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Attributing greenhouse gas emissions associated with land use and land use change to direct and indirect human and natural drivers: a modelling study to estimate their relative importance.

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Since humans cultivated crops, domesticated livestock and exploited woods and grasslands they have directly changed land use. In Europe, most of the landscapes are anthropogenically influenced. Each land use will have its carbon stock in the soil and vegetation that will depend on the geography, parent material of the soil, the climate and its land use history. For each land use and cover the soil carbon stock will reach a steady state where the rate of decomposition of the soil carbon is balanced by the organic material input each year. Each type of vegetation will reach a steady state depending on the length of its plants life cycle; for annual plants it is months, perennial grasslands it is years and for forest it is decades or centuries. In addition, the management of the crops, grasses or trees can be intensive, where the maximum vegetation is harvested or grazed, or extensive, when part of the plant material is left as a soil input. Net carbon flux will depend on the carbon balance between photosynthesis and respiration. Methane flux will mainly depend of the water content and redox potential of the soil and nitrous oxide emissions will depend of the type and amount of nitrogen input, pH and the relative timing of rainfall events, as well as the climatic conditions. In his study we have used site experiments to parameterize ecosystem models such as ECOSSE, DAYCENT, PASIM and DNDC on sites where there were more than one land use treatment to investigate the relative impact of human direct and indirect drivers compared to natural ones. Once the models have been parameterized the drivers to be investigated are systematically changed. The land uses investigated are grassland, forest, peatland and cropland. The direct drivers investigated are land use change (from cropland and grassland to bioenergy grasses, cropland to grassland and forest) and management change from intensive to extensive and vice versa. The management drivers investigated include tillage, fertilizer amount, timing and type, crop residue management, catch crops, field drainage and animal stock numbers. For each experimental site we have also run the model from the current conditions to the future using climate predictions applicable to the site for both high and low emissions scenario to look at the overall impact of greenhouse gas (GHG) emissions. In general, we conclude that anthropogenic drivers have a larger impact on net GHG emissions than natural drivers with the exception of extreme drought in peatlands.