Connecting Social and Ecological Systems: Towards an Integrated Toolbox for Assessment of Forest Policy Implementation

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Abstract

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The role of forests and forestry is changing in the contemporary society. For a long time forestry and forest sciences were able to establish and maintain an own identity as a professional guild. However, in present days, communication and co-ordination of activities with other sectors and interests have become a prerequisite in many parts of densely populated Europe, and this trend is spreading.

To accommodate and address this change in forestry/forest research, tools from both the natural and social sciences are needed and should be used to: (i) evaluate the needs of society in particular landscape in order to be able to develop applications of conventional forest science knowledge base; and (ii) communicate to the society, policymakers and decision-makers the key issues of importance for the forest sector.

In this study, an attempt is made to combine ecological and social (institutional) aspects of biodiversity conservation in the forest policy process. The methods, experiences and general knowledge from the relevant fields are combined in designing and applying a simple-to-use toolbox for facilitating the process of biodiversity conservation in the context of forest policy implementation. Forested landscapes in Sweden, Lithuania and Komi Republic in Russia served as study area for this dissertation.

The integrated toolbox developed in this dissertation provides an example of and a framework for evaluation and facilitation of biodiversity conservation in the context of forest policy processes. This set of tools explicitly recognizes the connectedness, complexity, and ideological differences of ecological and social systems, and employs individual features relevant to these systems in an integrated manner to the benefit of facilitating policy implementation. With the use of "two-dimensional gap analyses", the needs of society in particular landscape can be evaluated in order to ensure the provision of ecological, economic and social functions of forest in an optimal way.

Keywords: forest policy, biodiversity conservation, social and ecological systems, Sweden, the Baltic States, Komi, Russia.

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I dedicate this work to those who paid the biggest price – my sons Kestutis and Markas Lazdinis.

Contents

Appendix

Papers I-V

The present thesis is based on the following papers, which will be referred by their Roman numerals:

I. Angelstam, P. & Lazdinis, M. 2004. Tall herb sites as a guide for the protection and restoration of riparian forest ecotones. Submitted to *Forest Ecology and Management*.

II. Lazdinis, M. & Angelstam, P. 2003. Functionality of riparian forest ecotones in the context of former Soviet Union and Swedish forest management histories. *Forest Policy and Economics*, in press.

III. Lazdinis, M. & Angelstam, P. Maintenance of forest biodiversity in a post-soviet political system: Conservation needs as perceived by local stakeholders in Lithuania. (Manuscript).

IV. Lazdinis, M., Carver, A., Tõnisson, K., & Silamikele, I. Innovative use of forest policy instruments in countries with economies in transition: experience of the Baltic States. *Forest Policy and Economics*, in press.

V. Lazdinis, M. & Angelstam, P. 2004. Connecting social and ecological systems: an integrated toolbox for hierarchical evaluation of biodiversity policy implementation. *Ecological Bulletins 51*, in press.

Setting the stage: focus of the study

The definition of sustainable forest management calls for an equal consideration of multiple functions provided by forests, i.e., combination of relevant ecological, economic and social aspects (Liaison Unit Vienna, 2000). However, an issue of a great importance in applied ecology still remains of how to find the balance between the use of renewable resources and the maintenance of biological diversity (Hunter, 1999). Forest environments form a particularly clear example of this problem. During the 1990's there has been a strong international trend in forest management towards having to satisfy several objectives other than wood production (*e.g.* Liason Unit Vienna, 2000). As a result, different approaches to systematic conservation planning have been proposed (*e.g.* Noss, O'Conell & Murphy, 1997; Margules & Pressey, 2000).

The basis for estimates of the need for conservation areas rests on the principle of representativity of different ecosystems (*e.g.* Pressey *et al.*, 1996), and on estimates of the gaps in the area of protected forest with high conservation value needed to maintain viable populations of forest species. These approaches are generally defined as gap-analyses (Scott *et al.*, 1987, 1988, 1989, 1993; Iacobelli, Kavanagh & Rowe, 1995; Jennings, 2000). Ideally the resulting networks of conservation areas should secure viable populations of even the most demanding species in each type of forest environment. If the amount of still unprotected forest to protect is insufficient, both restoration and re-creation of forest environments may be needed to satisfy the long-term goal for biodiversity conservation.

