COST-BENEFIT ANALYSIS OF NEAR-NATURAL FORESTRY OF A BEECH STAND IN GRIBSKOV, NORTHERN ZEALAND, DENMARK

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ABSTRACT

Denmark has been managing rotational forests (RF) of Norway spruce for about 200 years despite the system has recently faced poor ecological stability, and hence raised economic and environmental risks and modern society's criticism. Nowadays, the Danish Nature Agency is converting all state owned RF of Norway spruce into a more nature-oriented and society-centered approach called near–natural forestry (NNF) so as to achieve sustainability of economic, ecological, environmental and social values.

The present study was a step ahead to evaluate in monetary terms the socio-economic and environmental effects of converting the current RF of Norway spruce stand into NNF of beech considering economic welfare values of four mostly demanded forest functions: timber production, recreation provision, groundwater recharge and protection, and carbon storage. The study applied cost-benefit analysis technique by means of benefit transfer. The study answered a major research question: How large are the economic welfare values of non-timber benefits of NNF to over-compensate cost of timber production including harvesting efficiency loss? The study area is focused specifically on a monoculture of Norway spruce stand in Gribskov, Northern Zealand targeted for conversion into European beech forest development type (FDT) guided by principles of NNF.

The economic calculations of timber were done starting from bare land after clear-felling of Norway spruce stand where considerably high plantation cost for beech stand establishment was assumed. The study also considered the advantages of natural regenerations, and economies of scales limitation of NNF against RF- measured by harvesting efficiency loss in regeneration harvests. The study used the standard tree growth table and economic data such as silviculture cost and stumpage price from Forest Economics Table. The economic welfare values from recreation of conversion to NNF over long-term was assessed by tracing Danes willingness to pay for NNF to four consecutive phases of the stand developments, using the respective "recreational scores" developed by EFORWOOD research project. The long-term economic welfare values of groundwater recharge gain of NNF of beech for drinking water use was valued multiplying it by the sum of the market price of groundwater and the Danes willingness to pay for groundwater protection. The long-term economic welfare values of carbon benefit was estimated multiplying living carbon stock developments differences between NNF of beech and RF of Norway spruce by carbon market price.

Then, the study estimated the gain/loss in economic welfare values of timber, recreation, water and carbon benefits in a common unit of accounts (DKK/ha) that allowed both an aggregation of the benefits and comparison between the relative importance of timber and non-timber benefits

using undiscounted measures (annuities) and discounted measures (net present values at 3% discount rate for infinite time horizon). Furthermore, sensitivity analysis was undertaken to examine particularly how changes in discount rates affect the socio-economic and environmental values; and how changes in relative price of timber affect the financial profitability of NNF, and the relative commodity importance.

The results revealed that changes in discount rate have a decisive influence on the profitability NNF of beech. Discount rates of 3% and higher, make the economic profitability of NNF of beech negative and less attractive than RF of Norway spruce mainly due to large regeneration cost for initial plantation of beech trees. On the other hand, discount rate of 2% and lower make NNF of beech more profitable than RF of Norway spruce since saving of subsequent plantation costs through natural regeneration of beech in NNF is realized. Extremely high harvest efficiency loss in NNF of beech would cause a negative economic profitability at 2% discount rate. However, the conversion to NNF of beech would gain at least 10 times larger aggregated economic welfare values from non-timber benefits than cost of timber to over-compensate the cost even in a 3% discount rate. The excess welfare gains stem from improved recreation provision, reduced evapo-transpiration loss, and increased carbon storages. The results also revealed that the rise in economic values of timber even with a 50 percent price rise in timber products is well enough below the economic welfare values of a single non-timber commodity at 3% discount rate.

In general, the conversion to NNF of beech embracing ensemble of attributes: natural regeneration, naturalness view, longer rotation, and winter leaf-less and smooth and plastic canopy of beech trees would produce synergies of worthwhile economic profit (at lower discount rate), recreation benefit, water benefit, and carbon benefit. This ascertains in monetary terms the betterment achievement of economic, social and environmental, i.e. ‘win-win-win’ objectives of NNF of beech. Assuming worst storms in non-native tree species and increasing Danes preferences for naturalness, groundwater protection, biomass energy sources and clean environment in the future will magnify the socio-economic and environmental benefits. Moreover, it is very likely that non-timber benefits will gain heavier weight than timber due to lower social discount rates applied in non-timber benefits than timber. The current study underlines the importance of welfare economics, and public preferences for multiple forest functions in achieving sustainable forest management.

Keywords: near-natural forestry, forest development types, cost-benefit analysis, harvesting cost penalty, economic valuations, multiple forest functions, outdoor recreation, recreation score, tree growth model, water balances model, biomass model.