Integrating the DPSIR - approach and the Analytic Network Process for the assessment of forest management strategies

Harald Vacik[*], Bernhard Wolfslehner, Rupert Seidl, Manfred J. Lexer

Department of Forest and Soil Sciences, Institute of Silviculture, University of Natural Resources and Applied Life Sciences, Peter-Jordanstr. 82, A-1190 Vienna, Austria.

* Corresponding author (harald.vacik@boku.ac.at)

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Extended Abstract
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Introduction

Within the scope of forest research there is variety of approaches of handling with SFM. The more "traditionalistic" view which comes from the original understanding of sustained (timber) yield is implemented in modelling sustainable timber production systems and sustainable forest economy systems respectively. On the other hand, an eco-physiological understanding of SFM is keeping up resulting in modelling of systemic states and dynamics as functions of ecosystem processes and substance flows. In this context, methods both serving communicational demands and dealing with multiple criteria and objectives gained in importance to go beyond the spheres where modelling approaches as described above convincingly operate.

Indicators are proven tools to assess or evaluate certain aspects of SFM (Mendoza and Prabhu 2003; Wolfslehner et al., 2005). They are custom instruments within political and certification initiatives. Indicators are powerful when to collect and report information within a system (e.g., SFM), which is usually characterized by a lack of knowledge, uncertainties and missing information about impacts, dependencies and feedbacks (Rametsteiner, 2001). On the other hand there are shortcomings when indicators are unclear defined, insufficiently reliable, not targeted or too strongly simplifying. Within SFM, indicators could serve various functions according to their purpose and their user (Linser, 2001).

For even improving their capabilities, indicators are often to be arranged in an indicator system in order to enrich problem perspectives and systemic understanding. The building of indicator systems or models forces to go beyond the boundaries of singular approaches because there is need for the analysis of linkages among indicators, check for plausibility and for concepts about changes in the system.

Application

In this study a Driving forces–Pressure–State–Impact–Response (DPSIR) approach of the European Environmental Agency (EEA) is adopted for the assessment of four alternative management strategies for a forest enterprise in Austria at the management unit level (EEA, 1999). The DPSIR framework seems highly capable of showing information in an analytical, causal way when differentiating between causes and effects as well as human measures and responses to control the amount of impacts to end users. However, the DPSIR approach itself does not accommodate demands of multi-criteria analysis and decision making since it suggests linearity in the relationship between human activities and the environment and fails to capture and evaluate different management options dealing with the problems of cause-

effects chain which are identified. Responding on these shortcomings, the Analytic Network Process (ANP) is introduced to represent connections and interactions between the indicators more accurately and in a systemic view within the model. The ANP is used to evaluate four different management strategies with regard to their potential in fulfilling the demands of sustainable forest management at Forest Management Level.

For the application of the DPSIR framework, the original approach had to be modified rather rigidly because forest management decisions should be addressed, and the objectives are transferred from environmental protection to the principles of SFM including economic, ecological and social indicators. So the DPSIR framework is modified by i) considering a forest management unit as the object system, ii) identifying driving forces which cause pressures at the FMU level, iii) interlinking the indicators in the framework with a MCDM method (ANP), and iv) evaluating time series of management strategies to estimate their effects over a certain period.

The relationships between the indicators of the different functional groups (DPSIR) and the alternatives are indicated in Figure 1 by means of arrows. Compared to original approach it is palpable that there are loops for the driving forces, pressures, impacts and responses indicating the relations between indicators also within a group. The management strategies are integrated bi-directionally both influencing the performance of the indicators and being influenced by a preconditioned and changing environment. As an exception, there is no influence of strategies on driving forces stated since they are assumed to be external.
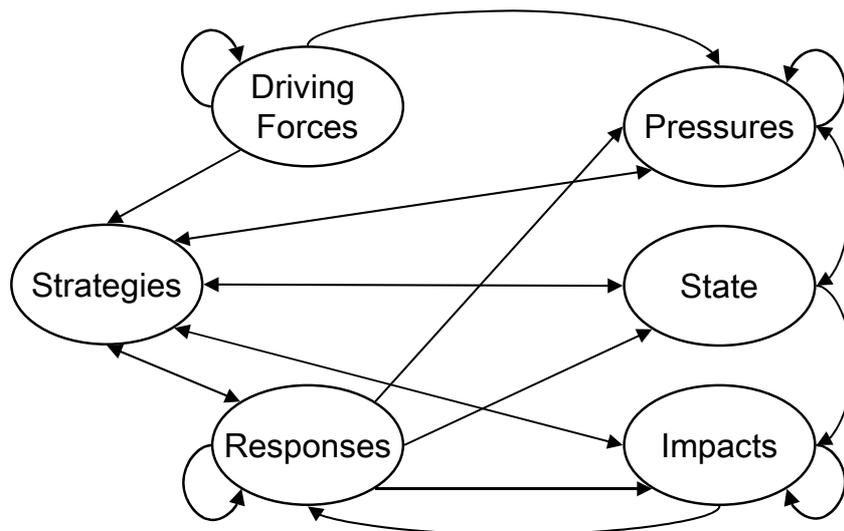

