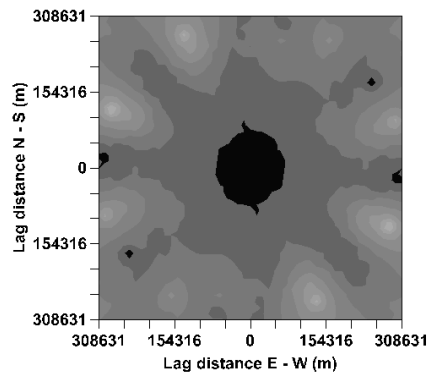
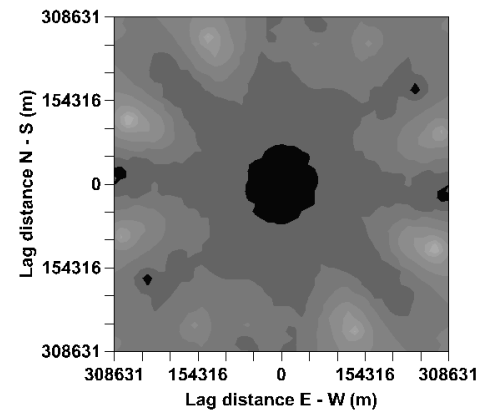
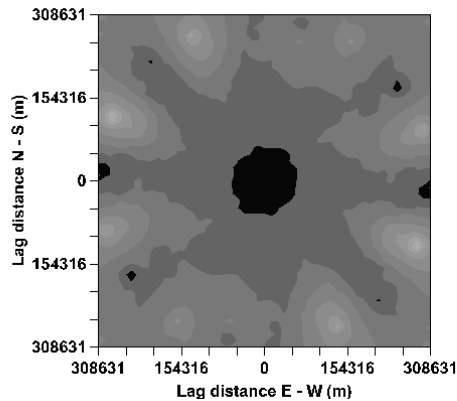


a)

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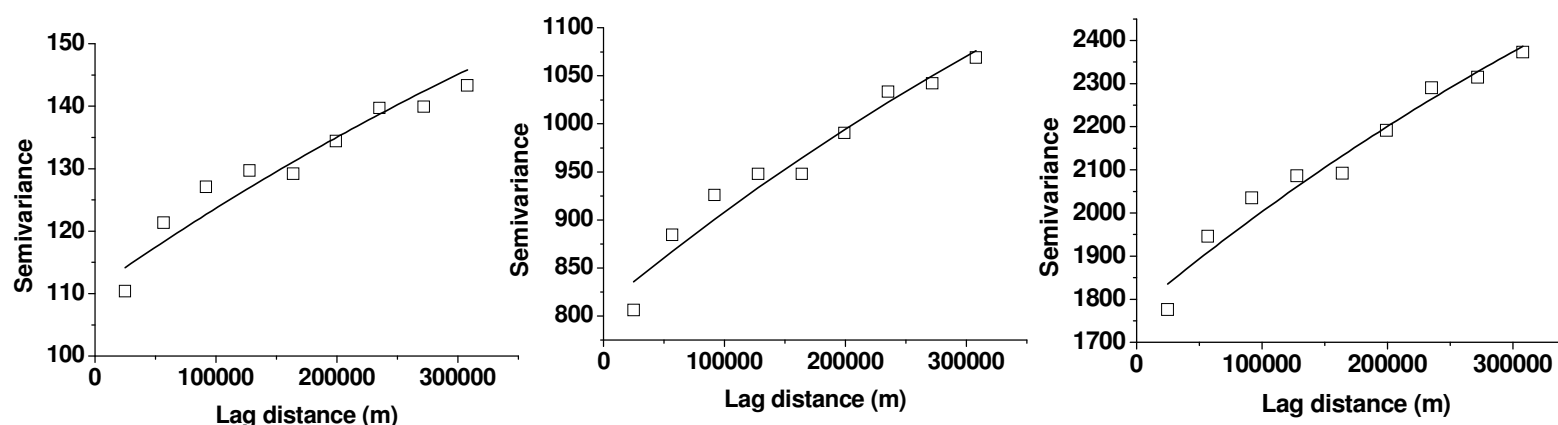


The variogram surfaces of the three SOCD datasets for mineral soils were broadly isotropic, with the lowest values located in the center, and it increased in all directions with the increase of the lag distance.