Different land use and forest management regimes world-wide in various time periods have resulted in larger or smaller gaps in the amount of habitat required for the conservation of biodiversity. In order to carry out conservation planning and assure maintenance of biodiversity in the governance of forest resources, besides biological knowledge on and scientific expertise in dealing with ecological systems, the effective policy implementation mechanism must also be present. In the social (or institutional) context, information on the needs for biological conservation must reach the right audience, so that the right decisions by society would be made (Boersma, 2001). The existing policy process, as related to biodiversity conservation and forest management in general, must provide an opportunity for setting conservational targets, choosing implementation instruments, and - through an organisational set up - successful achievement of the above objectives.

Only the right combination of both ecological and social (or institutional) dimensions of biodiversity conservation may lead to fulfilment of the conservation objectives (Figure 1). If treated separately, neither of these fields will lead to accomplishment of expected results (Brunckhorst, 2000). Scientific knowledge and expertise, without being successfully integrated into a societal process cannot become a part of management of natural resources (Bunnell & Johnson, 1998). Biodiversity conservation will not take part unless political will is generated and social and economic systems modified (Ehrlich & Wilson, 1991). Therefore, in the

search for gaps in biodiversity conservation, both biological and political dimensions must be considered.

In this study, an attempt is made to combine ecological and social (institutional) aspects of biodiversity conservation in the forest policy process. The methods, experiences and general knowledge from the relevant fields are combined in designing and applying a simple-to-use toolbox for facilitating the process of biodiversity conservation in the context of forest policy implementation.

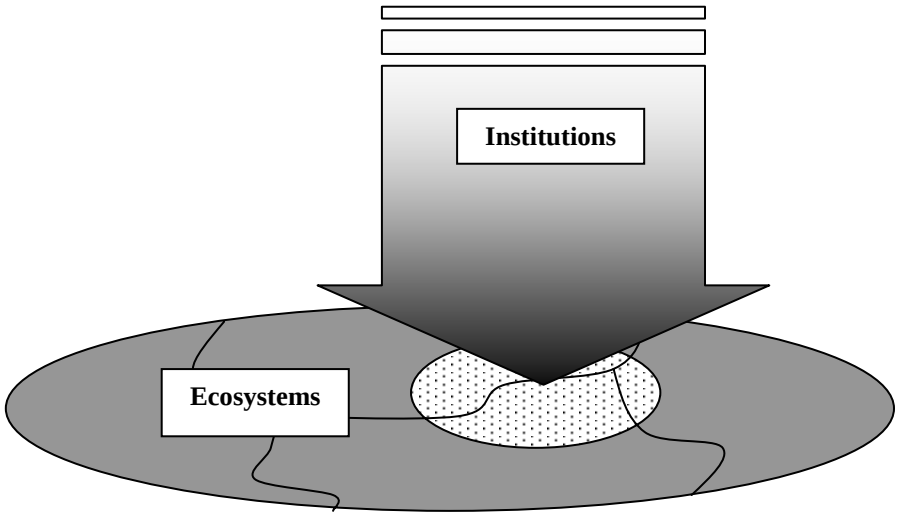

Figure 1. Ecological and social (institutional) dimensions of biodiversity conservation.

The broader context: the gap between societal processes and forestry/forest research

The role of forests and forestry is changing in the contemporary society (Ticknor, 1993; Kennedy, Thomas & Glueck., 2001; Elands *et al.*, 2004; Hoogstra, Schanz & Wiersum, 2004; Kennedy, & Koch, 2004; Ziegenspeck, Härdter, & Schraml, 2004). For a long time forestry and forest sciences were able to establish and maintain an own identity as a professional guild. However, in present days, communication and co-ordination of activities with, or even dissolution within other sectors and interests have become a prerequisite in many parts of densely populated Europe, and this trend is spreading also to other areas.

