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Adaptive management of forest resources: Principles and process

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'Nature Forest in Society' is the online discussion paper series of the Forest and Nature Conservation Policy Group at Wageningen University. In general, the Forest and Nature Conservation Policy Group focuses in research and teaching on political processes underlying the various relations between forests, nature and people. Political processes are thereby understood in a broad sense as the constrained use of social power in decision making processes of governmental, managerial or interest bodies from local to international level. The intention of the series is not to function as a publication media, but to provide insights into ongoing research activities at the group and thereby to stimulate the discussions on results, methods and approaches.

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FOREWORD

Since several years the Forest and Nature Conservation group of the Department of Environmental Sciences, Wageningen University cooperates with the International Agricultural Center (IAC) in Wageningen in organizing a seminar series together. This seminar series focuses on new approaches towards better understanding the interfaces between sustainable natural resources management, biodiversity conservation and rural development. This seminar is organized within the framework of the annual IAC training programme on 'Leadership and adaptive management in forest environments'. In addition to the course participants, also MSc. and PhD students in Tropical forestry from Wageningen University and persons from organisations with relevant programs and experience can participate in these seminars.

Since 1999, the central theme of the seminars has been focused on issues of adaptive management, collaborative forest management, joint decision-making and social learning. In 2002 it was decided to review the ideas which were discussed in earlier years and to incorporate these ideas in a review of literature on the concept of adaptive management. The result is this literature review, which was prepared by Drs. Henneleen de Boo of the Department of Sustainable Management of Natural Resources of IAC with additional inputs of Dr. K.F. Wiersum of the Forest and Nature Conservation Policy group of Wageningen University. It will serve as a background document to the 2002 seminar on 'Adaptive management for biodiversity conservation: a collective learning approach in conditions of social and ecological change'. It is planned that this report will be further elaborated into a thematic overview for use by people working in the field of tropical forestry development policy and practice.

In order to make the paper available to a wider audience than the participants to the IAC/WU seminar, it was decided to publish the report in the on-line Discussion Paper Series of the Forest and Nature Conservation Policy group. It is hoped that by including the report in this series, it will serve as an example of the integrated scientific and professional networks maintained within the Wageningen University and Research Center of which the university and the IAC form a part.

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1. INTRODUCTION

1.1. Adaptive management of natural resources

The term adaptive management was originally coined in 1978 by an inter-disciplinary team of biologists and systems analysts under the leadership of the Canadian ecologist Clarence Holling (Holling, 1978). Since then, it has been applied to a range of specific natural resource management conditions, including rehabilitation of salmon stocks in the Columbia River Basin, management of acid rain, and water management in the Florida Everglades. Its application to forest management and nature conservation projects in both temperate and tropical regions is now receiving increasing attention (British Columbia Forest Service, 1999; Salafsky *et al.,* 2001).

Various definitions of adaptive management are available in literature (e.g. Walter 1986; Parma, 1998; Shea, 1998; British Columbia Forest Service, 1999; Callicot et al. 1999; Salafsky et al. 2001; Jiggins & Röling 2002), see Box 1. The approach is grounded in the admission that issues involved in natural resources management are often so complex, that no professional standard solutions are possible. A first basic understanding guiding adaptive management is the notion that the interface between natural resource systems and social systems is often characterised by uncertainty and surprising developments, regarding both ecological and social aspects. Adaptive management is based on the notion that natural systems and social systems co-evolve: a change in the natural environment has an influence on the way resources are used and *vice versa* (e.g. Norgaard, 1981; Berkes & Folke, 1998). A second basic understanding of adaptive management is the notion that management must proceed, even if we do not have all the information we would like, or if we are not sure what all the effects of management might be. The concept considers management not only as a way to achieve objectives, but also as a process for probing to learn more about the resource or ecosystem being managed. Thus, learning is an inherent objective of adaptive management. As we learn more, we can adapt our policies to improve management success and to be more responsive to future conditions (Johnson, 1999). Thus, it is necessary to incorporate the views and knowledge of all relevant stakeholders regarding the use of natural resources in the ecosystem to be managed.

Box 1. Some definition of Adaptive Management

1. Adaptive management is a guiding principle for sustainable uses of natural resources at the interface between society and the biosphere. It is based on the notion that the release of human opportunities requires flexible, diverse and redundant regulation, monitoring that leads to corrective action, and experimental probing of the continually changing reality of the external world (Jiggins & Roling, 2002)
2. Adaptive management in natural resources management is a formal, systematic, and rigorous approach to learning from the outcomes of management actions, accommodating change and improving management. It involves synthesising existing views and knowledge of all relevant stakeholders, exploring alternative actions and making explicit forecasts about their outcomes. Management actions and monitoring programs are carefully designed to generate reliable feedback and clarify the reasons underlying outcomes. The process is one of so-called "social learning". The learning is facilitated by considering decision-making as an experimental process where predicted outcomes are tested through careful monitoring of the results. The learning is then followed by adapting decisions to the new insight. Social learning is stimulated by facilitating between the different perspectives and interests of the stakeholders involved. Management interventions are then adjusted based on this feedback and improved understanding. (British Columbia Forest Service, 1999)

Thus, adaptive management of natural resource systems is both *ecological-technical* and *people-oriented* (Gunderson & Holling, 2002). The *ecological-technical* aspects of adaptive management deal with the management practices, which aim at the sustainable use of natural resources and the desired forms of function fulfillment of the resources to be managed. The uncertainties involved in the functioning of large-scale and complex ecosystems are specifically addressed. Specific attention is

also given to the fact that natural resources undergo continuous processes of change (Walters & Holling, 1990).

The *people-oriented* or social aspects of adaptive management focus on the decision-making process, which leads to a mutually desired situation by a set of stakeholders with their various interests (Buck et al, 2001a). As a result of the dynamic conditions of natural resources as well as changing social conditions, the stakeholders may periodically change their positions and relationships according to the evolving new situations. Under such dynamic circumstances decision-making has to be a flexible process, designed for adjustment. The process is one of so called *collaborative* or *social learning.* The learning is facilitated by considering decision-making as an experimental process where predicted outcomes are tested through careful monitoring of the results. Adapting decisions to the new insight then follows the learning process (Wollenberg et al., 2001b; Jiggins & Röling, 2002).

Thus, in essence adaptive management is a methodological innovation in natural resource management with three specific features. In the first place it is based on a dynamic and multi-resource approach. In the second place it is based on a participatory approach. And in the third place it is based on an open-ended learning approach rather than an 'ideal solution' approach. Other recent management approaches such as Integrated Natural Resources Management, Community or Collaborative Resource Management and Ecosystems Management also involve several of these features. Adaptive Management is unique in its principle that by consciously combining these three features, it is possible to continuously adapt management to the dynamics of social and ecological systems and their interactions.

1.2. Aim and structure of the report

This document provides state-of-the-art information on adaptive management of natural resources. The principles of adaptive management have been applied in a wide range of ecosystems and countries. This document has a specific focus on the options of and experiences with the application of adaptive management in biodiversity conservation and management of tropical forests. The adaptive management of tropical forests and biodiversity will be discussed with a special focus on the social principles of adaptive management.

The report is structured as follows. In Chapter 2 the scientific context of the concept is clarified by means of a description of the main scientific developments and emerging social understandings which shaped the concept of adaptive management. Next, in Chapter 3 the main concepts implied in adaptive management are elaborated. This Chapter describes the major characteristics of adaptive management and how these characteristics gradually evolved. Special attention is given to the aspect of social learning which is inherent in adaptive management. In Chapter 4 the basic principles of the adaptive management process as well as major tools to be used in planning adaptive management schemes are described. Finally, in Chapter 5 several exemplary case-studies on adaptive management are presented. These case-studies were selected as illustrations of some of the major tools which can be used in planning and decision-making in adaptive management.

2. MAJOR DEVELOPMENTS WHICH SHAPED THE CONCEPT OF ADAPTIVE MANAGEMENT

2.1. Introduction

During the last three decades much attention has focused on environmental quality and ways to integrate environmental concern into the decision-making process. This originated in the growing awareness at the end of the 1960s, of the incompatibility between on the one hand, the exponential growth of the human population and material production, and, on the other hand, the long-term use of natural resources of the earth. As a result the management of the environment was considered a new topic from the beginning of the 1970s. With the growing concern about environmental degradation, management of natural resources became to be studied by disciplines other than the traditional professional disciplines such as forestry or wildlife management. The main characteristics of these traditional scientific disciplines were that they were based on a mono-disciplinary approach and mostly linear thinking. The environment and the natural resources were studied with the sole purpose of achieving a single specific goal. This had three major consequences. First, there was no integrated management of natural resources, and second management of natural resources was in the hands of specialists and experts who considered that they were able to determine optimal technical solutions. Moreover, the approaches were based on a static approach without consideration of the importance of ecological and social change. The growing environmental concerns of the 1970s indicated that these approaches had been unsuccessful in preventing environmental degradation to proceed.

As a result of the emergence of new scientific interest in environmental management, the traditional natural resource management disciplines were augmented by several new disciplines such as ecological sciences, environmental economics and social and political sciences. Also more attention became focused on interdisciplinary approaches to natural resource management.

As a result of these new scientific efforts, several new concepts and methods gradually evolved which tried to overcome the shortcomings of the traditional approaches to resource management. One of the most influential new approaches is the concept of adaptive management proposed by Holling (1978). At first, this concept was mainly developed for better management planning of large-scale and dynamic integrated resource systems. Gradually, the concept was elaborated so as to reflect not only concerns on environmental processes and impacts of environmental-people interactions dynamics, but also concerns on social dynamics such as changing values and diversifying opinions on the scope of environmental management. Thus, several basic considerations shaped the current concept of adaptive management (Table 1).

