Estimating the Change in Value of European Forestland under Climate Change

Is "Faustmann" an appropriate approach ?

Marc Hanewinkel

The paper describes an approach to estimate the change in value of European forestland under two climate change scenarios (A1FI and B2). The paper hypothesizes that range shifts of major commercial tree species in Europe due to climate change are linked to severe losses in the value of forestland. A first estimate for these losses for European forests is given based on a model for the future range shifts of important European tree species and an economic valuation of this process using a classical Faustmann-approach to estimate the change in Land Expectation Value (LEV). The input for the estimation of the LEV results from a large scale scenario simulation model EFISCEN that is based on national forest inventory (NFI) plots distributed all over Europe. The application of the Faustmann approach for this complex task is subject to a critical discussion.

The model to project possible range shifts of European trees is based on a large database of around 7000 plots of the International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forest). These plots are regularly distributed over Europe in a16x16km grid. Current climate envelopes for major tree species were calibrated based on theses plots using the Worldclim database (global 1 km climate data) and combined with own GIS modelling in order to express the major climatic gradients in Europe at a 1km spatial resolution. Generalized linear models (GLM) were then calibrated and applied to the whole European territory as an expression of the current range of trees. In order to assess possible range shifts, climate maps were developed that express future conditions following two IPCC scenarios, the A1FI scenario indicating a strong warming and the B2 scenario as a moderate scenario. Three sets of climate maps for each scenario were generated representing the same climate maps as under current conditions but adjusted to expected climate changes. The calibrated GLM models were then translated into GIS maps using the future climates representing potential range shifts. The resulting shifts were analyzed for range reduction/expansion and overlap with current ranges for six major tree species groups in Europe. First results of these models indicate that mainly cold-adapted and mesic species, namely Norway spruce, one of the main commercial tree species in Europe, but also European beech and Scots pine tend to loose larger fractions of their ranges than do more drought-adapted species like oak. Under the A1FI scenario the model predicts that in the year 2100 more than 60% of the overall 160 million ha of forest in Europe (without Russia) will be covered by a Mediterranean – oak forest type that is of almost no conventional commercial value, while major economic species like Norway spruce will be pushed back to the extremes of Europe in e.g. northern Norway.

In order to evaluate that process from an economic point of view, the value of the forestland of the major tree species was estimated using the classical land expectation value (LEV) based on a Faustmann approach as a proxy for the willingness to pay for forestland. Input of the Faustmann model were simulation results for the volume of thinning, final harvest and the remaining growing stock of the large-scale scenario model for Europe EFISCEN and actual data for costs and timber prices for major tree species in Europe. Results of this simulation show that there are considerable differences in the LEV between coniferous trees like Norway

spruce and hardwoods like oak, which might expand their ranges under climate change. Range shifts of the different species were analysed for “winners” and “losers” under the given scenarios and the differences in LEV of the remaining tree species ranges were calculated for the different scenarios. The results of this first approach to estimate the effect of climate change on the value of forestland show that, depending on the interest rate applied, a loss of LEV between 100 and 800 billion Euros for an area of 160 million ha of forest (between 600 and 5,000 Euro per ha) would be possible.
The paper finally discusses the limitations of the Faustmann- approach, that must still be looked upon as a comparative static approach in this case, for such a highly complex and dynamic problem. Especially the assumptions concerning perfect market conditions, constant future prices and costs and constant timber yield are scrutinised. A first precondition to improve the model output is a further development of growth models that should be able to depict growth and yield of major forest types in Europe under climate change. A combination of process-based and empirical models leading to climate-sensitive models would therefore be necessary. The next steps of the development of the EFISCEN model based on high resolution spatially explicit NFI data are outlined. Including major risks and their development under different climate scenarios is a second necessity. Again the development of mechanistic as well as statistical models or a combination of both is essential, together with improvements in forecasting extreme events. To account for volatile timber prices, methods accounting for stochasticity such as Monte Carlo simulations should be applied. A general outline of a modelling framework taking into account these aspects is presented.

Forest Research Institute of Baden-Wuerttemberg
Wonnhaldestr. 4
D-79100 Freiburg, Germany
Marc.Hanewinkel@forst.bwl.de