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- the experimental isotropic variogram



Model types	Depth (cm)	Nugget (C0)	Sill (C1+C0)	C0/(C0+C1)	Range (a) (km)	Effective range (km)	R^2
Exponential	0-10	110.8	221.7	0.5	811	2433	0.929
Exponential	0-30	810	1621	0.5	774.5	2323.5	0.955
Exponential	0-50	1776	3553	0.5	731.8	2195.4	0.964

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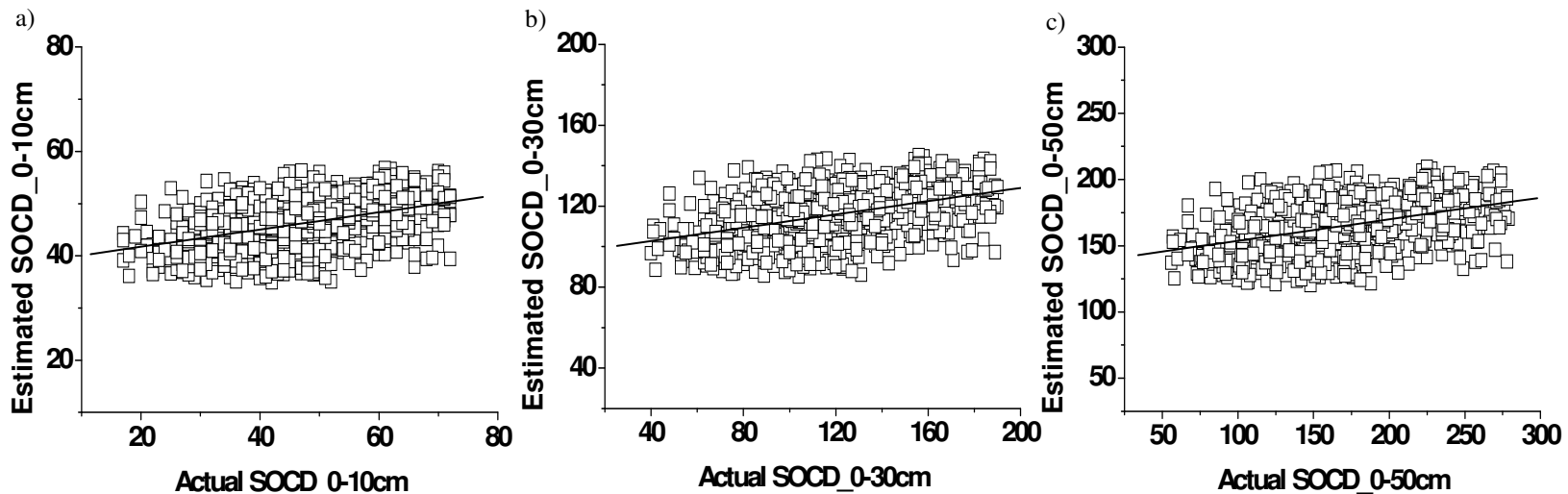
- The parameters of the exponential models were used for kriging interpolation to produce the spatial distribution map of SOCD (at the resolution of $500 * 500$ m) for mineral soils.
- Similar to the studies by McGrath & Zhang (2003) and Zhang & McGrath (2004), a search region of 32 (usually 16) nearest-neighbours was applied in order to offset the relatively high nugget effects.