Table 1 Basic scientific and social considerations which shaped the current concept of AM

Scientific considerations	**Social considerations**
• Solutions based on mono-disciplinary criteria will not adequately address environmental issues • Emergence of "new ecology", which recognised the dynamics of natural systems and unpredictable events. • Co-evolution between natural and social dynamics	• Changing values of natural resources due to social dynamics and concern about pollution and environmental degradation • Plurality of stakeholders and their views should be integrated in NRM • Bottom-up rather than top-down approaches: increased involvement of local communities and citizens in decision-making processes regarding the use of natural resources

Simultaneously with these changes in scientific considerations, also the more practical understanding of what is involved in forest management changed. All of these newly evolving insights shaped the current concept of adaptive forest management. They will be further discussed in this chapter.

2.2. Ecological complexity and dynamics

At present, the natural resources management discipline is academically divided in specialized domains such as forest management, wildlife or fisheries management, soil and water management, etc. However, in practice many of these domains are interconnected. For instance, irresponsible timber exploitation does not only result in forest degradation, but may also involve soil degradation. Or the cutting of riverine vegetation may result in both streambed erosion as well as a loss of suitable environments for fish as a result of higher water temperatures due to the loss of the shading effect of trees. In order to address such interacting resource processes, increasingly attention is given to integrated natural resources management. Also adaptive management is based on the understanding that natural resource systems are often complex and should be addressed in an integrated manner.

Moreover, adaptive management builds on the emerging insights from the 'new' ecology. In the past, in ecology it was normally assumed that ecosystems typically progressed steadily and predictably along well-defined successional pathways until they reached a stable, self-sustaining "climax" state. This final successional state was considered as the 'normal' or 'natural' conditions for ecosystems. At present, these assumptions are challenged, and it is increasingly considered that change of the natural environment is pervasive. According to recent understanding of the 'new ecology' (Botkin, 1990) many natural systems prove to be variable, non-linear, complex, rarely predictable, and have the potential for irreversible change. The old concepts of climax, equilibrium and optimality are no longer convenient in helping us understand how ecosystems function and evolve. Thus, the former equilibrium theory presuming stationary ecosystems is gradually being amended with non-equilibrium theories presuming non-stationary ecosystems.

In the equilibrium theories it was assumed that after emergence of an early successional stage as result of degradation or other forms of disturbances, ecosystems would move again to more mature ecosystems provided that the original disturbance was eliminated. It was assumed that the removal of the disturbing factor would bring with it stable conditions which enabled the gradual development towards mature ecosystems. In the 1970s several scientists started to challenge these assumptions, and indicated the importance of natural disturbance in a variety of ecosystems. At present it is accepted by many ecologists that in many cases environmental conditions are not stable but rather dynamic. The dynamics in natural environments are caused by three main processes which jointly cause that many ecosystems without human influence are not stable over long periods of time (Botkin, 1990; Sprugel, 1991):

- Environmental change: History proves that environmental change regularly occurs at several scales of time and place (Botkin, 1990). A clear example are the change in climate which occurred in the past and which are predicted for the future.
- Unpredictable/episodic events: Episodic events such as storms, floods, fires or volcanic eruptions or fluctuating weather conditions such as the 'El nino' events may cause unpredictable disturbance to the ecosystem. Such disturbances are inherent to the system, and must be included in any realistic definition of 'naturalness'. Such disturbances may have long-lasting effects on ecosystem characteristics.
- Catastrophic responses: Traditionally it was assumed that the impact of a disturbing factor on an ecosystem would increase more or less smoothly with the intensity of the disturbance. At present it is considered that the response to increasing stress is frequently far from smooth. Sometimes an ecosystem may seem untouched by increasing stress until it suddenly collapses to another state when certain threshold values are passed (Scheffer et al., 2002).

This change in ecological theory has important repercussions on the interpretation of the nature of 'natural' vegetations and ecosystems, and thus also on forest management and biodiversity conservation (Box 2).

Box 2 Contrasting ecosystem management approaches (after Sprugel, 1991)

Management approach according to equilibrium theory

Most ecologists in the first half of the 20th century believed that ecosystems typically progressed steadily and predictably along well-defined successional pathways until they reached a stable, self-sustaining "climax" state, which was the "normal or natural" condition for communities in that geographic region. Theories about ecosystem functioning, vegetation succession and species-area relationships, each had equilibrium assumptions at the core of their models. Succession theory has emphasized linear vegetation change and the idea of a stable and natural climax benchmark against which environmental change is assessed. Not surprisingly, these theories contributed to applied management recommendations. One example of a management recommendation based on this theory is found in the report of the US Advisory Committee on Wildlife Management in the National Parks of 1963. It was recommended that in Park Management "above all other policies, the maintenance of naturalness should prevail", and more specifically, that "the biotic association within each park should be maintained, or where necessary recreated, as nearly as possible in the condition that prevailed when the area was first visited by the white man". The Committee assumed that the parks were in a "climax" and thus "natural" state before humans invaded and exploited them.

Management approach under current non-equilibrium theory

With increasing knowledge about vegetation history it became obvious that identifying a specific point in time as epitomising the 'natural' state is ill-advised particularly for non-equilibrium systems. Non-equilibrium theory or "new ecology" emerged in the 1970s and challenged many of the static, linear, and equilibrium perspectives on ecological systems that underlie much management practices. It is now believed that in many ecosystems natural disturbance is so common that it keeps the system from ever reaching a stable state. Consequently, it is unrealistic to assume that climax is the "natural" condition for ecosystems to be in. Variability over space and time and unpredictable events, are major drivers of non-equilibrium theory. Notably in the dry tropics with great fluctuations in rainfall conditions non-equilibrium environmental conditions are common, but also in other regions they may occur. Under such conditions vegetation and biodiversity managers have to live with uncertainty (Scoones, 1994) and constantly adjust to natural variability. Management should be based on the principle of monitoring dynamics and adapting to emerging conditions rather than planning to reach a climax steady-state.

2.3. Social dynamics

From a societal point of view, changes in people's awareness and attitudes about the value of natural systems shaped the current approaches to natural resources management. Adaptive management for instance, has been gaining ground in response to a widely perceived environmental crisis. This crisis essentially concerns the relations between people and their physical and biological environment, as well as the manner in which those relations are changing the capacity of the ecological processes to fulfil the functions on which human existence depend (Jiggins & Röling, 1999).

The social values of natural areas changed in response to three developments within society, i.e. demographic processes, economic processes and political processes (Table 2).

Table 2 Major social dynamics impacting on natural resource use

Demographic processes	Economic processes	Political processes
• Population growth • Urbanisation resulting in commercial demands for many natural resources • Increasing number of affluent people demanding nature related rest and recreation	• Change from subsistence to market economy • Increased incorporation of former remote wilderness areas in economic infrastructure • Increase importance of off-farm employment	• Increased incorporation of former remote wilderness areas in political infrastructure • Increased global concerns for democracy processes involving active stakeholder participation

Population is often considered as a major driving force behind natural resource degradation. Although the impact of a greater number of people making uses of an often diminishing resource base cannot be doubted, it is important to consider that the impacts of population growth are compounded by concomitant social and economic changes, such as increasing commercialisation and new types of demands on natural resources by affluent people. Moreover, many traditional subsistence-based resource systems are changing, as local people diversify their farming activities or move to off-farm

employment. As a result of all these changes demands on natural resources change and the variety of stakeholders interested in natural resource use increases. The growing complexity was compounded by the changing institutional framework for managing natural resources. In traditional societies, these are often community-based. But with the advent of nation-states resource rights have often become nationalized. At present, this approach is challenged and increased attention is given to community-based options for resource management (Wiersum, 1999). These examples demonstrate that there is a growth in the number and variety of stakeholders involved in the use of natural resources. Consequently, society is demanding new approaches to management of natural resources and changes in the decision-making process regarding the use of natural resources.

The need for an improved approach to the organisation of forest management is demonstrated by the observation that in many tropical regions the traditional top-down approach based on professional management of mostly state-controlled nature areas has not been successful in obtaining the goal of biodiversity conservation or sustainable use of natural resources. The conservation initiatives have been criticised because of their narrow focus on genes, species and ecosystems and their consequent disregard of the interactions between the human population and the natural environment. The implementation of biologically-focused and/or legally focused approaches to conservation and the existence of pressures from politically powerful vested interest groups have contributed to the cultural and socio-economic marginalisation of many people living within or close to protected areas. As a result of these resource use conflicts, many protected areas around the world suffer from encroachment by the people living near them (Tacconi, 1997). In response, new approaches to natural resources management were developed which emphasised the need to involve local communities in decision-making processes.

2.4 Co-evolution of natural and social systems

As a result of the new scientific insights into the nature of ecological systems and the processes of social change, it became gradually understood, that human impacts on natural ecosystems should not be considered as just an 'external' influence, which needed to be eliminated or modified through proper management activities. Rather it should be considered as one of the dynamic factors impacting on ecosystems. Consequently, many researchers have begun studying the interactions between natural and social systems in order to conceive a new type of management. In the early 1980s the concept co-evolution was proposed as referring to the sequential adaptation of environmental and social systems. It was postulated that as a result of process of positive feedbacks ecosystems and social systems co-evolve and change in a manner favourable to mankind (Norgaard, 1981).

The notion of co-evolution was first proposed as a concept for explaining the development of agricultural systems, but it has been expanded to include also more general systems of using and managing natural resources. The concept of co-evolution became incorporated in two major scientific fields in respect to the management of natural resources. In the temperate regions the concept was incorporated in the field of ecological economics which emerged in the early 1990s. One of the key concepts of this approach is the co-evolution between changes in the natural environment and the way people use resources. Any environmental management plan should include the complex feedback loops between social and natural systems. As a result, a new type of environmental management has been emerging with the main purpose of organising interactions between social and natural dynamics. This type of environmental management is adaptive as it seeks to add to the study of environmental dynamics and the likely evolution of social systems in resource use (Lescuyer, 2002).

