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Using vegetation dynamics to generate forest species and crop type maps as well as land-use intensity measures to support carbon stock estimations

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Land-cover / land-cover change together with varying land-use intensity are forces of global importance especially within the last decades. This concerns the conversion of natural ecosystems into agricultural land, but also the intensified use of agricultural areas which both translate into respective (decreasing) carbon stocks. Unfortunately, land-cover information at field level is often missing at larger scales. While there has been some progress for a more detailed spatial and thematic characterisation within the domain of arable land, especially forest and grassland ecosystems are largely rudimentarily described. Here we present a framework to address to above mentioned issues which provides field level information on crop types, tree species and land-use intensity in grasslands as well as the underlying phenology at a national scale (Germany).

We used Sentinel 2 a/b time series (all observations between 2016-2019) at 20 m spatial resolution. For training and validation InVeKoS (LPIS) data, forest inventories as well as farmland management data covering considerable parts of Germany were employed. The number of mowing and fertilisation events as well as livestock density served as indicators to estimate land-use intensity. Crop type and tree species classification relied on a novel compositing approach which is tailor-made to operate in temperate (often cloudy) climates and is easily scalable from a local to a national level. Land-use intensity in grasslands together with land-surface phenology could be inferred via time series analysis on the seasonal evolution of vegetation indices. Both classification as well as intensity estimates also included machine learning methods (randomForest).

We could achieve ca. 90 % overall classification accuracy for crops (19 types) and ca. 75 % for tree species (4 deciduous, 4 conifers) across Germany. Crop type and tree species specific phenology varied according to underlying topography and climate conditions. We identified between 1-5 annual mowing events across Germany, for most regions 2-3. Land-use intensity estimates were in line with areas typical of high/low livestock density. Altogether, this framework and its products can well serve as a basis to support robust carbon stock estimates for different ecosystem up to the national scale.