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Impact of bioenergy production on carbon storage and soil functions

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An important renewable energy source is methane produced in biogas plants (BGPs) that convert plant material and animal excrements to biogas and a residue (BGR). If the plant material stems from crops produced specifically for that purpose, a BGP have a 'footprint' that is defined by the area of arable land needed for the production of these energy crops and the area for distributing the BGRs. The BGR can be used to fertilize these lands (reducing the need for carbon and nitrogen fertilizers), and the crop land can be managed to serve as a carbon sink, capturing atmospheric CO_2.

We focus on the ecological impact of different BGPs in Central Germany, with a specific interest in the long-term effect of BGR-fertilization on carbon storage within the footprint of a BGP. We therefore studied nutrient fluxes using the CANDY (CArbon and Nitrogen Dynamics) model, which processes site-specific information on soils, crops, weather, and land management to compute stocks and fluxes of carbon and nitrogen for agricultural fields. We used CANDY to calculated matter fluxes within the footprints of BGPs of different sizes, and studied the effect of the substrate mix for the BGP on the carbon dynamics of the soil. This included the land requirement of the BGR recycling when used as a fertilizer: the footprint of a BGP required for the production of the energy crop generally differs from its footprint required to take up its BGR.

We demonstrate how these findings can be used to find optimal cropping choices and land management for sustainable soil use, maintaining soil fertility and other soil functions. Furthermore, site specific potentials and limitations for agricultural biogas production can be identified and applied in land-use planning.