Also in the tropics the concept of co-evolution received much attention, mostly in the realm of studies on traditional forms of resource use. Originally, attention focused on the co-evolution of agricultural systems and society in traditional societies (Norgaard, 1981). Later the approach became extended to

the realm of natural resource management. Much attention focused on the interaction between resource uses and the institutional setting for controlling that use. Within the framework of the common property resources theory (Ostrom, 1990) attention became focused on how local societies had originally managed natural resources as a common property and how they had developed an intricate set of natural resource tenure rights and regulation. The overruling of these local systems by either state regulation or privatisation often resulted in resource degradation rather than in improved management as originally anticipated. These experience demonstrate that the ecological, social, and economic characteristics of using resources should be considered in order to conceive positive interactions among stakeholders. Environmental disputes may only be tackled by social organisations in which satisfactory and consensual solutions can be developed by all stakeholders.

The traditional resource management organisations often included an intricate set of organized practices to adjust to the uncertainties involved with dynamic environmental conditions (Berkes et al., 2000). Notably in arid regions with large fluctuations in annual precipitation the organisation of resource use was based on the principle of living with uncertainty (Scoones, 1994). But also in more humid regions a range of strategies were employed to deal with risk, e.g. through the employment of multi-resource strategies which ranged from extraction of wild products from natural vegetation types to (semi-)domestication of valuable plant and animal species. These different resource use practices were mostly characterised by a specific set of tenure regulations for controlling access to and use of the resources. Moreover, the relations between the different types of resource use were often dynamic. For instance, forest management practices could be either intensified or de-intensified in response to agricultural intensification (Wiersum, 1997).

At present, it is acknowledged that such processes of co-evolution do not only take place at local level, but that they may also involve interactive processes at larger scales. Notably as a result of the various types of globalisation processes increasingly natural resource management practices such as biodiversity conservation or regulation of carbon-dioxide emissions are influenced by international regulations and/or organisations. These global trends increasingly impact on local systems of natural resource use (Wiersum, 2000).

2.5. Changing views on forest management organisation and planning

During the last decades also important changes in thinking concerning the formulation and implementation of forest management organisation and planning have taken place. Forest management can be defined as the process of making and implementing decisions with regard to the use and conservation of natural resources and the organisation of the related activities (Duerr *et al.*, 1979). According to this definition a major component in natural resources management regards the process of decision-making. Sometimes forest management is interpreted as a technical activity focusing on the manipulation of ecological processes and sustainable extraction of forest products. Since the 1980s this restricted interpretation has gradually been amended by a much more general interpretation in which management refers to the combined process of decision-making regarding use and conservation of forest resources and the implementation of these decisions. In this approach, the decision-making process in planning the management practices is considered as an essential feature of the forest management process. During the last decade, important changes in thinking about the most appropriate approach towards such planning and decision-making process have taken place.

Dimensions of forest management

In forest management planning in essence three major features have to be considered, i.e the basic objectives for management, the most appropriate form of organisation for management, and the most appropriate technical practices (Box 3). During the last decades several changes in considering how to deal with these features have taken place.

Box 3. Three major questions to be considered in forest management planning (Wiersum, 2002)

1. What should be the objective of forest management: which products and services should be aimed at and which people should benefit from different categories of products and services?
2. What kind of organisational structure (e.g. public, communal, private or collaborative structures) is needed for decision-making on the objectives for management, as well as the selection of management practices and the control over their proper implementation?
3. Which technical and silvicultural practices should be implemented to maintain or even increase the desired forest functions and to sustainably harvest the desired forest products?

In the conventional approach to forest management the first question of what kind of organisation is most suitable was *a-priori* decided upon. It was considered that forest management could best be planned and implemented by professionally trained people working within a state-legitimised organisation (Wiersum, 2002). Management plans were developed and implemented in a top-down approach. At present the bottom-up and participatory approach in which local communities are actively involved in the management has become more common practice. The changing perception of the role of natural resources for society has greatly influenced these changes. Also the tendency of governments retreating from direct involvement in natural resources management has greatly facilitated this development (Ebregt *et al.*, 2000).

Thus, in the convential approach to forest management attention was focused only on the last two questions. However, even the objectives for forest management were usually predetermined (Wiersum 2002). Forest management was primarily focused on national interests in the form of commercial timber production as a means to contribute towards economic development and to provide state revenues, or in the form of forest conservation as a means to contribute towards environmental protection. Consequently, the forest management planning mainly focused on the preparation and implementation of timber exploitation and forest conservation practices. At present a more diverse array of objectives is considered ranging from the specific forest-related needs of the local communities to the global environmental functions of forests, e.g. in respect to biodiversity conservation and sequestering of carbon-dioxide. Thus, over time the objectives of management planning have become increasingly more multifunctional, and the preparation and implementation of forest management plans focuses on the integrated management of multiple uses of forests land in response to both local, national and global demands. This means that the rather detailed production or exploitation plans have evolved into integrated and flexible management frameworks (Ebregt *et al.*, 2000).

Basic approaches to forest management planning

The change from predominantly timber-oriented forest management to multiple-use forest management had as result, that in planning forest management due attention has to be given to existing pluriform views of different stakeholder groups on the desired objectives as well as the best option for implementation of forest management. Thus it is now recognised that the formulation and implementation of forest management plans involves decision-making on a much wider range of management aspects than was considered in the past. Consequently, a major consideration in forest management is the question on how best to incorporate the varied and often conflicting demands for forest products and services. This requires not only a reconsideration of the organisation of and objectives for forest management, but also the basic process of management planning. In this respect, two contrasting planning approaches can be distinguished, i.e. a blueprint (or end-goal) planning approach and a process planning approach (Box 4). In the past, the combined effects of long production processes and belief in scientific knowledge for modelling a 'normal' forest resulted in the predominant use of the blueprint approach. But with the growing recognition of the complex, dynamic

and often uncertain processes one has to deal with in forestry, a gradual change has taken place from convential technocratic blueprint approach towards a process approach in which organisational aspects and dynamic decision-making processes are key issues (Ebregt et al., 2000; Wiersum, 2002).

Box 4 Contrasting basic approaches to forest management planning

Blueprint (or end goal) planning
A planning approach based on identification of desired future state of the forests and appropriate technical inputs to reach that ideal state. The approach is based on a long planning horizon and the assumption that forest managers can exert a great influence on this long-term process by application of linear goal-means relations. The roles of episodic events and social dynamics in the long-term process are given little attention.

Process planning
A planning approach based on identification of the best manner to steer complex processes with attention for the role of uncertain events. In this approach there is no believe in linear goal-means relations, but trust in self-regulating social forces. The approach is based on a relatively short planning horizon and high planning frequency on basis of information obtained from an intensive monitoring system.

Conclusion

The evolving conceptual changes of forest management planning have not made the preparation and implementation of management plans easier. In fact, management plans have become more complicated. In the first place, the new understanding about the role of uncertainty and dynamic processes in integrated systems means that increased attention must be given towards monitoring and continuous adaptation of management practices to newly emerging conditions. In the second place, the new call for democratization and stakeholder involvement means that more partners are involved, participatory approaches must be used and the increased pressures from society, market and political level have to be dealt with. The concept of adaptive forest management forms a basis for operationalisation of these new basic insights as to what is involved in forest management.

3. EVOLVING CHARACTERISTICS OF ADAPTIVE MANAGEMENT

3.1 Introduction

The concept of adaptive management of the environment (Holling, 1978) was originally developed within the USA as an integrated approach towards managing large-scale environmental systems. Adaptive Environmental Assessment and Management (AEAM) was presented as a simulation-based approach to assess the potential impacts of a specific development project on its natural environment. AEAM was used in small workshops comprising scientists from different disciplines, decision-makers, and computer modelling experts to establish the scope of an appraisal, to identify the key components of environmental systems, and to construct a simulation model of the systems likely to be affected by a development. Computer simulations were used to determine the likely outcome of the proposals based upon certain assumptions. Periodic workshops allowed the model to be refined, as additional data became available.

The main advantage of this approach was that assumptions can be varied and the simulation can be done repeatedly to show the implications of a range of decisions. AM is one of the only approaches to natural resources management from the 70s that still exists and evolves. In fact, AM was a precursor to present approaches in that it was the first to account for the dynamic of the natural environment.

Table 3 Comparison of Adaptive Forest Management in USA with Joint Forest Management in India (Wiersum & De Hoogh, 2002)

	Adaptive Forest Management	**Joint Forest Management**
Basic consideration	Eco-challenge based	Livelihood-challenge based
General objectives	Involving local communities in eco-system management should assist in achieving conservation objectives and sustain forest communities	Involving local communities in forest management should contribute towards both community empowerment and forest conservation
Environmental aim	Maintain ecological processes	Rehabilitate degraded lands
Aim of production	Adaptation of commercial timber management	Basic-needs forest products
Scale	Eco-zone 40,000 - 100,000 ha	Communal/group-managed forest areas up to 400 ha
Interpretation of community	Administrative village	Specific forest-user groups
Boundary setting	Forest Department	Jointly decided by Forest Department and user groups

Gradually, the interest in using this approach has become extended from the temperate regions to tropical regions. Consequently, the approach had to become adapted to the prevailing developments in tropical forest management. In the tropical regions, since the early 1970s much attention has been given towards the development of community-based forest management (Wiersum, 1999; Arnold, 2001). At present, under the title Adaptive Collaborative Management increasing attention is given to combine this community-based approach with the adaptive management approach (Wollenberg et al.,

2000; Buck et al., 2001a). As a result of the historic backgrounds, the focus of adaptive management in the USA and in tropical countries, is not quite similar (Table 3). Notable in tropical countries, in the development of the concept of adaptive management explicit attention is given to how to address the processes of social dynamics. The evolving principles of how to deal with social dynamics will be further elaborated in this Chapter.

3.2 Adapting to social dynamics

3.2.1. Involving stakeholders in decision-making

The main disadvantage of the original approach to Adaptive Management was that the planning for environmental management was in the hands of specialists. Their assumptions and assessments were frequently disconnected from the actual decision-making process on the ground. Other stakeholders had no voice in the choice of impacts and assessments. Gradually it became acknowledged that the lack of their involvement limited the effectiveness of the proposed adaptive management schemes, and that more participatory approaches to adaptive management needed to be developed.