Another trend in contemporary forestry and forest science is related to the spatial scale. Traditionally most of the decisions were taken within the boundaries of forest cover at the stand scale. Nowadays, however, forestry decision-making and forest sciences are moving up to the landscape scale, where sectoral interests must be closely co-ordinated with other needs and interests of local, national as

well as international communities (Sayer & Campbell 2003). This also means that forestry and forest science need to leave the forest and consider the interactions within actual landscapes such as watersheds.

With these changes, forestry and forest science have become largely dependent on the decisions made and policies formulated in broader interdisciplinary contexts. The interface between conventional forest science (and those part of operational forestry), and the ones in charge of or involved in policy-making, is filled with policy advisors, policy analysts and an increasingly active public (Maini 1998). Often they have little knowledge of forestry-related issues as well as of the forest ecosystems.

Moreover, different segments of society seek information organised in different ways. If communication within the sector has established channels that take place with the help of scientific publications, co-operation in networks as well as on a personal basis, conveying our interests in the context of landscape-scale decision-making including several other sectors is not that easy. Senior decision-makers, politicians and the general society are often interested only in answering questions such as "are we winning or losing?" (Figure 2).

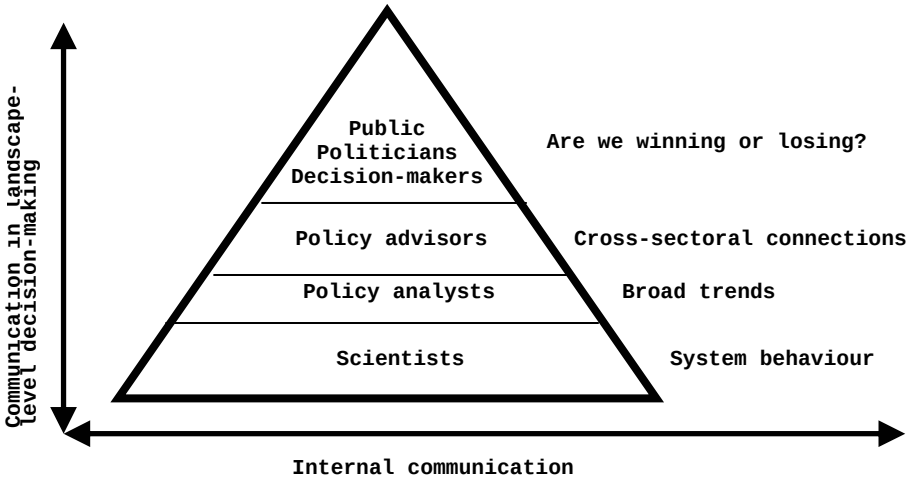

Figure 2. Communication in forest sector at the landscape level (adapted after Maini 1998).

Therefore, moving up in the pyramid of communication, the information on forest-related issues increasingly must be synthesised. Nowadays, we must realise that forestry has become only one of many interests of society's (represented by politicians) use of different values in landscapes, and forestry is not necessarily prioritised. Due to this complexity only the key findings concerning change in resources and the state of forest biodiversity can be communicated to decision-makers, politicians and the general society.

On the other hand, in order to identify itself and address the right issues within the context of dynamic social, economic and ecological processes in a given landscape, the forest sector must learn about the societal needs and lists of

priorities. Evaluating the core needs of society and developing proper applications in actual landscapes is another crucial task for forestry and forest sciences.

However, the synthesis and focus on essential issues in this two-way communication process between society and the forest sector in a broad sense require combination of a broad range of special skills. Unfortunately, due to the fundamental conceptual differences between ecological and social systems, this task is not an easy one.