Figure 1. An adapted DPSIR framework including management strategies

For the evaluation of the four management strategies 33 indicators have been related to the D-P-S-I-R clusters. In practice, it is not an easy task to assign an indicator to one of the DPSIR clusters because it is always a matter of perspectives. By definition, an Impact is resulting from changes in environmental quality (EEA, 1999). In order to delineate this problem properly and to broaden the scope towards the three columns of SFM the Impacts within this adapted DPSIR framework are defined as the ratios of the current and the State of the next period in a prospective view for ecological, economic and socio-economic indicators (Figure 2). Input data for the ANP assessment were gained by the output of the hybrid forest patch model PICUS v1.4 and qualitative assessments of experts (Lexer and Hönninger, 2001). For each management strategy the performances of 33 indicators were calculated for a time period of 100 years at 20-years time-steps and for three different climate change scenarios. The qualitative assessments of the management strategies are based on pairwise comparisons for each indicator recurring at different time steps. The simulation outputs have been transferred to indicator priorities using linear preference functions.
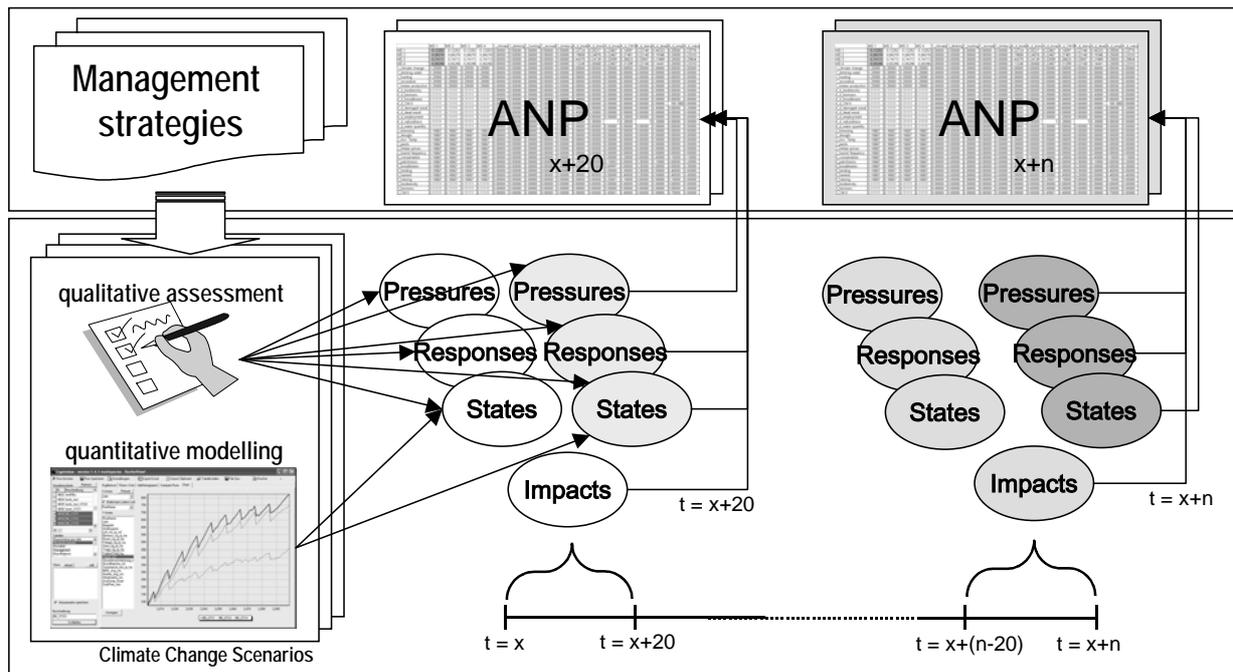
Figure 2: Data and information flow in the adapted DPSIR framework

Conclusion

The application of the DPSIR evaluation scheme is processing a holistic view on the performance of forest management strategies with pressures driven by external forces influencing the actual states of a forest and their impacts over time, yet to be antagonized by management responses. Covering all this, the overall results of the ANP evaluation show an undisputed favour of the conversion strategy for all time steps and climate change scenarios with regard to the principles of SFM. A transformation of the present conifer plantations dominated by Norway Spruce to more close-to-nature forests by introducing and pre-planting deciduous tree species is promising on the long run.

Hence, it has been the rationale of this study to combine the strengths of tools that enhance system understanding and those of multi-criteria decision making for the purposes of SFM while keeping the whole concept at least semi-quantitative by integrating ecosystem modelling results. This integration creates new viewpoints towards the communication of decision-making, towards the relations between ecosystem and decision-modelling, and towards the applicability of established approaches *per se.*

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