The term stakeholders refers to all institutions, social groups and individuals who possess a direct, significant and specific stake in a certain area. Thus, the term incorporates all people who are directly or indirectly affected by, or interested in, forest management (Borrini-Feyerabend, 1996). Stakeholder interests depend on both regional ecological and socio-economic conditions, livelihood conditions of local communities and institutional arrangements for managing the natural resources. As discussed above, at present these socio-economic conditions are undergoing a rapid change. The complex and dynamic interactions between these conditions make decision-making for sustainable management or conservation of natural resources prone to uncertainty and surprise. This applies also to tropical forests where communities are found and where the conditions are highly complex and uncertain (Wiersum, 2000).

When considering how stakeholders can be optimally involved in the decision-making on use and management of natural resources, two aspects deserve specific attention:

- Which interest groups should be involved in the decision-making process regarding the use and conservation of natural resources and what is the range of their interests?
- How do these stakeholders interact with each other?

3.2.2. Pluralism amongst stakeholders

Nature provides human society with a wide variety of functions, ranging from the provision of food and medicinal resources, buffering of CO_2, recreation and tourism, to less tangible benefits such as religious and spiritual values. As a corollary to this multi-functionality there exist different stakeholders categories who are interested in one or more of these functions. Between these various stakeholder groups there are often incompatible ways in using the resources or struggles to be the first to acquire these “finite” benefits. In other words, different (groups of) stakeholders have different interests in the use of natural resources or even compete with each other in respect to the desired forms of function fulfillment (Borrini-Feyerabend, 1996).

The key entities of pluralism in social systems in tropical forest environments are the stakeholders. Stakeholders are individuals or –more usually- groups of people, organised or unorganised, who have a share, interest or stake in a particular issue or system (such as natural resources). Stakeholder groups can be characterized as groups of people with common objectives and sets of interests with regard to the resource in question and the environment (Grimble & Chan, 1995). Stakeholders can be distinguished by scale -local, regional, national and international- and time, for example current

stakeholders (ourselves) and future stakeholders (our children and future generations). Another fundamental division between stakeholders is between those who affect (determine) a decision or action, and those affected by it (whether positively or negatively).

Table 4. Example of stakeholders for tropical forest resources (After: Grimble *et al.,* 1994)

Institutional level	Examples of stakeholders	Issues of interest in the forest
Global and international	International agencies	Biodiversity conservation
	Foreign governments	Climatic regulation
	Environmental lobbies	Global resource base
	Future generations	Several, but hard to determine
National	National governments	Timber extraction
	Macro planners	Tourism development
	Urban pressure groups	Resource and catchment protection
	NGOs	Conservation and development issues
Regional	Forest Departments	Forest productivity
	Regional Authorities	Water supply protection
	Downstream communities	Erosion control
Local off-site	Downstream communities	Protected water supply
	Logging companies and sawmills	Access to timber supply
	Local Officials	Conflict avoidance
Local on-site	Forest-fringe farmers	Timber and Non-timber forest products
	Livestock keepers	Grazing and fodder
	Medicinemen	Medicinal plants
	Women fuel collectors	Access to timber supply

An example of stakeholders for tropical forest resources and their specific interests is given in Table 4. This example illustrates how diverse the interests in forests ecosystems can be among different stakeholders. Adaptive management seeks to deal with these pluralistic views, interests and values by including all relevant stakeholders in the decision-making process. However identifying groups of stakeholders is not enough, as they change their positions and relationships according to evolving new situations. Thus, the example given in Table 4, gives a rather static impression. The dynamics between and within the stakeholder groups can be very high and thus can have serious implications for the results of an adaptive management exercise.

In natural resources management stakeholder groups are usually assumed (explicit or implicit) to be relatively homogeneous groups, with members sharing the same characteristics, distinguishing them from other groups. For example, in community based forestry, it is usually assumed that there exists a distinct "local community" whose ideas and interests in resources use negotiations are often expressed by a committee representing the community's ideas. However, communities are not, of course, bounded, homogeneous entities, but socially differentiated and diverse structures (Borrini-Feyerabend, 1996). Gender, caste, wealth, age, origins, occupation, and other aspects of social identity cross-cut these so-called community boundaries. Social differences within communities can be linked to sharp differences in which resources are valued. Livestock keepers may value forestland as a source of grazing, browse, or fodder. Gender divisions of labour and responsibility frequently give women particular interests in fuelwood and wild foods, whether oilseeds, fruit, nuts and leaves (Skutsch, 2000; Leach, 2002).

3.2.3 Interactions amongst stakeholder groups

In view of the stakeholder pluriformity in the use of natural resources, it cannot be assumed that resources are always equitable shared or democratically distributed. Rather, often conflicts between different stakeholders concerning resource use may exist (Skutsch, 2000; Anderson, 2002). Notably resource uses, which overlap spatially, seasonally, or in terms of regulations applying to them may all be a source of conflict. These conflicts may be explicit and solved by a process of bargaining and

negotiation, but in other situations they may be implicit and overruled by social and power relations. People responsible for adaptive management projects should be extremely sensitive to such power relationships, in order to be sure that all stakeholders feel comfortable to express their views. These internal dynamics and power relations does not only apply to local communities. For example, people working in a certain organisation (identified as belonging to one stakeholder group) may have different backgrounds, knowledge, and work incentive structures; those of an urban-based senior forest official may be very different from those of a front-line extension worker. Dynamics among different stakeholder groups may be caused by various aspects, such as policy impacts, funding dynamics and changing networks. It is through negotiation and struggle both within and among stakeholder groups that particular conceptions of forest, values, policy priorities, and associated regulations become established and may change (Leach, 2002).

3.3 Adaptive management as a social learning process

The aim of adaptive management is to come to grips with the situation of normative pluriformity and dynamics in stakeholder interests. It is tried to accomplish this aim by involving multiple stakeholders in a decision-making process based on so-called experiential learning. Active monitoring and feedback from the results of decisions are core aspects of this iterative process. Learning takes place collectively and is therefore also called social or collaborative learning.

Definition of social learning

Social learning is only one of the various terms emphasising the importance of activities, which encourage combining knowledge from various sources and perspectives, including laypersons or experts, politicians or activists. In literature dedicated to natural resources management and conservation "collaborative learning" (Daniels & Walker, 1996), "joint learning" (Pretty, 1994), "platforms for decision-making" (Röling, 1994; Steins & Edwards, 1999), "community learning" (Steele *et al.,* 1999) and "building bridges" (Beek, 1997) are some of the terms referring to this process. Social learning is by far the most frequently used term and therefore it was chosen for the current document.

But, what then is involved in social learning? Maarleveld and Dangbégnon (1999) characterise social learning in natural resources management as: "A continuous dialogue and deliberation among scientists, planners, managers and users to explore problems and their solutions. Communication together with experimentation enables adaptation among the relevant actors to adjust and improve management."

Box 5. Four dimensions of social learning (Buck *et al.,* 2001b)

1. Conflict mitigation and political decision making
2. Knowledge sharing for innovation and solving problems
3. Communication and relationship building
4. Capacity building and community or organisational development

Dimensions of social learning

Buck and co-workers (2001b) distinguished four dimensions (Box 5) of social learning that are of particular importance in collaborative management of tropical forests. First of all, *conflict mitigation and political decision making*. Conflict and power relations play an important role in natural resources management discussions. Conflicts among different interest groups are usually related to differences in the level of political power (Anau *et al.,* 2002). Careful attention should be paid to the strong inequities that exist among stakeholders in most community forest settings during social learning and adaptive management exercises. (Buck *et al.,* 2001b).

The second dimension of social learning is *knowledge sharing.* Social learning acknowledges that interest groups bring different knowledge to the learning process, including knowledge in the form of values, capacities, perspectives, methods, and stores of historical experience (Daniels & Walker, 1999). Such knowledge and experience, effectively shared, are critical assets in solving forest management and related problems. Knowledge sharing is thus related to innovation and solving problems (Buck *et al.,* 2001).

Central to both the political and knowledge sharing dimension of social learning is the idea that constructive interaction among interest groups can be encouraged by lifting barriers to communication to make it more open and responsive (Steins & Edwards, 1999). Social learning facilitates joint problem solving by fostering perceptions of interdependence, trust and mutual appreciation. It demonstrates to actors that they can benefit from working together toward a commonly shared goal, and generates confidence in further efforts at collaborations. Thus the third dimension of social learning is *communication and relationship building* that results in sharing knowledge and enhanced capacity for action (Buck *et al.,* 2001b).

The fourth dimension of social learning is *capacity building, and community or organisational development*. Social learning refers to the collective process of accumulating knew knowledge by a particular social group. This collective aspect of social learning stresses how knowledge is developed and shared among a given group to help construct new motives for action and patterns of interaction (Buck *et al.,* 2001b).

4. PROCESS AND OPERATIONAL PRINCIPLES

4.1. Introduction

As discussed in the earlier chapters the key characteristics of adaptive natural resource management are adaptation of management activities to newly evolving ecological and social processes as well as social learning. For implementation of adaptive management these characteristics need to be operationalised. In this chapter the process and major operational tools for adaptive management will be elaborated. It is important to recognise that adaptive management is highly dependent on a number of factors, such as for instance the political setting, the social and educational background of the involved stakeholders, the ecological circumstances as well as the end-goal of the management exercise such as biodiversity conservation or governance of common-property resources. In the next chapters specific examples of the application of adaptive management under diverse conditions will be given. Due to this diversity in settings there exists no standard approach for operationalisation of adaptive management. Nonetheless, still an overall process as well as number of important operational principles can be identified. These will be further discussed in this chapter.

A number of authors have developed a framework for adaptive management. In this framework three major elements can be distinguished, i.e. the basic adaptive management process, operational principles and application tools, see Figure 1. Regarding the basic adaptive management process, several steps or phases can be identified which should be considered in the adaptive management process (BC Forest Service, 1999; Salafsky *et al.,* 2001). This basic adaptive management process concerns the basic planning cycle. In several aspects the basic adaptive management process is rather similar to regular project cycle management. There are, however, some major differences in comparison with regular project cycle management, notably regarding the reiterative and reflective nature of the process, see Box 6. The basic adaptive management process will be described in Chapter 4.2.

