

A new concept in sustainable forest management – the need for forest ecosystem and landscape research

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ABSTRACT: The greatest advance in ecosystem research was made in the last century. The development and acceptance of forest ecology by foresters occurred because it provided a means for recognizing, understanding, classifying and mapping the natural variation of forests. Forest ecology involved studies at the individual, population, community, and ecosystem levels but such studies always needed to involve the ecosystem concept. Today, the new concept of “ecosystem and landscape forestry” integrating ecological and socio-economic research has been developed on the basis of EU COST Action E-25 *European Network for a Long-term Forest Ecosystem and Landscape Research Programme*. An analysis has been carried out of the present situation in forest research in the Czech Republic. The need for forest ecosystem and landscape research is obvious.

Keywords: sustainable forest management; forest ecology; ecosystem research; landscape research

In most cases, forests as a renewable natural resource represent undoubtedly the basis of wealth of a country and provide also an existence basis of the society. Forests give also the character to the country. Today, the economic importance of forests is many times compared with their environmental role. Europe holds most of the world's major types of forest ecosystems, it has a long history of human influence and provides good historical records of environmental changes and human impacts. The multi-functional use of forests is emphasized. In Central Europe, the forests are mainly managed. Management objectives and intensity vary. Sustainable management must have a basis in the knowledge of forest ecosystem principles and functions. Reasonable management and use not only of forests require the knowledge of forest types, their structure and functional characteristics, but also their behaviour under different ecological conditions including utilization forms and man-made environmental changes.

Historical overview of the concept of sustainable forestry

Sustainability has traditionally been seen as the ability to maintain productivity i.e. sustainability of yield. The approximately 200 year-old definition of the concept of sustainability was originally defined to the increment of wood. Later on, nature-oriented thinking in the silviculture was adopted (GAYER 1886) in Central Europe, but various authors dealt with this topic before. The silvicultural methods used were aimed at maximization of single product production, whether it was e.g. timber for saw

material, timber for pulp, fuel wood, cork, etc. This has lead to a situation where the European forests have been managed in a way that is different from that of natural forest dynamics: e.g. the dominant use of single species and even-aged forest stands. The most urgent objective of silviculture based on sustainability dealt with site sustainability (improving site-ecological conditions of production). The modern definition of sustainability is of an ecosystem nature and regards the forest as a whole, including neighbouring ecosystem IRSLINGER (1997). New management strategy for the forests of Europe was accelerated by the Ministerial Conferences for the Protection of Forest in Europe (Strasbourg 1990, Helsinki 1993, Lisbon 1998, Vienna 2003).

Development of forest ecosystem research

It has been a consistent experience throughout the history of forestry that only by understanding the ecological characteristics of forests they can be managed successfully. The empirical approach of “try and see” will become less and less useful because of the time required to produce an answer is too long. Later on, it was necessary to make possible accurate prediction about forests and their management without waiting decades or centuries for evidence on the success of our management practice. Such predictions cannot be made without understanding of forest ecology. In spite of that, recognizably ecological research began in the late 18th century and the greatest advances in ecosystem research were made in the last century (KIMMINS 1987). The development and acceptance of forest

ecology by foresters occurred because it provided a means of recognizing, understanding, classifying and mapping the natural variation of forests. Forest ecology is merely the application of general ecology to the specific type of an ecosystem, viz. the forest. Within the second half of the 20th century, forest ecology involved studies at the individual, population, community, and ecosystem levels, but such studies always needed to involve the ecosystem concept (ODUM 1971; SPURR, BARNES 1980; WARING, SCHLESINGER 1985), OTTO (1994), WARING and RUNNING (1998), DUVIGNEAUD (1998), BEGON et al. (1990) or biogeocoenose concept (SUKACHEV 1959). In spite of different meaning later on the term “ecosystem type” has been used as a synonym for “biogeocoenose”. For the first half of the 20th century, most of the progress in ecosystem research had been made through empirical, descriptive approaches, later on theoretically based mathematical models have come into increasing use. The *International Biological Programme* (IBP) in the 1960s and 1970s and ecosystem research within the *Man and Biosphere* (MAB) programmes were the first international, interdisciplinary long-term ecological research projects. The forest decline phenomenon in the second half of the 20th century has contributed to a growing appreciation of the importance of ecosystem research.

