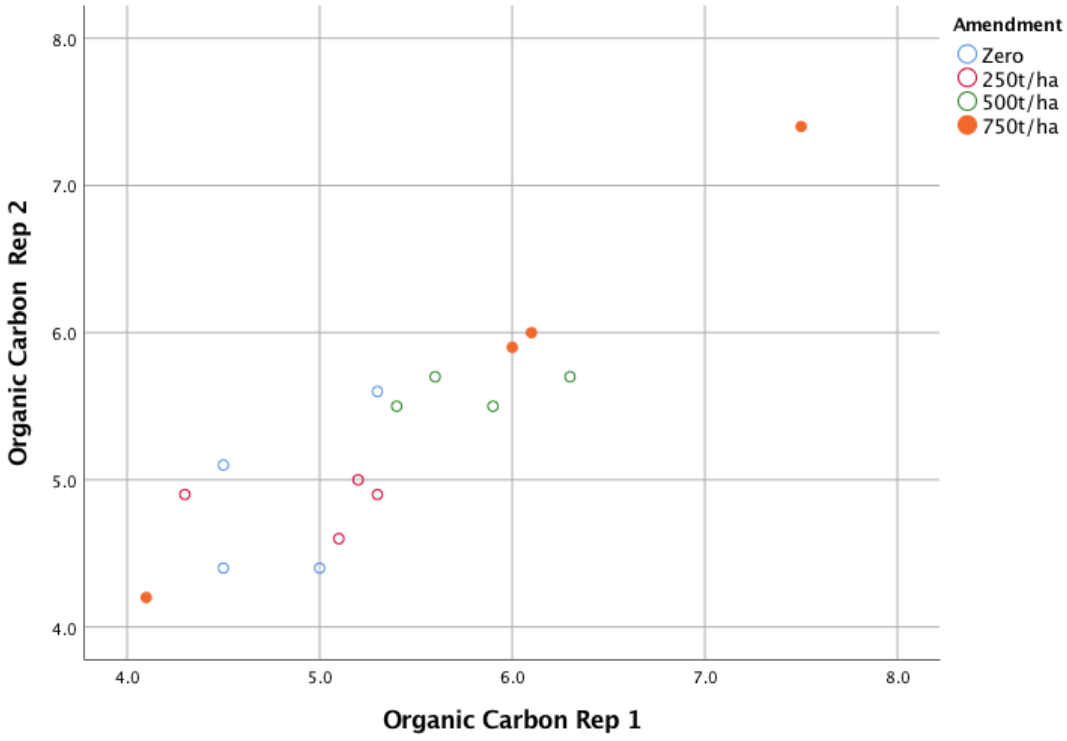
Project progress to 31-3-18

As was reported in December, 12 composite soil samples (each composed of 25 x subsamples, at depth 0-0.15m) have been successfully collected from the BioReGen project trial site in Rainton Bridge, Sunderland, and analysed for a range of determinants, including a full suite of contaminants, total and available nutrients. As the results of the analysis of soil organic carbon successfully showed an increase roughly in proportion to the rate of compost application in 2007, statistical analysis was carried out using SPSS in preparation for a publication targeted at Science of the Total Environment. However, detailed examination of the data has revealed an underlying problem with rather variable data in the four samples from the highest application rate plot. Accordingly, the commercial laboratory was asked to re-analyze stored samples for TOC. The confirmatory analyses received, which involved resampling the < 2 mm laboratory sample, show a statistically significant positive correlation (Pearson correlation coefficient = 0.901, two-tailed test $p < 0.01$) but also illustrate the underlying problem: The first and second samples from the 750 t.ha^{-1} plot returned both the highest and lowest overall concentrations of organic carbon in any sample in the overall study (Fig 1).

Fig. 1 Soil organic C (%) in samples returned by replicated analysis.



Statistical analysis.

The mean values of OC in the groups of 4 soils does still increase progressively in proportion to the compost application rate in samples from the control site, to the 250 t.ha^{-1}, 500 t.ha^{-1} and 750 t.ha^{-1} amended sites for both sets of analysis (table 1). As considerable scatter is seen in the 750 t.ha^{-1} data, in one-way (simple) ANOVA no significant differences were found between the means of the four groups (amendment rate) at the 95% significance rate for the first or second

batches of analyses of OC ($F(3,12) = 2.044$, $p=0.161$ and $F(3,12) = 2.040$, $p=0.162$ respectively). Likewise Bonferroni post hoc comparisons showed no significant (at $p < 0.5$) differences between pairs of groups. Using a repeated measures ANOVA also failed to show significant difference between the OC1 and OC2 repeated analyses of the same analytical sample (using the Greenhouse-Geisser corrected data as Mauchly's Test of Sphericity was violated, $F_{(1,15)} = 0.731$ $p = 0.399$).

Table 1. Average values of soil organic C (%) for replicated analyses

	Control (zero)	250 t.ha^{-1}	500 t.ha^{-1}	750 t.ha^{-1}
Rep 1	4.825	4.975	5.800	5.925
Rep 1	4.875	4.850	5.600	5.875

For the first round of analysis (Rep 1) the OC in samples amended at 500 t.ha^{-1} were found to be significantly different from those in the (unamended) control soils ($p=0.013$), but for the second round of analysis they were not significantly different at the 95% level. For those samples amended at 250 t.ha^{-1} and 750 t t.ha^{-1} rates they were not significantly different from the control samples in either round of analysis. The OC content of samples amended at 500 t.ha^{-1} were also significantly higher than those amended at 250 t.ha^{-1} in both the first and second set of analyses (at the 95% and 99% levels respectively). The results of such pairwise comparisons should be viewed with caution compared to ANOVAs, due to the propagation of Type 1 errors.

The lack of statistical significant differences may in part due to the combination of small samples size (n=4) and apparent scatter in the OC analysis for samples taken from each plot, even though each one was a bulked sample of cores of equivalent mass from 25 subsample sites. In particular, the first and second samples collected in the 750 t.ha^{-1} plot showed the lowest and then highest concentrations overall. Since these were collected in W- and M-shaped traverses respectively of 25 subsamples over the same area, parallel to the longest axis and across the entire width of the plot, it is difficult to attribute this to field sampling error. However, correlating PTEs tend to confirm a smaller or larger contribution from a compost-amended soil component in the two samples. Box plots (Fig 2) illustrate the difficulty trying to statistically distinguish groups of samples for the range of values returned for the 750 t.ha^{-1} plot.

Given the likely importance for publication in an international academic journal of obtaining statistically significant data demonstrating a higher residual soil carbon content in the plot with the highest original amendment rate, the site was revisited on 10th March, with the first and second samples re-collected and submitted for full analysis. The results, received yesterday, returned OC at 6.7% and 7%, so hopefully this will resolve the issue.

Future work

The need to resample from site and re-analyse, after awaiting the melting of lying snow, has led to delay in the anticipated programme of 2- 3 months. However, the results are positive and clear, so international publication preparation can now continue and should still be possible before the longstop date of 1/8/18.