Box 6. Major differences between basic adaptive management process and regular project cycle management

1. The emphasis on social actors with their individual learning needs within and across the different phases of the process.
2. The iterative nature of the process or the admission that you always can go back to a previous stage to adapt former decisions on the basis of newly gained information.
3. After the management exercise has entered the last phase, the process has to start all over again. The results of the management exercise are used to adapt the assumptions and management actions to the new insight.

In addition to the basic adaptive management process, also a set of specific "operational principles" can be distinguished for the adaptive management framework. As mentioned in Chapter 1.2, this report will focus specifically on the people oriented or social aspects of adaptive management. Social learning was identified as one of the key characteristics of adaptive management, but this characteristic is not specifically addressed in the basic adaptive management process. However, social learning plays an important role in all the process phases. The incorporation of social learning in the adaptive management framework can be accomplished through the identification of several operational principles that facilitate collaborative processes. These principles can then be linked to the basic adaptive management process. As indicated in Figure 1 these operational principles can be implemented in the various process phases. For each phase the selection of the most appropriate operational principles must be reconsidered. For example, in the starting phase of the basic adaptive management process multi-stakeholder negotiations will take place for establishing a common framework. This group of stakeholders is not necessarily the same as for example, the stakeholders implementing the management plans. Thus, in each phase of the process it must be considered which group of stakeholders and which type of multi-stakeholder negotiations is most appropriate. The same

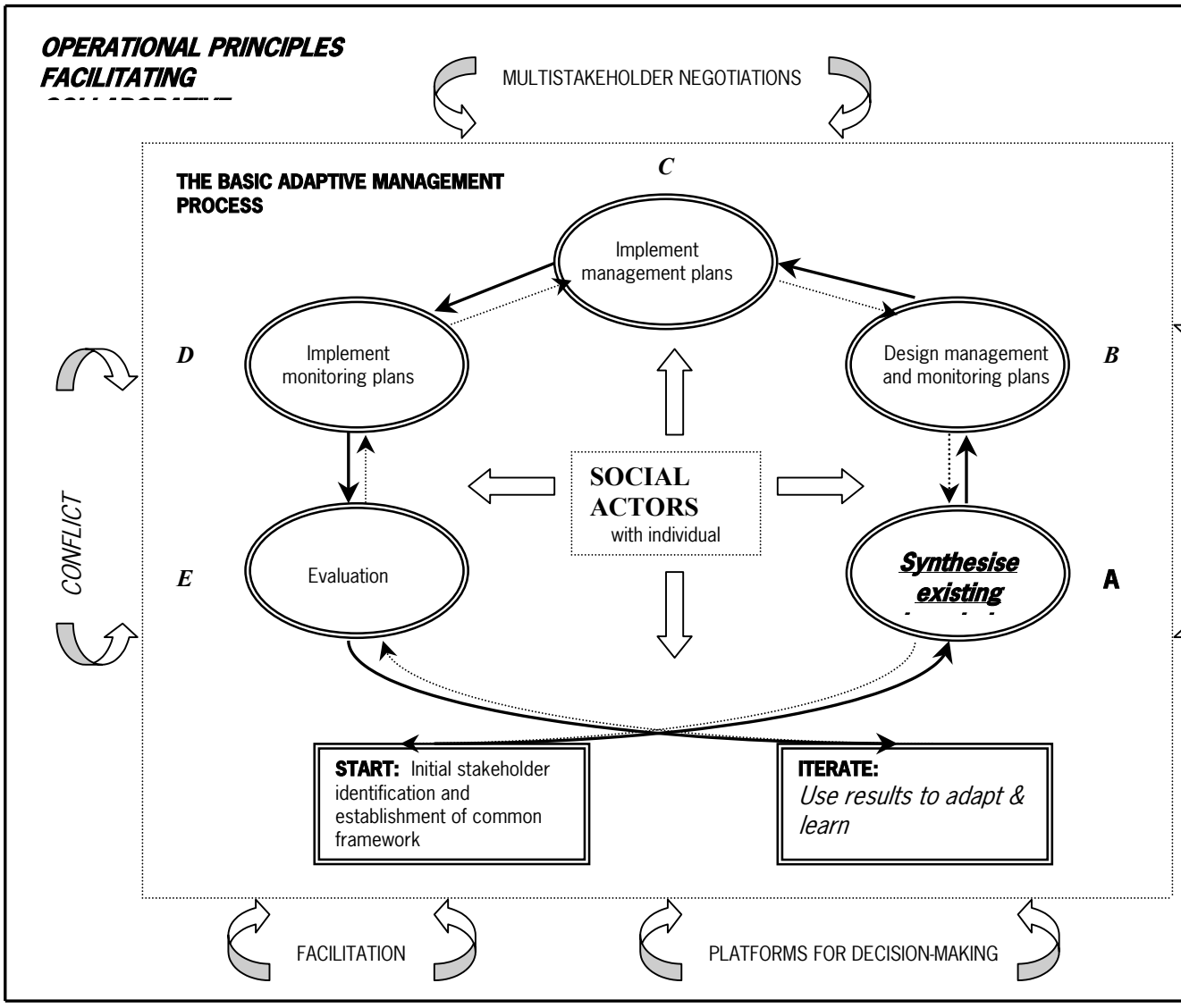

Figure 1. ADAPTIVE MANAGEMENT FRAMEWORK showing relationship between (1) the basic adaptive management process (comprised of se
principles facilitating collaborative processes, and (3) tools to increase adaptivity and learning (Sources: BC Forest Service, 1999; Salafsky *et*

argument applies to the other operational principles facilitating collaborative processes. The main operational principles for adaptive management will be discussed in Chapter 4.3.

Social learning is, however, not only improved by facilitating collaborative processes, but also by facilitating the learning itself. Therefore, a third dimension in the framework of adaptive management is the identification of specific tools to facilitate adaptivity and learning. In the various phases of the adaptive management process different tools may be used to facilitate adaptivity and joint learning. These tools should allow the synthesis of existing knowledge and generation of new information, thus stimulating learning. In Chapter 4.4 several examples of such tools will be discussed. These examples are indicative only, as there are more tools to increase adaptivity and learning. The examples in this report were selected because they have proven to be well-suited to the adaptive management process. In Chapter 5 case-studies will be presented which illustrate the practical use of these tools in adaptive management.

4.2. The basic adaptive management process

4.2.1. Introduction

This paragraph will give an overview of the main elements and issues to be considered during the different phases in the basic adaptive management process. The process described below might be interpreted as a blue-print scenario for adaptive management and can give a rather static impression. In reality however, some of the elements described for specific phases will overlap, some phases will have to be revisited during the process and adapted to new information gained, and some may be done in more detail than others. The dynamics will be apparent once it is recognised that the operational principles facilitating collaborative processes can be implemented and reconsidered in each phase of the basic adaptive management process. Moreover, the course of the basic adaptive management process is dependent on the tools to increase adaptivity and learning used. Some phases of the basic adaptive management may sometimes even be ignored, depending on the purpose of the management exercise, the case specific social and ecological factors, as well as the operational principles and tools used. However, all phases described below are important to consider in adaptive management: omission of one or more will hamper the ability to learn from management actions. Moreover, documenting the key elements of each phase, and communicating the results are crucial for developing further capacity for adaptive management (BC Forest Service, 1999).

4.2.2. START: Initial stakeholder identification and establishment of a common framework

The starting point for adaptive management involves identifying key stakeholders, who will participate in the management exercise. It is important to realise that this is an initial stakeholder identification, the stakeholder composition has to be reconsidered when entering a new phase in the basic adaptive management process. For the initial stakeholder identification it is important to involve those people who will implement, monitor and be affected by the management plans as well as managers and scientists. An example of stakeholders in a forest environment could be: forest managers and planners, knowledge experts from a range of disciplines (e.g. hydrologists, foresters, social scientists, wildlife biologists), policy makers, logging companies, local communities and NGO representatives. Stakeholders usually have a variety of perspectives, skills, and areas of expertise (BC Forest Service, 1999).

The identified stakeholders should agree to engage in a common framework oriented at finding a solution in a collaborative way to a certain problem. They should try to define what the common purpose of the management exercise is. Is the management exercise aiming at conservation of natural resources, economic development of local people or improving governance issues? Establishing a common framework and purpose is important for creating a benchmark for measuring success. While

working towards a common purpose, the extent to which this purpose is achieved can be gauged and then the actions can be adjusted to optimise the realisation of it. A common purpose also ensures that the different stakeholders understand and agree on a common end. This is particularly important to management exercises that have multiple partners and that seek to address both conservation and development issues. Different primary interests usually result in conflict situations. This will lead to decreased efficiency in project implementation and a higher likelihood that nothing lasting will be achieved (Salafsky *et al.*, 2001).

4.2.3. Phase A: Synthesise existing knowledge and define problem

After identifying a common purpose, the stakeholders should synthesise existing knowledge about the area concerned, define the scope of the management problem, and explore the potential outcomes of alternative management options (BC Forest Service, 1999). A primary inventory of existing knowledge about the area concerned can be achieved by means of a resources assessment and an institutional assessment (Box 7).

Box 7. Two preliminary assessments for synthesising existing knowledge among stakeholders (After: Lal et al., 2001)

1. *Resources assessment:* uses traditional science and indigenous knowledge to provide a preliminary inventory of relevant biophysical elements and existing flora and fauna. It also considers the dynamics of the natural processes that contributed to the current status of the environment as well as the functional processes and interactions between key components of the natural system.
2. *Institutional assessment:* identifies the rules and regulations that govern activities within the ecosystem and other institutions that may indirectly affect the system. Traditional institutions that may be relevant, as well as the management instruments used by the different agencies involved, including indigenous communities are assessed.