First, in general the relationship between social and natural systems is still poorly understood (Machlis & Forester, 1996). Second, forest resource management process until recently was viewed as linear. The conventional reductionist view in science considered that complex phenomena could be studied and controlled by reducing them to the basic building blocks and identifying the mechanisms of interaction (Holling, Berkes & Folke, 1998). Third, the operational link between social and ecological systems is difficult due to fundamental ideological differences (*e.g.* Penn, 2003) (for more in-depth review of the above conceptual differences see paper V in this dissertation).

Therefore, in order to bridge the gap between forestry/forest research and societal processes (*e.g.*, policy-making and implementation) on the landscape level the barriers such as those listed above should be addressed. Explicit recognition of the connectedness, complexity, and ideological differences of ecological and social systems is the first step towards maintaining and improving the importance of knowledge base on forests and forestry in order to better serve the society with new applications (Vogt *et al.*, 2002). A prerequisite for further development of forestry and forest research is to understand both ecosystems and institutions, and the complex interaction between them. Integration of several fields of research (*e.g.* socio-economic issues, biodiversity, timber production, water, climate, ecosystem and landscape dynamics in general) is therefore necessary in order to manage this system contained of humans and nature. The second step is development and application of scientific tools and planning instruments allowing to focus on essential issues, which could be communicated to, discussed and integrated with the broad range of societal interests.

This means that in order to bridge the gap, tools from both the natural and social sciences are needed and should be used to: (i) evaluate the needs of society in particular landscape in order to be able to develop applications of conventional forest science knowledge base; and (ii) communicate to the society, policymakers and decision-makers the key issues of importance for the forest sector. This means, assessments of the status of actual landscapes with their distinct land-use types and ownership as well as of the relevant institutions are required (Lazdinis, 2002; Angelstam *et al.*, 2003). On the basis of such an approach substantive proposals for improvements in land management practices can be made, which will be commensurate with the demands of landowners, land users and society as a whole. These tools should be used in active adaptive manner in the framework of cyclic planning process.

Methodology and results

General structure of the thesis

A broad range of scientific methods was used overall in this study. Combination of research transcending individual disciplines requires also knowledge of the variety of scientific instruments typically relevant to the distinctive fields of research (Jakonsen, Hels & McLaughlin, 2004). The summary of work completed in the context of this dissertation is structured along the traditional subdivision into ecological and social dimensions and provided in Table 1.

Table 1. *Studies completed in the context of this dissertation*

	Ecological dimension	Social dimension
Summarising (umbrella) article	Paper V: Lazdinis, M. & Angelstam, P. 2004. Connecting social and ecological systems: an integrated toolbox for hierarchical evaluation of biodiversity policy implementation. *Ecological Bulletins 51*, in press.	
Licenciate exam spring 2002	Paper I: Submitted to *Forest Ecology and Management*. Angelstam, P. & Lazdinis, M. 2004. Tall herb sites as a guide for the protection and restoration of riparian forest ecotones.	Paper II: Lazdinis, M. & Angelstam, P. 2003. Functionality of riparian forest ecotones in the context of former Soviet Union and Swedish forest management histories. *Forest Policy and Economics*, in press.
PhD thesis 2004	Paper III. Manuscript in progress. Lazdinis, M. & Angelstam, P. Maintenance of forest biodiversity in a post-soviet political system: Conservation needs as perceived by local stakeholders in Lithuania.	Paper IV: Lazdinis, M., Carver, A., Tõnisson, K., & Silamikele, I. Innovative use of forest policy instruments in countries with economies in transition: experience of the Baltic States. *Forest Policy and Economics*, in press.

The two papers (I and II) about riparian forest ecotones provide an introduction to some of the elements of both ecological and social dimensions in biodiversity conservation. Paper III focuses on the issue of biodiversity conservation, however, with an emphasis of the study on human attitudes and interests. Paper IV may be considered as purely of an "institutional" nature, as it addresses policy instruments applied in forest governance in the Baltic States. The last paper (V), as part of this dissertation, attempts to integrate the available tools in both ecological and social systems in order to evaluate, and subsequently facilitate, policy implementation in the field of biodiversity conservation. The objectives of, methods used and results discussed in the above papers are individually presented further in this section.