Multidisciplinary research projects based on above mentioned programmes in Europe and North America contributed to the evolution of forest ecology and particularly to the development of several disciplines such as soil chemistry and plant ecophysiology.

Present and future perspectives of forest management

Today, a new concept of “ecosystem and landscape forestry” integrating ecological and socio-economic aspects was initiated by ANDERSSON et al. (2000) and a new paradigm of sustainability in forestry and research

priorities have been developed on the basis of EU COST Action E-25 *European Network for a Long-term Forest Ecosystem and Landscape Research Programme*. The main objective of the project is to develop a scientific base and to initiate a European network of sites for forest ecosystem and landscape research of relevance to sustainable forest management. A schematic framework of the project is given in Fig. 1.

One of the main objectives of the COST Action E-25 is to establish a common database of European field experiments relevant to sustainable forest management, containing comparable information about sites, data and appropriate research programmes. Making national inventories of existing field research facilities is a necessary step in order to create this database for which guidelines are needed (MARELL et al. 2003).

Basic components of future studies will be aimed at structure, function and dynamics of ecosystem and landscapes. Corner-stones will be biogeochemical cycling (primary production and element input, turnover and losses at ecosystem and landscape levels), water cycle, biodiversity, interactions between population dynamics and biogeochemical cycling. Observations will combine remote sensing methods, statistical inventories, transects, instrumentation etc.

Consequently, much of the research has been focused on the major types of silvicultural methods and their effects on the ecosystem. Recently, the recognition of other functions of the forest ecosystems demands for an increased knowledge about alternative silvicultural methods, natural disturbance regimes, and their effects on the forest ecosystems: e.g. mixed species stands and uneven-aged forests. Therefore, the identified scientific issues below should be seen against the background of comparing different silvicultural methods with those of natural forest ecosystem dynamics. The modern concept of sustainable forest management brings to bear a wide range of disciplines on the management of the forest (ANDERSSON et al. 2000)

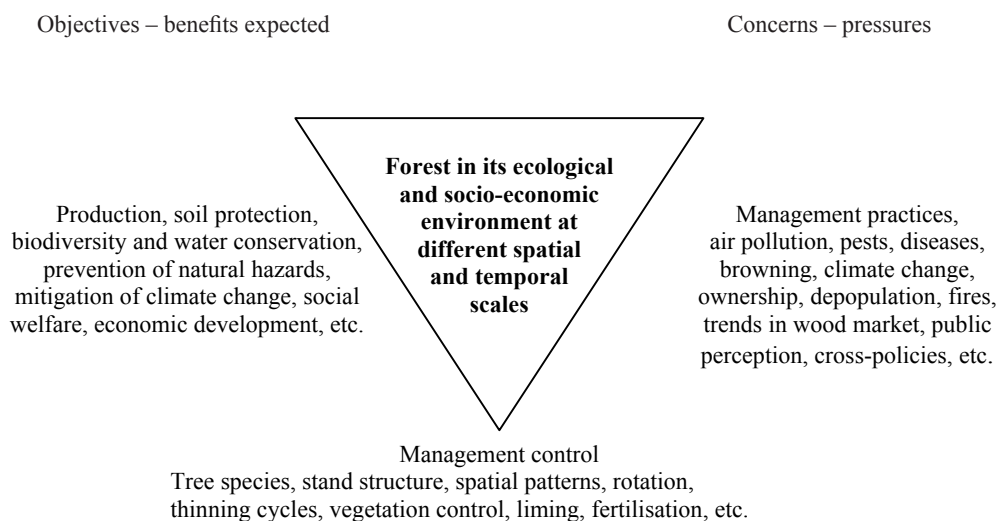


Fig. 1. A triangular network from which management questions arise (MARELL et al. 2003)