These primary inventories of existing knowledge will be of great help to define the scope of the management problem. Most conservation or development projects take place in rather complex situations. People responsible for executing an adaptive management exercise have to understand the complicated ecosystems that they are working in. They also have to understand the cultural, social, economic and political systems that influence the behaviour of the many stakeholders at the project site. And all of these different ecological and human factors interact with one another in dynamic and unpredictable ways (Salafsky *et al.,* 2001). The inventories of existing knowledge should increase insight and learning about the system.

In order to achieve an effective adaptive management exercise, during this synthesis information on the following issues need to be integrated (Lal *et al.,* 2001):

- Nature and scope of the specific problems, issues, or concerns;
- Existing value systems and patterns of interactions between owners, users and managers;
- Interactions between existing natural, economic, and social systems and possible cause-and-effect relationships and linkages between human activities and ecological functions and processes; and
- Spatial and vertical boundaries of relevant interactions, based on ecological and/or economic considerations

Some tools are available to contribute to this process of synthesising existing knowledge, such as conceptual models (paragraph 4.4). Conceptual models are especially useful in showing the causative relationships between certain factors that are believed to impact the common purpose of the management exercise. Factors are the specific events, conditions, policies, attitudes, beliefs, or behaviors that affect the management goal (Margoluis & Salafsky, 1998).

The next step is figuring out what management actions are required which will ultimately lead to the fulfillment of the common purpose as defined in the starting phase. Therefore, measurable management objectives and a list of potential management actions to achieve these objectives should be defined (BC Forest Service, 1999). If the management project is well conceptualised and well designed, realisation of a project's objectives should lead to the fulfillment of the common purpose of the management exercise.

Management objectives can be measured by means of indicators. Indicators are units of information measured over time that document changes in a specific condition. A given objective can have multiple indicators (Margoluis & Salafsky, 1998). The next step in the process is to select indicators the are relevant to the objectives and responsive to the management actions. Thus, indicators are measurable attributes of system behaviour that allow you to weigh management options, and eventually assess outcomes. It is necessary to make explicit forecasts or assumptions about the outcomes of management activities, in order to assess which actions are most likely to meet the management objectives (BC Forest Service, 1999).

4.2.4. Phase B: Design management and monitoring plans

Phase B involves the design of a management and monitoring plan that will provide reliable feedback about the effectiveness of the chosen management actions. A number of management options should be considered, for example: a passive approach, where one action is implemented; an active approach, where several alternatives are compared; or testing a range of options at a pilot scale, before testing one or more at a larger scale. Afterwards, these proposed management options or alternative management designs should be evaluated based on the following criteria: ability to meet long term objectives, ecological and economic costs, risk of negative outcomes, and ability to fill key gaps in understanding. Then, a decision should be made which proposed plan to implement.

The design of a monitoring plan should include a number of issues, see Box 8. After implementation of the management and monitoring plans a lot of data will be collected which need to be managed and analysed in a proper way. The results will form the basis of the evaluation process and subsequent adaptation of management interventions. Therefore it is necessary to plan data management and analysis already in phase B. The methods that will be used to analyse data, the system for managing data over the long term and the people who will interpret data and who will access them need to be agreed upon. It is also necessary to state how management actions or objectives will be adjusted. The intensity and degree of response in an indicator that will trigger a change in management actions or objectives should be defined. In addition, it should be identified *who* needs *what* information *when* in order to make timely changes. Finally, it is important to set up a system to communicate the results and information (BC Forest Service, 1999).

Box 8. Issues to be specified in monitoring protocol (BC Forest Service, 1999)

- The type and amount of pre-treatment data required;
- Frequency, timing, and duration of monitoring;
- Indicators to be monitored at each interval;
- Appropriate spatial scales for monitoring different indicators;
- Who is responsible for undertaking different aspects of monitoring

4.2.5. Phases C & D: Implement management and monitoring plans

Until this point the adaptive management process has involved planning, developing a shared and common vision, agreement on a common purpose, a project management plan outlining the actions to be undertaken, and a monitoring plan. These planning activities are important and take a great deal of work and energy. The key, however, is to turn this planning into action and collect data that have been identified as being important in the monitoring plan. Adaptive management is fundamentally about

taking action and learning. As a result the most critical step in the entire process involves implementing the management plan (Salafsky *et al.,* 2001).

In addition to the management plan, the monitoring plan needs to be implemented. Monitoring is often neglected in conventional approaches to management, yet is critical to improvement. Monitoring allows the stakeholders to assess how actions actually affect indicators. This information then allows the stakeholders to evaluate the effectiveness of alternative actions, adjust the assumptions of how the system functions, and take appropriate corrective action (BC Forest Service, 1999).

4.2.6. Phase E: Evaluation

In this phase, data are analysed and actual results are compared to the forecasts that were made in phase A. The evaluation should explain why the results occurred and include recommendations for future action. If the management actions did not achieve the expected results, it is because either the assumptions were wrong, the actions were poorly executed, the conditions at the project site have changed, the monitoring was wrong, or some combination of these problems. Adaptation involves changing assumptions and actions to respond to the new information obtained through monitoring efforts. In this respect, negative or unexpected outcomes can be as informative as positive, predicted outcomes. The results, whether expected or unexpected, must be documented and communicated, so that knowledge and experience are passed on to other people facing similar management issues (BC Forest Service, 1999; Salafsky *et al.,* 2001).

4.2.7. ITERATE: Use results to adapt and learn

The last phase in the adaptive management process is the most crucial one. It is time to use the results of all the work done, in order to adapt and learn. The information gained through the preceding steps, especially the results of data-analysis must be used to adapt the management, where-ever necessary, in order to have value. Adaptation is about systematically using the information obtained through monitoring to take action to improve the management exercise. If the actions did not achieve the expected results, the assumptions and actions should be adapted to respond to the new information. It means staying flexible, examining past actions, and looking for key opportunities to leverage change. Learning requires an organisation to have a commitment to figuring out how to do the work better and how to use and benefit from mistakes rather than hiding them.

The most important point to keep in mind is that after going through the basic adaptive management process once, this process has to start all over again. The basic principle of adaptive management is to apply the different phases as shown in Figure 1 in a cyclical manner. The key to adaptive management is that is an ongoing and iterative process. The stakeholders synthesise existing knowledge about the area concerned, they create an image (or model) of how the system works and experiment with management actions and collect and analyse data about these actions. Then the results are used to modify the image (or model) and suggest new actions. Subsequently, data are collected and analysed about these new actions and used to adapt and learn again. Each time the process is starting again, hopefully enhances the ability to achieve the common goal agreed upon (Salafsky *et al.,* 2001).

4.3. Operational principles for facilitating social learning

4.3.1. Introduction

This paragraph will give an overview of the various operational principles for facilitating social learning. Social learning was identified as one of the key characteristics of adaptive management, but is not explicitly referred to in the basic adaptive management process. Therefore, these operational principles were identified as a separate dimension of the adaptive management framework (Figure 1). The identification of this specific dimension emphasises that the proper selection of operational

principles play an important role during adaptive management process. It is important to recognise that these operational principles have to be reconsidered in each phase of the adaptive management process. For example, facilitation in the starting phase A will not necessarily occur in the same way as in phase B, and conflict handling will not be the same in phase A and in phase E.

As mentioned earlier, social learning involves a continuous dialogue and deliberation among scientists, planners, managers and users to explore problems and their solutions. Such communication together with experimentation enables adaptation to adjust and improve management (Maarleveld & Dangbégnon, 1999). The social learning process should be based on strategies, mechanisms and conditions that enable actors to creatively collect, analyse and act on new information together (Woodhill & Roling, 1998). These strategies, mechanisms and conditions are most effective when they are sensitive to the power differences among stakeholders, build on complementarities in their knowledge, and are designed to enhance interactions. One way to achieve this is by facilitating a collaborative process involving actors with different agendas. Operational principles facilitating collaborative processes are: multi-stakeholders negotiations, collective responsibility, platforms for decision-making, facilitation and conflict handling. These principles will be briefly discussed in the following paragraphs.

However, social learning can also be advanced by facilitating and understanding the learning process itself. Maarleveld and Dangbégnon (1999) identified different learning loops, in which learning takes place not only about social and environmental facts (single loop learning), but also about the theories and methods for observing the world (double loop learning) and, even more fundamentally, the importance of learning in the first place. But these are the more theoretical aspects about learning. There is not much known about strategies and mechanisms to facilitate the learning itself. Usually, these are the more practical and technical implementation tools, which will be discussed in paragraph 4.4.

4.3.2. Multi-stakeholder negotiations

Professionals working in environment and development recently have focused on formal stakeholder identification and negotiation processes to address the competition among different groups for natural resources (Borrini-Feyerabend et al., 2000; Edmunds & Wollenberg, 2002; Grimble & Chan, 1995; FAO, 1999; Steins & Edwards, 1999). Multi-stakeholder negotiations seek to involve all or as much as possible relevant stakeholders in the decision-making process regarding conservation or development issues, either in respect to policy or management interventions. Several analytical tools to identify stakeholders for multi-stakeholder negotiations exist. These range from a rather simple and static "stakeholder analysis" identifying the plurality of perspectives within a given natural resource setting at a certain moment, to a more complicated "environmental entitlements approach", which also accounts for the ecological dynamics and the ways these intersect with socially-differentiated activities (Leach, 2002).

Box 9. Assumptions underlying most multi-stakeholder approaches (After: Wollenberg & Edmunds, 2001)

- A neutral or object space for negotiation can and should be created;
- Consensus is desirable;
- All stakeholders need to be involved for the process to be effective;
- Stakeholders should share information openly;
- Negotiations can be considered in isolation from other strategies employed by stakeholders;
- Generally, the principal barrier to effective collective action is poor communication.