Study area

Forested landscapes in Sweden, Lithuania and Komi Republic in Russia served as study area for this dissertation (Figure 3).

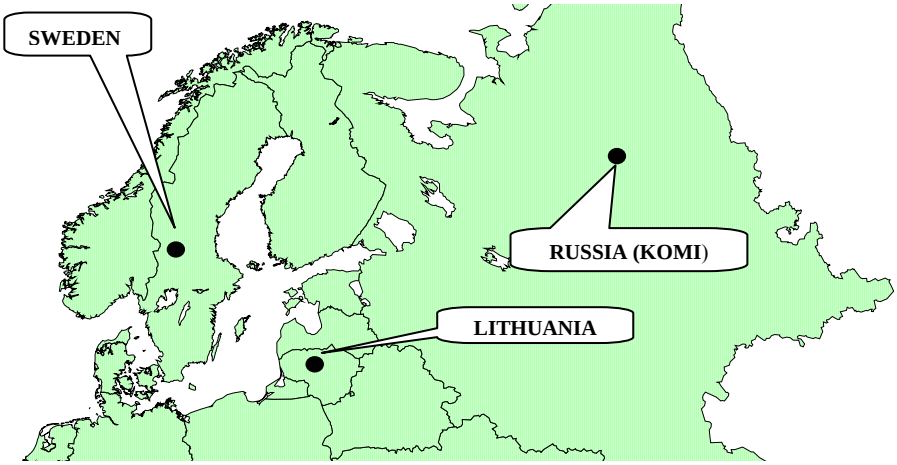

Figure 3. Study area.

Due to relative political and historical stability in Sweden, forest management and biodiversity conservation trends have developed at a steady pace. Long traditions in forestry and a high significance of the forest sector for the national economy have created a complex decision making environment. Varying environmental conditions from south to north make management of forest resources and conservation of biodiversity even more complicated tasks (Angelstam & Pettersson, 1997). Therefore, for the purposes of this study, it was considered that in order to find a balance between the use of renewable resources and the maintenance of biological diversity in Sweden, particular emphasis should be paid to reference areas with similar, however, less complex, climatic conditions, more dynamic political arena, and less complicated decision-making environment.

Former Soviet Union in general, and more particularly Lithuania, in this dissertation, was most commonly used as one of the reference areas. The forested area of this country is much smaller than that of Sweden, as well as the entire forest (and related) sector. Decision-making environment in Lithuania has fewer interest groups and relevant stakeholders as compared to Sweden. The above differences between two countries influenced the choice of using Lithuania as a less complicated reference, both ecologically and institutionally, where the instruments for biodiversity conservation could be developed. Additionally, the availability of spatially explicit forest databases for the entire country provided a unique opportunity for this research endeavour.

In the Komi Republic, forest management history is relatively recent, as compared to Sweden (for more details see paper II). During the 17th century, forest was used only near large cities. However, with the connection of development in oil and coal industry, the volume of logging increased significantly. Komi

Republic, being an administrative unit of the former Soviet Union, provided a good match for Lithuania, serving as reference areas for Sweden.

The ecological dimension (papers I and III)

In paper I, results of the study on riparian forest ecotones are presented. Riparian corridors were selected as the study object due to their importance in biodiversity conservation. Riparian forests provide the foundation for significant plant and animal species richness, structure and process in both terrestrial and aquatic ecosystems. In naturally dynamic boreal forests, stands with gap-phase dynamics along streams often provide a network of habitat with a high degree of continuity in tree canopy cover. The intent of this paper was to evaluate management guidelines advocating constant width of riparian forest protected zones in managed landscapes. Based on the experience that tall herb sites indicate a potential for temporally continuous gap-dynamics forests, three null hypotheses were tested, i.e. that tall herb sites: (1) are equally common in the riparian zone and in the surrounding forests; (2) have the same width on both sides of a stream; (3) and their widths are independent of the width of the adjacent stream. The ground vegetation in transects along and perpendicular to streams was described as well as in the surrounding landscapes, in naturally dynamic and managed riparian ecotones in the former USSR and Sweden, respectively. Tall herb sites were found to be 21 to 27 times more common close to streams than in the rest of the landscape, and riparian ecotone widths varied considerably along streams. Streamside ecotone width was independent of stream width. As conclusion, in this study it was suggested that the local site conditions could be used as guide for conservation, restoration and re-creation of networks of riparian continuous cover forest ecotones.

