THE 4PER1000 INITIATIVE — WHAT CAN WE LEARN FROM THE EROSION-CARBON NEXUS?

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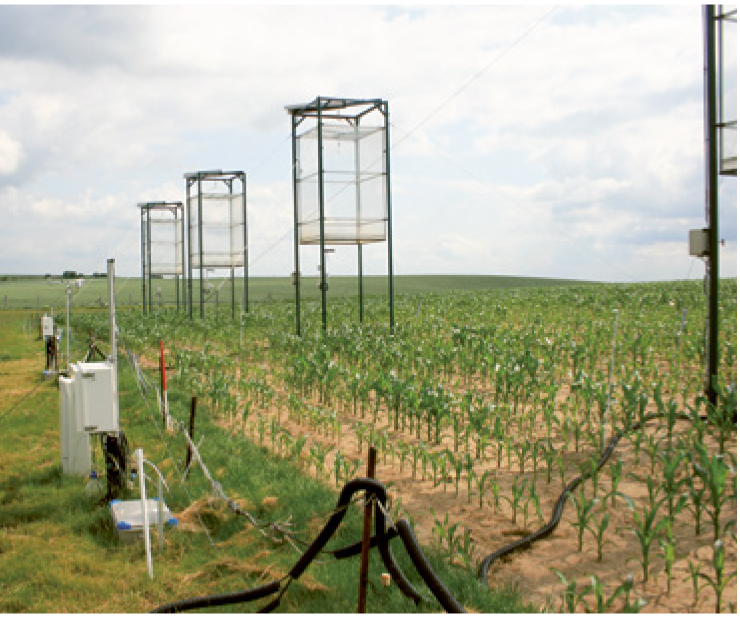


The CarboZALF experimental site near Dedelow (NE Germany)

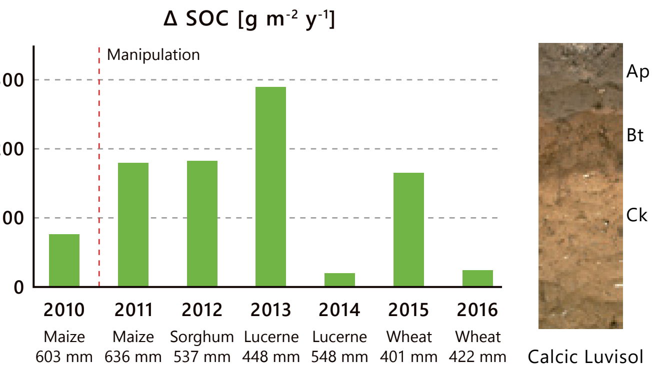
At the climate conference in Paris 2015 (COP21), an initiative was launched to reduce atmospheric CO_2 by means of an enhanced carbon sequestration into soils — the »4per1000 initiative: Soils for Food Security and Climate«. The basic idea behind this initiative is that a global increase in soil organic carbon (SOC) stocks by just 4 per mill (per year) will compensate for 80 % of the annual CO_2 increase in the atmosphere. A significant and sustainable increase of soil organic carbon, e. g. by management practices or amelioration, can only be achieved in soil systems far from equilibrium conditions, such as rewetted, formerly drained peatlands or carbon-unsaturated mineral soils

Basic principles of an enhanced carbon sequestration in carbon-(C)-unsaturated mineral soils can be tested in soils affected by soil erosion, since this process brings C-unsaturated subsoil to the surface.

At the CarboZALF-D experimental site near Dedelow (NE Germany), the magnitude, rates and mechanisms of soil C sequestration are quantified under controlled field conditions. A long-term manipulation experiment started in autumn 2010 with an artificial soil displacement in sloping terrain. Since 2010, all C fluxes needed to derive a full C balance have been measured for representative soil types. This includes a continuous CO_2 flux monitoring (net ecosystem exchange, NEE), a quantification of C exports by crop harvest as well as solute transports of organic (DOC) and inorganic carbon (DIC). Summing up all fluxes yields soil-specific full C balances corresponding to the change in SOC over time (= Δ SOC). After 6 years, the SOC stock of the artificially eroded site (Calcic Luvisol) has increased by 0.9 kg C m^{-2} in total. This effect has been described as »dynamic replacement« in scientific literature. We observed surprisingly high mean annual C sequestration rates (144 g C m^{-2} y^{-1}) - comparable to natural peatlands.

To further unravel the mechanisms of plant C transfer into the topsoil we set up a tracer study ($^{14}CO_2$ pulse labelling) for an eroded and non-eroded site, both grown with maize. The lab experiment revealed a very fast and surprisingly high transfer of plant C into the protected soil organic matter fraction (eroded ~2x non-eroded soil).

Our study proved the concept of a high, fast and sustainable C sequestration in mineral soils showing a high C saturation deficit. Of course, inducing soil erosion is not a reasonable measure to sequester CO_2-C. However, due to our new mechanistic understanding, we postulate the same effect for a controlled admixture of subsoil material into the plough (Ap) horizons. For this purpose, we will develop and test specific tillage systems to achieve a fast, considerable, and sustainable CO_2-C sequestration without a loss of soil fertility.



Dynamics of soil organic carbon (SOC) stocks at an eroded Luvisol from the CarboZALF experimental site

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