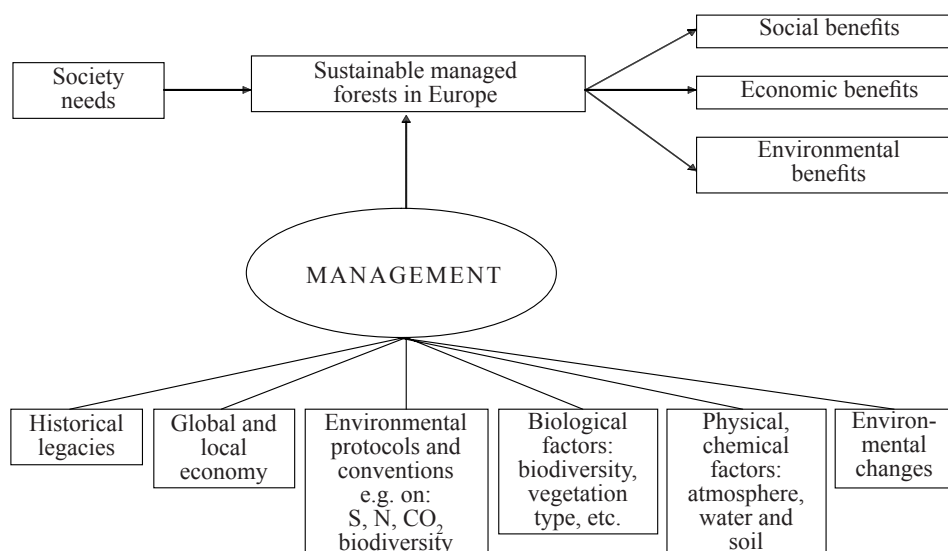


Fig. 2. Basic knowledge and facts determining planning and management for sustainable forestry (ANDERSSON et al. 2000)

and sustainability has been understood as much in terms of the maintenance of balanced nutrition of the plant cover, maintenance of the soil capacity for future production, maintenance of the hydrological stability of catchments, or the maintenance of other more society-centred values and amenities (FARRELL et al. 2000). Basic knowledge determining planning and management for sustainable forestry is shown in Fig. 2.

The knowledge needed for sustainable forest management concerns the ecological processes that are internal to the forest and those concerning the interactions between the forest and other elements of the landscape. Additionally, a holistic approach of the landscape is needed for the understanding of ecosystem functioning where the spatial structure of the landscape plays a key role.

Processes internal to the forest include ecosystem functioning, forest use, resilience, soils, stability, and vitality. Those processes identified as concerning the interaction between the forest and other elements of the landscape include climate change, CO₂, game behaviour, hydrology, nutrient cycling, socio-economics, and vegetation dynamics (Fig. 3).

The uniqueness with a landscape approach is that of considering and adding the spatial pattern and structure of the landscape and its components, and how it affects the forest ecosystem dynamics and their functioning.

Situation in the Czech Republic

The Czech Republic is one of the countries where, due to comparatively high population density and growing