Paper III focuses on assessing the conservation needs as perceived by local stakeholders. Using two forest management districts in Lithuania as case studies, it was investigated how local stakeholders directly involved in forestry operations understand biodiversity and the management efforts needed to implement conservation. Using a structured in-depth interview approach of key informants and a telephone survey the needs of those stakeholders from their own perspective were evaluated. It was found that local stakeholders were relatively well informed about the need for biodiversity conservation in general, but less about the specific means to maintain biodiversity at different spatial scales. Their understanding of the biodiversity concept and perception of practical implementation of conservation instruments varied and did not always correspond to the initial objectives of the instruments. The local stakeholders reported no need for use of additional conservation instruments than those at the stand scale.

This study was carried out in Lithuania, having a post-soviet political system, with very limited traditions and experience in public participation. Prevailing traditions of centralised policy- and decision-making for at least a decade, after the break down of the Soviet regime, were coupled with foreign aid facilitating development of the forest and environmental sectors in the former Soviet Union countries. The direct and indirect political pressure within the framework of bilateral co-operation and international processes often supported this “export” of

the expertise from western to eastern societies. In the context of rapidly changing and developing economic systems as well as shifting social values, most of this "know-how" has been adopted without deeper considerations. One example is the introduction of a whole range of instruments to facilitate conservation of biological diversity in forest ecosystems.

The paper concluded that the notion of biodiversity conservation was introduced in Lithuania using a top-down approach, with little involvement of local stakeholders in the preparatory and policy formation stages of relevant instruments, and that this practice should be changed by enhancing participation of stakeholders in policy- and decision-making.

The institutional dimension (papers II and IV)

In paper #2, functionality of riparian forest ecotones in the context of two – former Soviet Union and Swedish – forest management histories is investigated and discussed. Forest management in Central and Eastern Europe, under direct or indirect Soviet influence, for a long time followed different management objectives and strategies as compared to the forest management in countries with market economies in Western Europe located in the same biogeographic zones. In the light of the appearing paradigms of natural disturbance regimes and ecosystem-based forest management we evaluate forest management in the former Soviet Union and Sweden with respect to conservation of riparian forest ecotones. The focus of this study was the site and forest age class distribution both along watercourses and at randomly selected locations in the surrounding terrain in managed landscapes in Sweden and the former Soviet Union, respectively. It was found that along watercourses in the former Soviet Union 20% of the overall forest cover was classified as old-growth compared with 6% in the surrounding landscape. By contrast, although the proportion of site type distribution was similar, such forests were neither found along watercourses nor in the surrounding landscape in Sweden. The results hence showed that the Soviet management policy resulted in better conditions from the biodiversity conservation perspective. The conclusion was that the forestry decision-making environment does matter for practical forest conservation.

During the study presented in paper IV, forest policy instruments in the Baltic States were compared and discussed. Policy tools form one of the key components in the forest policy process. The main objective of this paper, therefore, was to highlight national innovations in application of forest policy tools, and in doing so, to present national decision-makers with a broader variety of instruments available for solving issues of concern in the national forest sectors. This study at a general level of classification found almost no differences between the sets of policy instruments used in Estonia, Latvia and Lithuania. However, analysis of individual elements comprising each forest policy tool led to the identification of some national peculiarities. Based on the differences in application of elements of individual policy tools, innovative approaches in individual countries were presented.

