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Biogeosciences Discussions

Interactive comment on "No change in topsoil carbon levels of Great Britain, 1978–2007" *by* P. M. Chamberlain et al.

Anonymous Referee #3

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The main conclusion is that that there has been no net change in topsoil carbon in Great Britain in recent decades, in apparent contradiction to the findings of the National Soil Inventory (NSI) of England and Wales, reported by Bellamy et al., and much of the paper is devoted to speculation on the reasons for the differences between the two studies. There are many possible reasons for the differences, as discussed in the paper and further below. To understand them properly requires a full statistical comparison.

Defra has recently commissioned a project (Defra Project SP1101) to make such a comparison, involving representatives of the Countryside Survey (CS) (including the second and third authors of this paper) and the NSI, and an independent statistician. The project will report in September this year. It seems highly premature to publish the current paper, with its rather speculative discussion, before that study has reported.

Specific points

Page 2268 line 21 and page 2269 line 23

It is misleading to highlight that the losses in the NSI were up to 50%. Only a small number of sites had such losses and most were far smaller. From the spread of changes shown in Fig 4, evidently significant numbers of the CS sites also showed losses (and gains) of this magnitude.

Page 2269 lines 21-25

Bellamy et al. did not conclude climate change was the major cause of the losses measured in the NSI, they merely suggested a link. Kirk and Bellamy (2010) show that the major causes were past and continuing changes in land use and management, with a small contribution of climate change.

Page 2270 lines 12-19

Here it says 5 samples were taken from 5 "segments" of each of 256 plots in 1978 then each plot was resampled in 1998 – were the same locations taken within each "segment"? How were the segments defined? In Table 1 it says 277 plots were sampled in 1978 and 160 in 1998. Why are these numbers different? And how did only sampling 160 plots in 1998 give only 100 less samples in 1998 if only half the plots were resampled. Line 19 says 560 plots sampled in 2007 but table 1 says 1629?

Page 2270 lines 17-18

What proportion of the plots was re-located by maps and what proportion by markers? Presumably it would not be possible to achieve a re-location accuracy of 2-3 m (page 2287 line 12) with maps.-

Page 2270 line 26-page 2271 line 1

If the plot locations varied over time, what does a re-location accuracy of 2-3 m (last point) mean?

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Page 2271 lines 1-4

The difference in sampling method will affect the results; presumably sampling by trowel from the side of a soil pit would not give a uniform sample over 0 -15 cm. But a more important limitation is that only one sample was taken per segment. There is large short-range variability in soil carbon, even at a range of 2-3 m. This severely constrains the reliability of the estimate of the "plot" carbon content. By contrast, in the NSI, 25 cores were taken at each site on a 20-m by 20-m grid centered on the target point and bulked for analysis, and the same procedures were used for both samplings.

The problems with short-range variability and re-location error are evident in Fig. 4 of the paper. What is notable about the CS histograms of change are the heavy tails which show that the CS values for change are subject to substantial re-sampling error (e.g. if a peaty patch of soil in the plot was sampled in the baseline survey, but not at re-sampling, or vice versa). Data with a histogram like that should be analysed using robust statistical methods (e.g. Winsorized means).

Page 2271 lines 16-18

The use of regression predictions in place of a quarter of the baseline data needs to be taken into account in the subsequent analysis. If, as is likely, the "missing" 26% of the 1998 values were distributed substantially differently from the others (e.g. disproportionately on mineral soils), then the robustness of the method is compromised. More importantly, the variability of these 26% of observations will be smaller than the real data, and this will have inflated the significance level. This should be accounted for in the bootstrap re-sampling.

Page 2287 line 12

Relocation distance in the NSI was $\leq$ 20 m (equal to the side of the plot sampled) on enclosed land and $\leq$ 50 m on open land.

Page 2287 lines 15-16

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The statement that Walkley-Black is not appropriate for measuring soil carbon in soils with > 80-150 g kg-1 is misleading. All analytical methods have their pros and cons. Walkley-Black is more accurate than LOI across most of the range of soil carbon contents, but it becomes less accurate at large carbon contents, greater than approx. 150 g kg-1. The paper by Vos et al. cited does not appear in the references.

Page 2287 lines 16-17

The statement that a mixture of Walkley-Black and LOI was used in the re-sampling of the NSI is misleading. In the first and second phases of the re-sampling Walkley-Black was used for all samples. In the third phase (land uses other than arable and managed grass), soils with OC > approx. 150 g kg-1 were analysed by loss on ignition (LOI). This involved less than 6% of the samples. In Bellamy et al. it is mistakenly stated that all soils with OC > 150 g kg-1 in both samplings were analyzed by LOI. The editors of Nature declined to publish an erratum note on this because they considered it did not seriously mislead readers; it is however reported in Lark et al. (2009).

Page 2287 lines 24 -page 2288 line 18

The suggestion that the change in lab methods in the NSI resulted in major systematic errors is wrong. The change in method affected less than 6% of the samples, and only those with OC > 150 g kg-1. So this cannot have caused major errors. For the soils analyzed by LOI, the maximum C content was 500 g kg-1 because the LOI conversion factor was 0.5, as Chamberlain et al. say. Hence the upper limit of 500 g kg-1 for the re-sampled soils in Fig. 2 of Lark et al (2006). However, this only affected 6% of the soils, and so had no major bearing on the overall results. Only 5% of the soils in the original sampling (measured by Walkley-Black) had C contents > 300 g kg-1 (see Table 1 in Bellamy et al.).

Page 2285 lines 1-6

The statement that Bellamy et al.'s results may be partly explained by regression to the

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mean is wrong. There is a possibility of a regression to the mean in Equation (1) of Bellamy et al., which they used to interpolate the soil carbon changes at the sites that were not re-sampled for the map in Fig 1b, but did not use anywhere else in the paper. However, Lark et al (2006) show that the bias due to regression to the mean in this equation is small. So regression to the mean does not affect Bellamy et al.'s results in any way.

References

Kirk G.J.D. & Bellamy P.B. (2010) Analysis of changes in organic carbon in mineral soils across England and Wales using a simple single-pool model. Eur. J. Soil Sci., 61, 401–411. Lark R.M., Bellamy P.H. & Kirk, G.J.D. (2006) Baseline values and change in the soil, and implications for monitoring. Eur. J. Soil Sci. 57, 916–921. Lark R.M., Bellamy P.H. & Kirk, G.J.D. (2009) Response to comments on 'Baseline values and change in the soil, and implications for monitoring' by Potts et al. Eur. J. Soil Sci. 60, 483–484.

Interactive comment on Biogeosciences Discuss., 7, 2267, 2010.