

Comparison of measured and modelled soil organic carbon for a northern European long-term experiment site

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Introduction

Introduction

- Soil organic carbon is a key variable with regard to soil fertility influencing yield and yield security of agricultural crop production by regulating water budget and nutrient cycling. Those services might become even more relevant with respect to climate change.
- The sensitivity of crop yields on soil organic carbon content is influenced by site-specific conditions. To assess future vulnerability of yield security with respect to soil organic carbon contents in European croplands soil-crop models must consider the interaction of SOC and crop growth.

Method

- Long term experiments distributed across Europe that include treatments which lead to variable soil organic carbon contents can provide information on those relationships.

- Before examining the effect of SOC on crop growth via regulation of the nutrient and water cycle the applied model has to be evaluated with respect to an adequate representation of the modeled crop growth and SOC change
- The CENTURY 4.6 ecological model was used for estimating the soil organic carbon changes for the researched area. Modelled sites: crop rotation, crop rotation with added organic matter
- Input parameters: monthly average maximum and minimum air temperature, monthly precipitation, lignin content of plant material, plant N, P, and S content, soil texture, atmospheric and soil N inputs, and initial soil C, N, P, and S levels.

Conclusions

- The results of the simulation shows that the SOC changes of the researched crop soil by Century model is appropriate and the model is a good tool for the estimation of the investigated long-term experiment sites.
- The comparison of measured and modelled time series of SOC shows that the specific effects of organic amendments of various types (sewage sludge, green manure, straw, farm yard manure) on SOC can be simulated with Century.
- The model proved to be adequate to simulate the SOC in bare fallow treatments and treatments with low fertilizer N applications but overestimated final SOC stocks for treatments without N limitation.
- The CENTURY model can successfully estimate the yield data for the common crops. The results are in the same magnitude both for the added organic matter and for the added organic matter + mineral nitrogen fertilization treatment (table 2). For silo corn, the further fine tuning of the parameterization is necessary.
- As modelled crop biomass is overestimated by Century for the Swedish sites but meets measured results for German and Italian sites (Lugato et al. 2007) we suppose that the sensitivity of crop growth against temperature has to be adapted.

| Site and reference | Latitude/ Longitude | Country | Land use | Experiment years | Treatments | Initial SOC (g C / m ² to 20cm) | Mean total annual rainfall (mm) | Mean annual temperature (°C) |
|--------------------|---------------------|---------|----------|------------------|--|--|---------------------------------|------------------------------|
| Ultuna | 59.82N, 17.65E | Sweden | Arable | 56 | Straw, peat, sawdust, sewage sludge, FYM | 4291 | 502 | 5.7 |
| Darmstadt | 49.87N, 8.65E | Germany | Arable | 20 | Straw, FYM | 3101 | 775 | 9.9 |
| Speyer | 49.32N, 8.34E | Germany | Arable | 42 | Straw, FYM, FYM compost | 2170 | 622 | 10.7 |

Table 1: the long term experiment sites

Results

| Crop | Modelled yield (g/ m ²) | SD | Measured yield (g/ m ²) | SD | Modelled yield (g/ m ²) | SD | Measured yield (g/ m ²) | SD |
|---------------|-------------------------------------|--------|-------------------------------------|--------|-------------------------------------|--------|-------------------------------------|--------|
| winter wheat | 75.08 | | 67.70 | | 113.39 | | 62.85 | |
| oats | 120.61 | 112.68 | 153.12 | 41.28 | 198.63 | 174.04 | 153.10 | 38.12 |
| silo corn | 122.63 | 34.20 | 1273.06 | 604.79 | 553.32 | 138.52 | 1256.78 | 485.56 |
| summer barley | 164.42 | 119.43 | 126.16 | 47.67 | 265.82 | 177.39 | 124.21 | 45.19 |
| summer wheat | 134.38 | 50.31 | 155.07 | 23.98 | 196.52 | 50.27 | 158.20 | 27.58 |

Table 2: measured and modelled yield of the Ultuna site (FYM organic treatment and FYM + N mineral fertilization)