An integrated toolbox for assessment of forest policy implementation: Two-dimensional gap analysis (paper V)

The overarching discussion on ideas presented in this dissertation may be found in paper V. An effective implementation of recent policies on sustainable forest management, which include the maintenance of biodiversity, requires an integrated set of tools for evaluating the status of ecosystems and of the policy implementation process by society's institutions. As a way of integrating analyses of ecological and social systems in these two dimensions in the context of forest policy formation and implementation, it was proposed to combine methods from natural and social sciences using the term "two-dimensional gap analysis". The ecological dimension involves analyses of the networks of different types of ecosystems in actual landscapes. It includes: 1) estimation of regional gaps in the amount and representation of different ecosystems; 2) analyses of the functionality of the habitat networks in terms of hosting viable populations and ecosystem processes; and 3) understanding of how protection, management, and restoration measures can be combined in practice at different spatial scales. The social dimension concerns the implementing actors and institutions in a selected actual landscape or region and includes: 1) identification of the actors and mapping of policy networks; 2) identification of the issues of concern; and 3) evaluation of policy implementation in the defined socio-ecological system. The examples of methods to carry out all six steps in the context of the policy formation and implementation cycle were provided in this paper.

Conclusions: the paradigm has changed

This dissertation attempted to apply the variety of research methods and tools, the collection of which in one integrated and overarching approach is transcending individual disciplines. This integrated toolbox provides an example of and a framework of evaluation and facilitation of biodiversity conservation in the context of forest policy processes. This set of tools explicitly recognises the connectedness, complexity, and ideological differences of ecological and social systems, and employs individual features relevant to these systems in an integrated manner to the benefit of facilitating policy implementation. With the use of "two-dimensional gap analyses", the needs of society in particular landscape can be evaluated in order to ensure the provision of ecological, economic and social functions of forest in an optimal way. It can also help to communicate to the society, policymakers and decision-makers the key issues of importance for the forest sector.

However, to successfully apply and expand the toolbox, some issues must be recognised. It has to be acknowledged that fundamental paradigm for forest policy formation and implementation has changed. Sectoral policy initiatives do no longer provide an appropriate response. A different type of action, which embeds forestry and forest research in thematic and territorial processes, is needed. The crucial question is how the contribution of forestry and forest research can be

maximized within this new framework. Forest policy- and decision-makers as well as those practicing forest-related sciences should adapt to and not resist this change and be the first to take the initiative in meeting this challenge, otherwise they may find themselves more and more in the defensive role in the forest policy processes.

To accommodate this change, managers and their institutions must realise that socio-ecological systems are complex, self-organising, and adaptive systems with dynamics in multiple spatial and temporal scales across several levels of organisation. Only an explicit recognition of this complexity and application of transdisciplinary approaches will lead to progress in combining the efforts of managers and scientists to effective forest policy implementation. In general, on the one hand, the policy- and decision-makers must be educated and equipped with techniques to cope with both increasingly complex and inter-related environmental issues (Bierbaum, 2004). The successful policy-makers and managers of natural resources of tomorrow will need to be able to understand the language of many disciplines and integrate information across them to find feasible, efficient and socially-acceptable solutions (Bierbaum, 2004). Moreover, they must be skilled enough to facilitate the reciprocal process of learning and communication – both about the needs and expectations of stakeholders as well as educating stakeholders to be literate decision-makers. Local stakeholders, on the other hand, must make the efforts to become literate decision-makers and learn to explicitly state their interests, as well, as make decisions concerning management of natural resources in a responsible way.

Forest scientists, and particularly those working in the field of biodiversity conservation, must expand their interests beyond the boundaries of their ecological systems of expertise and acknowledge this change in paradigm as well. Moreover, they must take a leading role in facilitating multidirectional communication in the implementation of forest policies. The professional help is necessary in conveying the message between individual disciplines, sectors, and stakeholders. However, to effectively provide this help, instruments available from integrated toolboxes, as suggested in this dissertation, could be employed.

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