Stakeholder identification and negotiation have promised to bring visibility, compromise and democratic decision-making to stakeholder relations (Edmunds & Wollenberg, 2001). In forest management, multi-stakeholder negotiations would seem to benefit less powerful groups (such as

indigenous people, subsistence farmers and forest product collectors) in particular by publicly acknowledging their claims, creating a forum to reach compromise between them and other stakeholders (such as corporations, NGOs and governments), and legitimating compromises with formal agreements. However, the benefits of multi-stakeholder negotiations to disadvantaged groups depend on how the negotiations are undertaken. The concept of multi-stakeholder negotiation is based on several assumptions (see Box 9), such as the assumption that a neutral or object space for negotiation can be created, and that stakeholders share information openly. Such assumptions may have as result that abuses of power or more structural, enduring inequity between stakeholders are not given enough attention or are even not recognised (Edmunds & Wollenberg, 2002).

4.3.3. Platforms for decision-making

Natural resource platforms are negotiating and/or decision-making bodies (voluntary or statutory), comprised of different stakeholders who perceive the same resource management problem, realise their interdependence in solving it, and come together to agree on action strategies for solving the problem. Such platforms are characterised by their tendency to consider resource management issues from a broader perspective. The platforms are formed by stakeholders who (1) work collectively towards an understanding of the resources base; (2) co-operate in solving social dilemmas associated with collective resources use; and (3) undertake joint action with respect to perceived problems. The use of natural resource platforms for encouraging mutual learning with the objective of solving problems and improving the situation is an essential aspect of social learning strategies (Steins & Edwards, 1999). In other words, platforms for decision-making are metaphorical or real spaces, where stakeholders can interact and learn together. Platforms can be one-time meetings, workshops, elected committees, formally appointed boards or councils or even government bodies (Röling & Jiggins, 1998). Various tools such as scenarios (Chapter 5) can be used to facilitate platforms and stimulate debate among relatively co-operative stakeholders. The selection of appropriate tools such as scenario's for communicating interests in a common language rather than in an antagonistic manner is essential for the proper functioning of platforms (Wollenberg *et al.,* 2000).

Several aspects need consideration for proper functioning of natural resource platforms. An important issue is how key stakeholders are represented in the platforms and how representatives are held accountable to their constituencies. Another issue is how to generate an open and free discussion among numerous actors without bringing the platform to a total impasse of immobile positions. In this respect proper facilitation of the platforms is very important (Röling & Jiggins, 1998). A third major issue is how platforms interact with conventional decision-making bodies. These relations need to be examined to assure that the platform has legitimacy and efficacy (Buck *et al.,* 2001b).

Wollenberg and co-workers (2001b) have composed an overview with information of various professional practitioners in the field of community forestry about their experiences with collaborative approaches to forest management and their relationship to social learning. This report documents how platforms evolved, which problems were encountered, and how platforms can exist at different levels, such as loosely configured self-evolved networks of forest user groups (Kafle, 2001) or platforms on larger scales at the landscape level (Ayling, 2001).

4.3.4. Facilitation

To promote partnership and social learning among different groups of stakeholders in multi-stakeholder negotiations or platforms facilitation is crucial. Facilitators are needed in cases of strong power imbalances, unresolved conflicts or communication problems among the parties concerned, and when the parties belong to quite different cultural and educational backgrounds (Borrini-Feyerabend *et al.,* 2000).

Facilitators are often the catalysts for social learning. They bring stakeholders together in various configurations to plan, co-ordinate, demarcate, monitor, reflect, learn and act together in other ways (Buck *et al.,* 2001b). A key issue concerns the feasibility and effectiveness of facilitation by internal, local actors versus external project supported actors. Borrini-Feyerabend and co-workers (2000) identified key characteristics of external facilitators, see Box 10. External facilitators can be effective in dealing with macro-level constraints on collaboration, such as formal government policy or project finance (Massawe, 2001). External facilitators, however have higher chances to misinterpret the interests of important local actors (Nemarundwe, 2001).

Box 10. Key characteristics of external facilitators (After: Borrini-Feyerabend *et al.* 2000)

- Recognised as independent
- Generally respected by all those involved
- Capable of relating with everyone on their own terms
- Able to listen
- Able to pose key questions (such as, on the roots causes of the various problems)
- Capable of getting the best out of the participants and helping them to see a better future for themselves and their communities

Another important characteristic of facilitators (whether external or internal) is that they need to be sensitive to and strategic about existing relationships among stakeholders, especially the political aspects of social learning. This means that especially the stakeholders' historical relations with each other must be taken into account (Anau *et al.,* 2002) as well as their different interests in the collaborative process, styles of learning and existing knowledge. Facilitators can use this information to make a plan for what groups to get together when, and what issues to focus on within each meeting. They are likely to structure shared learning through a number of steps and build collaboration over time, with plans revised in response to the outcomes of early steps (Buck *et al.,* 2001b).

4.3.5. Collective responsibility

One more essential element for having success and being effective in adaptive management is collective responsibility. Complex management issues require leadership, not only the leadership of the ones responsible for management exercises, but the collective leadership of everyone in his own right and position. So, not only the people who were traditionally responsible for forest management such as Forest Departments and Regional Authorities, but also people from local communities, who might feel hesitant to express their views about management due to historically grown power relationships, should learn to be responsible. After all, it is at the local level that things might happen. A proactive approach needs to be adopted, in which each stakeholder can identify where he/she can have an influence. How stakeholders can be effective depends on their personal qualities and skills, but also on the values they hold (de Hoogh, 2002)

4.3.6. Conflict handling

As indicated before, current principles of multi-stakeholder processes in natural resource management suggest that co-ordination should be grounded in negotiations that involve all relevant stakeholders, identify their interests, facilitate effective communications and learning, create a neutral space for interactions, and seek to achieve consensus. It is assumed that this type of co-ordination is dealing effectively with conflicts within and among different stakeholder groups. Experience in forest areas indicate however, that some of these aims might be unrealistic and even work against disadvantaged groups, such as local forest-dependent communities (Anau *et al.,* 2002; Edmunds & Wollenberg, 2001; Edmunds & Wollenberg, 2002).

Actually, some of the assumptions underlying multi-stakeholder approaches (Box 9) are easily refutable. For example, neutral communication and fair negotiation outcomes may only be possible in

settings where the power to influence forest management is relatively well-balanced among stakeholders. However, such settings rarely exist. In practice, dominant and powerful groups commonly set the terms of communication to meet their own interests. Multi-stakeholder negotiations frequently use the language and unspoken rules of behaviour of dominant parties. Written materials, technical terms and equipment are used in forums with illiterate participants, which are not surprisingly very hard if not totally non- understandable for them (Edmunds & Wollenberg, 2002).

Box 11. Definition of disadvantaged groups (After: Edmunds & Wollenberg, 2001)

"Disadvantaged groups of people are those people with limited power to influence decisions in multi-stakeholder settings. Their power is limited by their social status, their representation in public for a or their negotiating capacities."

In a forest environment disadvantaged groups are for example, indigenous people living in the forest, subsistence farmers or collectors of forest products, who are consistently the weakest players in negotiations with powerful corporations, international NGO's, government officials and local elite.

Natural resources management practitioners often expect negotiations to result in consensus and agreements that bind stakeholders to a coherent course of action (BC Forest Service, 1999; Borrini-Feyerabend, 2000; Margoluis & Salafsky, 1998; Salafsky *et al.*, 2001). Facilitators aim to identify a common interest and achieve consensus. Yet consensus may mask the multiple interests that bubble beneath the surface during negotiations and are left unstated or bargained away. The degree and durability of agreements are usually overestimated, as the positive feelings shared among stakeholders during negotiations often disappear once they leave the negotiating table (Edmunds & Wollenberg, 2002). Disadvantaged groups might also hesitate to express their views openly in front of powerful groups during negotiations and thus agree with them to avoid confrontation. Further, agreements should not be regarded as the end of the process. The effective life of an agreement can be very short, and is often subject to external events beyond the control of stakeholders. Adaptive management is dealing with this issue by constructing agreements that can be re-negotiated in co-ordination with unexpected events (Edmunds & Wollenberg, 2002).

Another issue is that bringing all affected stakeholders to the negotiation table bears certain risks. Convenor's biases and agendas directly influence the selection of stakeholder groups, the people who represent each group and how the expression of interests is facilitated in the meeting. The decisions rarely meet everyone's objectives. The compromises made, in turn, are political choices that reflect to whom convenors and facilitators are accountable (Edmund & Wollenberg, 2002). In fact it may not be desirable to negotiate with all stakeholders at once. Communication differences and the possibility for unfair decision-making are likely to increase where powerful stakeholders are matched with weak ones. Inventiveness and sensitive facilitation are required to enable stakeholders with different social status or power relations to meet and exchange ideas effectively. Choosing a facilitator who cares about empowering weaker parties and who can maintain a fair and open attitude with the other parties, would be a good option (Wollenberg et al., 2000).

Also the assumption that information should be shared freely among stakeholders needs careful consideration and a critical look at the real process of control over information. If disadvantaged groups are expected to share information freely in multi-stakeholder negotiations, they can be put in the difficult position of having to choose whether to be supportive of the process, versus giving potentially valuable information to those who could use that information against them. Especially where trust among stakeholder groups is low, it may be unwise to reveal one's true interests or assume that other groups are communicating their interests and valuable information honestly (Anau *et al.,* 2002).

But what then can we do about conflicts based on differences in political power? How do we handle conflicts? There are plenty of tools available for conflict identification, analysis and resolution (Skutsch, 2000). However, experience in the use of these conflict management tools still needs to be built up. Each of these tools has its strengths and weaknesses, but they share one common characteristic, i.e. they all imply the making of value judgements. Consequently, none of them is politically neutral. Edmunds and Wollenberg (2002) identified several steps to be adopted in multi-stakeholder negotiations in order to achieve fair outcomes for people with less political power, see Box 12. The steps do not eliminate the vulnerability and representation of disadvantaged groups, but do help to place these issues at the centre of the communication and negotiation process. They suggest that such treatment needs to become a standard of professional achievement in order that more democratic processes and outcomes can be achieved.

