Investigations on the influence of climate change on the carbon dioxide release from soils of selected Hessian long-term soil monitoring sites

Dr. Karl-Heinz Emmerich, Oliver Wegener, Prof. Dr. Hans-Richard Wegener

At present about twice as much carbon is stored in soils with approx. 1500 gigatons organic carbon, as occurs in the atmosphere, and three times as much as in the vegetation. Soils are thus from a global view one of the largest carbon dioxide reserves.

According to initial calculations about 240 million tons of carbon are currently stored in Hessian soils (~$138 \cdot 10^6$ t in forest soils, ~$67 \cdot 10^6$ t in arable land soils, ~$37 \cdot 10^6$ t in grassland soils). With the projected climate warming enormous quantities of this storage carbon could be set free into the atmosphere.

With this project it should be reviewed if first results from Hessian long-term soil monitoring sites can be substantiated by laboratory experiments, so as to accelerate forecasts regarding the potential release of carbon dioxide from soils.

With the existing data sets (1992 – 2007) a general decrease of the carbon contents in Hessian soils could not be proved. The overall levels remain largely stable. But an analysis, differentiated according to land use and soil landscape, showed that there are obviously different potentials and developments, depending on the region and usage: both increases and decreases in carbon content were found. The observation of two arable land sites on loess, for example, shows a decrease in carbon content of about 0.2 % since 1993 (absolute difference). This is equivalent with a loss of about 14 t carbon per 10 000 m² in 14 years.

The incubation tests in the laboratory with different soils of 12 Hessian long-term soil monitoring sites were carried out under controlled climatic conditions with a simulated accelerated climate change (different temperature levels: 5, 10, 15, 20, 25, and 30 °C; unvaried soil moisture).

The laboratory experiments showed that higher temperature in general leads to a higher release of carbon dioxide due to an increasing biological activity in soil.

Regional diversities are important: For example, the long-term soil monitoring sites in the Rhön region (forest and grassland) show the highest carbon release.

There is a clear correlation between the release of carbon dioxide and land use. The release is highest at humous topsoils of forests, lowest at arable land soils. But the conversion of the carbon release (mg $CO_2 \cdot g^{-1}$ dry soil $\cdot d^{-1}$) of the laboratory experiment into potentially releasable carbon per 10 000 m² (kg $CO_2 \cdot ha^{-1} \cdot d^{-1}$) shows that the potentially releasable carbon quantities are highest on arable land, followed by grassland and forest.

A precise balancing is currently not possible. Due to the enormous quantities of carbon stored in soils, minimal changes would lead to large quantities of carbon dioxide being released into the atmosphere (0.1% loss in soil carbon in Hesse means about 250 000 t more carbon in the atmosphere).

Additional laboratory and field experiments are needed to provide detailed forecasts on the impact of climate change on soil carbon release.