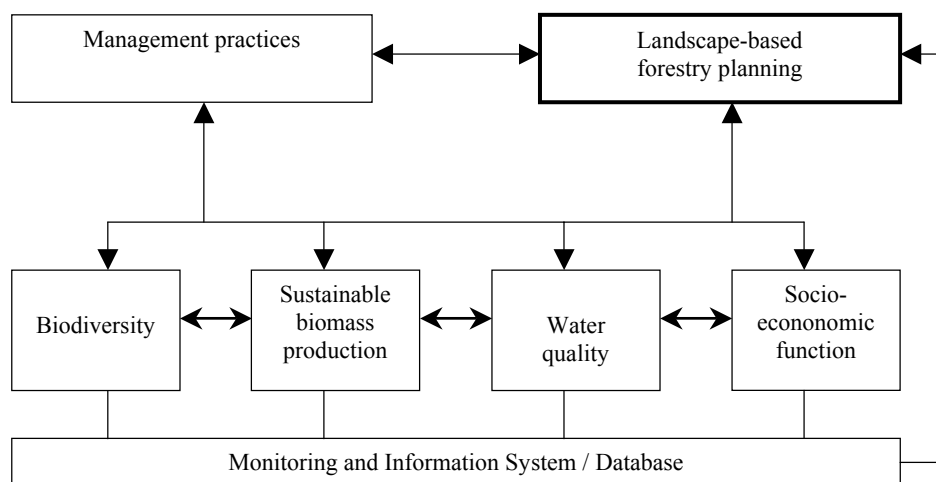


Fig. 3. Major components of ecosystem and landscape forestry aiming at sustainable forest management (ANDERSSON et al. 2000)

economic potential, the countryside has been dramatically changed within the last century. At present, almost 60% of the total forest area of the country (2.6 million hectare) are with visible symptoms of injury (VANČURA 1997). Marked forest decline appears mainly in mountain areas where up to now more than 45,000 ha of forests (1.7% of forest area) had to be untimely cut down and other 35,000 ha (about 1.4% of forest area) are dying or dead. Destruction of forest resulted in large air-pollution clear-cuts with extremely unfavourable condition for reforestation (SLODIČÁK 1997). The effect of air pollution is combined with snow-breaks and windfalls. Another main serious problem of forestry is inconvenient tree species composition. The aim of present forest research in the Czech Republic is to develop scientifically verified arguments (criteria and indices) to be applied in sustainable forest and landscape management. These shall be based on analyses of present conditions of forests and landscapes in the Czech Republic. Emphasis is laid on wood production as a renewable raw material and on meeting all other social and environmental functions. The study is motivated by changes in the hierarchy of the functions of forests and also by requirements of European Union to amend legislation in the field of forest policy and environment protection in terms of sustainable development. Main research is carried out by universities (Mendel University of Agriculture and Forestry in Brno, Czech University of Agriculture in Prague, Masaryk University in Brno), various institutions in the Academy of Sciences (Institute of Landscape Ecology, Institute of Entomology), by the Forestry and Game Management Research Institute and by several private institutions.

Institutional research

The institutional research project of the Faculty of Forestry and Wood Technology in Brno *Sustainable Forest and Landscape Management – from Concept to Reality* is aimed at searching for scientifically supported arguments for sustainable development of forest ecosystems in relation to the landscape under conditions of the Czech Republic.

At the Faculty of Forestry and Environment, Czech University of Agriculture in Prague, 4 projects are dealt with. A project *Multi-purpose Forest Management under Limit Socio-economic and Natural Conditions* deals with problems of methods and procedures of sustainable forest management optimum from the viewpoint of environment, technology and economics under limit conditions.

A project *The Use of Rare Forest Tree Species in Multi-functional Forestry and in the Forest-wood Complex in the CR* deals with problems of rare forest tree breeding with respect to the amount and quality of their production and harmful agent resistance.

A project *Possibilities of Increasing Ecological Stability, Retention and Accumulation of Water in the Landscape*

is aimed at the global study of the problem in the landscape with respect to flood control.

A project *Restoration of Functional Forest Ecosystems of the Krušné hory Mts.* deals with the extent of degradation of forest ecosystems of the Krušné hory Mts. affected by an air-pollution disaster and possibilities of remedial measures.

Research Institute of Forestry and Game Management in Prague deals with problems of stabilization of forest functions in biotopes disturbed by anthropogenic activities. In addition to this, research is focussed on forest tree breeding and gene pool preservation of valuable and threatened populations of forest trees.

Grant projects

Within the assignment of Czech and foreign grant agencies, research projects relating to sustainable management of forests are dealt with in the institutions mentioned above. It is necessary to mention for example the Laboratory of Ecological Physiology of Forest Trees of the Institute of Landscape Ecology, Czech Academy of Sciences aimed at plant physiological processes. These processes are studied with an objective to describe the production under conditions of changing environment, i.e. elevated concentration of atmospheric CO₂ and ultraviolet (ultraviolet-B) radiation. At present, activities of the Laboratory are focussed on the monitoring and evaluation of carbon pools in various types of mountain ecosystems. Research activities of the Laboratory are carried out on the experimental research site Bílý Kříž in the Beskids. The complete list of projects can be found in the central database of CEP projects: <http://www.msmt.cz>.