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- cross validation



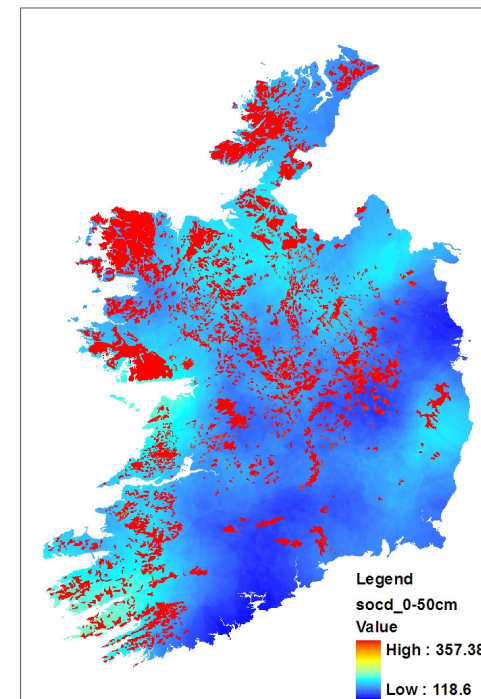
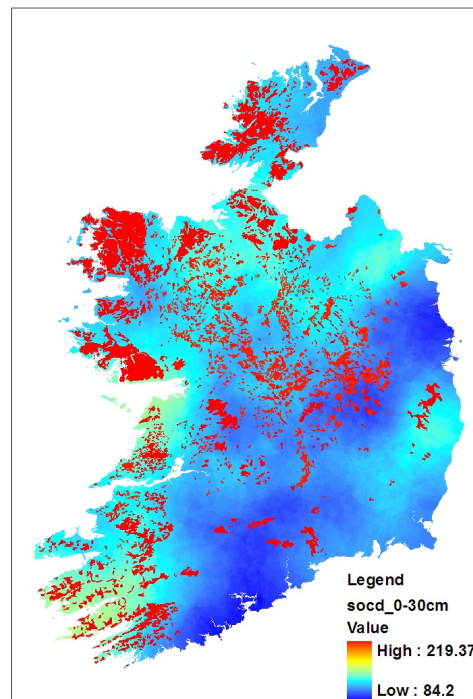
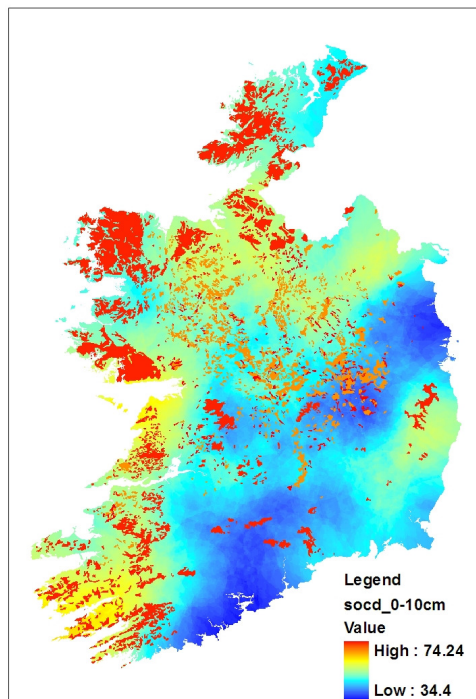
Indicators	0-10 cm	0-30 cm	0-50 cm
Mean Absolute Error (t/ha)	8.2	22	33
Median Absolute Error (t/ha)	6.8	18	27
Mean Absolute Relative Error (%)	20	22	23
Median Absolute Relative Error (%)	15	16	16

Spatial distribution of SOCD



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- The highest SOCD values located at the western coastal area, where elevation and precipitation are also the highest and peat soils predominate.



SOC D by land cover



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Land cover	SOC density (t/ha)				SOC stock (10 ¹² g, Tg)			
	0-10 cm	0-30 cm		0-50 cm	0-10 cm	0-30 cm		0-50 cm
	This study	This study	Eaton <i>et al.</i> (2008)	This study	This study	This study	Eaton <i>et al.</i> (2008)	This study
Arable land	43 (6)	108	80	155	24	59	44	85
Forest	54 (10)	151	130	234	34	97	83	149
Grassland	47 (8)	122	100	178	179	461	377	671
Heterogeneous agricultural areas/other	50 (9)	132	90	194	27	72	50	106
Nonvegetated semi-natural areas	0	0	0	0	0	0	0	0
Peatland	58 (9)	174	133	275	71	210	160	333
Suburban	22 (4)	55	50	79	2	5	4	7
Urban	0	0	0	0	0	0	0	0
Water bodies	0	0	0	0	0	0	0	0
Wetland	24 (26)	63	150	93	2	4	10	6
Sum					338	908	728	1357

Conclusion



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- Our estimate of SOC stock to 50 cm of Ireland is 1357 Tg, which is larger than the estimate by Eaton *et al* (2008) (1469 Tg to 1 m depth) and the estimate by Tomlinson (2005) (2021 Tg for entire soil profile). Our estimates of soil organic carbon stock for the Republic of Ireland are the most accurate yet, because we use the most up to date databases of Ireland.
- SOCD distribution map at the national scale produced with geostatistics (for mineral soils) and GIS techniques (for peat soils and the combination of the mineral and organic soils), but further research on the uncertainties around the estimates is required.



National Development Plan 2007 - 2013



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