Report on country-level Analyses
D4.4 aimed at the development of a process-based understanding of land-use intensification, integrating biophysical, economic and institutional drivers of land-use changes in Europe in the last 100-300 years. To this end, two major tasks were performed: (1) empirical analyses of land use and land cover change in nine European countries. (2) methodological advances for a better understanding of the forest transition.

Empirical analyses of land use and land cover change in nine European countries during the last centuries led to the hypothesis that general patterns in land-use intensification exist which can be observed at different points in time and in some variations. Prior to industrialisation (i.e. before c. 1950), cropland expansion drove environmental pressures, such as the “Human Appropriation of Net Primary Production” (HANPP). With the Green Revolution, agricultural areas retreated, while agricultural output increased, allowing for forest recovery. In this period, environmental pressures were more determined by the intensification of existing agricultural areas. In total, the combination of the two effects led to relatively stable values of HANPP in Europe throughout the 20th century, ranging between 20% of NPP_{pot} (Net Primary Production of potential vegetation) in Sweden and 80% (Denmark). Since c. 1990, the collapse of the Eastern block (case studies for Romania, Albania) and EU policies (case studies for the Netherlands, Denmark) significantly reduced harvest in some countries. Overall, “HANPP efficiency”, i.e. the amount of biomass harvested per unit of HANPP almost doubled throughout the 20th century in the weighted average of our sample. This came at some ecological cost, as illustrated by the increasing number of tractors per unit of cropland (by over 200% in 1961-2000) and the use of fertilizers per unit of cropland (by 25% in 1961-2000). (figure 1)

The forest transition was analysed by a methodological exercise for the case of Austria (figure 2): A comparison of carbon (C) stocks assessed from forest inventories in Austria in the period from 1830 to 2010 with model results from commonly used book-keeping models showed significant differences: Inventory data (green line) revealed that forests acted as a C sink, while the book-keeping model (red line), based on the fact that forest harvest increased more strongly than forest area, produced a C source in recent decades. By including information on changes in annual increment of forests, an adapted version of the bookkeeping model (grey line) reproduced the inventory data. The best fit required annual increment per unit of area to increase significantly since 1910. These results are in contrast to common interpretations arguing that growth in forest carbon density in recent decades is largely a result of environmental change. In the early 20th century, such environmental effects, by and large, did not exist. Therefore societal drivers must have been responsible for changes in wood density of Austria’s forests. This exercise thus showed that traditional book-keeping models significantly underestimate the effect of forest management, and improvements are needed in order to derive robust measures for climate change mitigation.