COST project

At the Faculty of Forestry and Wood Technology in Brno, a project *Long-term Research Areas on the Level of Ecosystems in the Czech Republic – a Contribution to the European Network* is dealt with. The project is dealt with within international cooperation in research and development (COST) and continues in the programme COST EU ENFORS E-25 – *European Network for a Long-term Forest Ecosystem and Landscape Research Programme* (<http://www.enfors.org/>). The COST project is a supporting project of ENFORS activities and its ambition consists in meeting the attributes of the project under conditions of the CR, i.e. to create a scientific base for establishing the network of long-term research plots aimed at sustainable management in forests and in the landscape, to establish a database for long-term forest research including comparable scientific information and to provide access of the information to the European network. The final objective of the project is to support and improve European co-operation and to ensure higher effectiveness of financial means spent on research.

Demonstration areas

In 1995, a survey of forest stands managed according to the system of near-natural silviculture was carried out. The result of the survey is an overview in the form of a catalogue where about 80 plots are briefly described in different forest regions of the Czech Republic. These plots are well managed by foresters and researches. A number of the stands is included into the European network of exemplary areas of near-natural forestry within the European Pro Silva Committee conception.

CONCLUSION

It has been a consistent experience throughout the history of forestry that only by understanding ecological processes within forests they can be managed as sustainable. The modern definition of sustainability is of ecosystem nature and regards the forest as a whole including neighbouring ecosystems. The empirical approach of "try and see" will become less and less useful because the time required to produce an answer is too long. The greatest advance in ecosystem research was made in the last century. The development and acceptance of forest ecology by foresters occurred because it provided a means for recognizing, understanding, classifying and mapping the natural variation of forests. Within the second half of the 20th century, forest ecology involved studies at the individual, population, community, and ecosystem levels but such studies always involved the ecosystem concept. The *International Biological Programme* in the 1960s and 1970s and ecosystem research within the *Man and Biosphere Programmes* were the first international, interdisciplinary long-term ecological research projects. The forest decline phenomenon in the second half of the 20th century contributed to the growing appreciation of the importance of ecosystem research. The necessity of ecological research was accelerated by adapting the new management strategy for forests of Europe after the Ministerial Conferences for the Protection of Forests in Europe. Today, the new concept of "ecosystem and landscape forestry" integrating ecological and socio-economic aspects was initiated in Europe by EU COST Action E-25 ENFORS. The objective of the paper is to support arguments for the broader use of ecosystem research in the conception of sustainable management and at the same time to promote the broader use of forest ecology within forest research and education of forest managers.

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Nové pojetí trvale udržitelného lesního hospodářství – potřeba výzkumu lesních ekosystémů ve vazbě na krajinu

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ABSTRAKT: Největší pokrok ve výzkumu ekosystémů byl učiněn v posledním století. Nastal rozvoj ekologie lesa a lesníci ji akceptovali, protože poskytovala prostředky pro poznání, pochopení, klasifikaci a mapování přirozené proměnlivosti lesů. Ekologie lesa se zabývala výzkumem na úrovni jedince, populace, společenstva a ekosystému, avšak takové studie vždy vyžadovaly ekosystémové pojetí. Dnešní nová koncepce „ekosystémového a krajinného lesního hospodářství“, integrující ekologický a socio-ekonomický výzkum, byla vyvinuta na základě programu EU COST Action E-25 *Evropská síť pro dlouhodobý výzkumný program lesních ekosystémů a krajiny*. Potřeba výzkumu lesních ekosystémů ve vazbě na krajinu se jeví jako nezbytná.

Klíčová slova: trvale udržitelné lesní hospodářství; ekologie lesa; lesní ekosystémy, krajinný aspekt

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