Box 12. Steps to be adopted in multistakeholder negotiations (Edmunds & Wollenberg, 2002)

- Inform participants fully about to whom convenors and facilitators are accountable.
- Give disadvantaged groups the option to not participate in negotiations and to not be made more visible to powerful stakeholders.
- Create possibilities for disadvantaged groups to use alliances with more powerful groups in negotiations.
- Acknowledge the right of disadvantaged groups to identify "non-negotiable" topics, or items they view as inappropriate for discussion in the negotiations.
- Acknowledge that each group may not fully and unconditionally support proposed agreements. Encourage stakeholders to express their doubts about agreements. View "consensus" as likely to mask differences in perspective and discount the input of disadvantaged groups.
- Assess the likelihood that external events will require revisions in agreements and make provisions for disadvantaged groups to be involved in those revisions.
- Prepare disadvantaged groups for the possibility that the good will demonstrated among groups in multi-stakeholder forums may not last.
- Approach negotiations as one strategy among several that disadvantaged groups may pursue simultaneously.
- Assess the legitimacy of processes, decisions and agreements in terms of the role and implications for disadvantaged groups. Analyse the reasons for participation or non-participation by each group in negotiations, how groups are represented, the roles of convenors and facilitators, and the history of relationships underlying agreements.
- View negotiations as a long-term, iterative process and be ready to monitor impacts and adjust strategies to assist disadvantaged groups accordingly.

4.4. Tools to increase adaptivity and learning

4.4.1. Introduction

Adaptive management seeks to achieve adaptation through iterative social learning among stakeholders. Learning means transforming information into new knowledge. Social learning involves a process of interactive learning, in which new knowledge is acquired through interactions with other people. It can occur in many different ways depending on the roles, identities, capacities and power relations among the people seeking to learn. It can take place through simply exchange of information and dialog among stakeholders, undertaking a collaborative inquiries, or exchanging experiences through cross-visits (Wollenberg *et al.,* 2000).

Often the focus of learning is on the monitoring of past actions, which is called *retrospective learning*. This type of learning is especially of relevance if adaptive management interventions are designed as trials or experiments. The lessons drawn from the experiences are used to adjust the next set of management actions (Wollenberg *et al.,* 2000). In addition, anticipating and exchanging perspectives about the future can be an equally important source of learning. This type of learning is called forward looking or *anticipatory learning*. It focuses on gathering information about what might happen based on an understanding of drivers of change, the probabilities of future events and the interests of different actors. Anticipatory learning may contribute towards adaptivity by increasing preparedness. Anticipatory techniques can be very useful tools for adaptive management, because they enable the

different stakeholders not only to respond to change, but also to be prepared to adapt to it (Wollenberg *et al.,* 2000).

In the next paragraphs some major examples of tools which can be used to stimulate retrospective learning and anticipatory learning will be described. Conceptual models and criteria and indicators are useful tools for retrospective learning, while scenarios and environmental impact assessment are useful tools for anticipatory learning. As indicated in the adaptive management framework (Figure 1) each tool can be used in one or more specific phases in the basic adaptive management process. An example of the practical use of each tool will be given in Chapter 5.

When selecting a certain tool for use in adaptive forest management one must keep in mind, that the tool must be understandable for the stakeholders who are involved in the adaptive management process. Some tools such as scenarios can use different instruments, such as pictures, written stories, dramas, or maps. In the selection of a certain tool or instrument, the users' capacities, preferences and resources should be kept in mind. For example, in a community forest system, where people have low levels of education and limited financial resources, a scenario in the form of a drama or a map can be much more useful than a complicated computer simulation model. Sometimes, it may be more desirable to work with different groups of stakeholders at different times, using different tools (Wollenberg *et al.,* 2000).

4.4.2. Conceptual models

Conceptual models are effective tools in getting an understanding of the system or site under study. They can be used during the various phases in the adaptive management process. Existing knowledge can be synthesised in these models. The models can also be used to explore different management options or to design management trials or experiments. The information obtained from the monitoring and evaluation of these trials can again be incorporated in the models.

A conceptual model consists of a diagram indicating a set of relationships between certain factors that are believed to impact or lead to the common or target goal of the adaptive management exercise. Such factors can be specific events, situations, conditions, policies, attitudes, beliefs, or behaviours that affect the target condition. Some of the most important factors that must be considered in model building for conservation projects are direct and indirect threats to biodiversity, as well as contributing factors. Direct threats are factors that immediately affect biodiversity or physically cause its destruction. Indirect threats are factors that underlie or lead to the direct threats. And contributing factors are factors that are not classified as direct or indirect threats but somehow affect the target condition (see Box 13).

A good conceptual model presents a picture of the situation at the project site, showing the assumed linkages between the various direct and indirect threats that affect the target condition, presents only relevant factors, is based on sound data and information and results from a team effort (Margoluis & Salafsky, 1998). By making such a picture, existing knowledge of the projects' stakeholders is integrated in the conceptual model. Figure 2 shows an abstract form of a conceptual model, showing the factors linked to the target condition.

After developing an initial conceptual model of the project site, the model can be used to determine what actions to take and to develop a management plan. Developing a management plan starts by ranking the various threats that are identified in the model and deciding which are causing the biggest problems and which are most easily addressed. After selecting the threats to be addressed, the factors linked to these threats are identified with the help of the model. The next step is to develop a specific objective for that factor. Objectives are specific statements detailing the desired accomplishments or outcomes of a project in relation to specific factors (Salafsky *et al.*, 2001). A

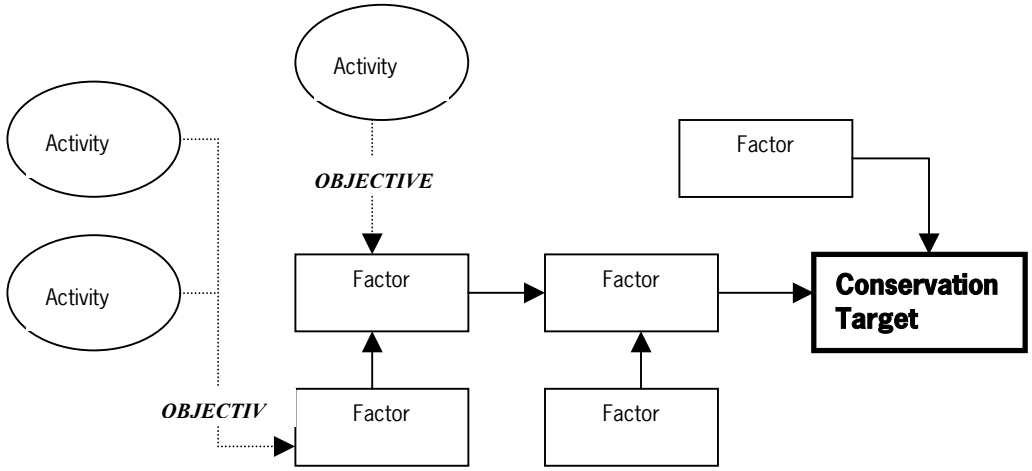

Figure 2. Example of conceptual model, including activities and objectives (Salafsky *et al.*, 2001)

good objective meets the criteria of being impact oriented, measurable, time limited, and practical (Margoluis & Salafsky, 1998). Once the specific objectives are developed, the activities that will accomplish these objectives must be developed. Activities are specific actions undertaken by project staff designed to reach each of the project's objectives. A good activity meets the criteria of being linked, focused, feasible, and appropriate (Margoluis & Salafsky, 1998). The key to the management plan is that each objective is targeted at a specific factor in the model that is linked to the target condition. If the theory is correct, completing all of the activities will enable the project to meet its objectives and ultimately change the target condition (Salafsky *et al.*, 2001).

Box 13. Practical example of different components of a conceptual model (based on: Margoluis & Salafsky 1998)

Target condition: tropical forests and fauna in Waitiki National Park
Target goal: to protect tropical forests and fauna in Waitiki National Park

Factors:

direct threats:	***indirect threats:***	***contributing factors:***
slash and burn activities	poverty	weather
hunting	lack of knowledge on hunting restrictions	social/cultural values
mining		

Example of objective and activities developed for factor hunting:

Objective: to reduce 90% of illegal hunting incidents in Waitiki National Park.
Activities: 1. Discuss hunting restrictions with local communities
2. Show communities Park Boundaries
3. Develop community self-policing system.

A practical example of the different components in the conceptual model is provided in box 13. The use of conceptual models in practical work situations is illustrated by the case study in Chapter 5.2.

4.4.3. Criteria and indicators

Criteria and indicators (C&Is) are especially useful for monitoring and evaluation of the management activities undertaken (phases D and E of the basic adaptive management process). This section will highlight some key issues regarding the formulation and use of C&Is in forest management. Lammerts van Bueren & Blom (1997) defined a set of principles, criteria and indicators (PC&Is) as a hierarchical standard that serves as a tool to promote sustainable forest management (SFM). Hierarchical standards are the basis for monitoring and reporting and serve as a reference for assessment of forest management. Initially, efforts to develop such hierarchical standards concerned forest management activities in timber concessions, in order to be able to certify these forests. At present, the hierarchical frameworks are applied to a much wider range of forest management including the conservation of protected areas.

Several standards have originally been developed to assess sustainable forest managed aimed at timber production. The variety of criteria and sometimes unclear interpretation of terms complicated comparison of monitoring, evaluation and assessment of forest management practices in different parts in the world. Lammerts van Bueren & Blom (1997) have made an effort to standardise global usage of criteria and terms. Their hierarchical framework (Figure 3) enables a systematic breakdown of the overall management goals (e.g. SFM) into parameters that can be managed or assessed. Three main parameters are distinguished. Principles relate to the main objective to be incorporated in the management, e.g. economic, social and ecological principles. Such principles are translates into criteria which indicate the desired states or dynamics of the ecosystem and the social system. Indicators are measurable parameters for the criteria. Finally, verifiers are needed to clarify the source of information for the value attached to an indicator (Lammerts van Bueren & Blom, 1997).

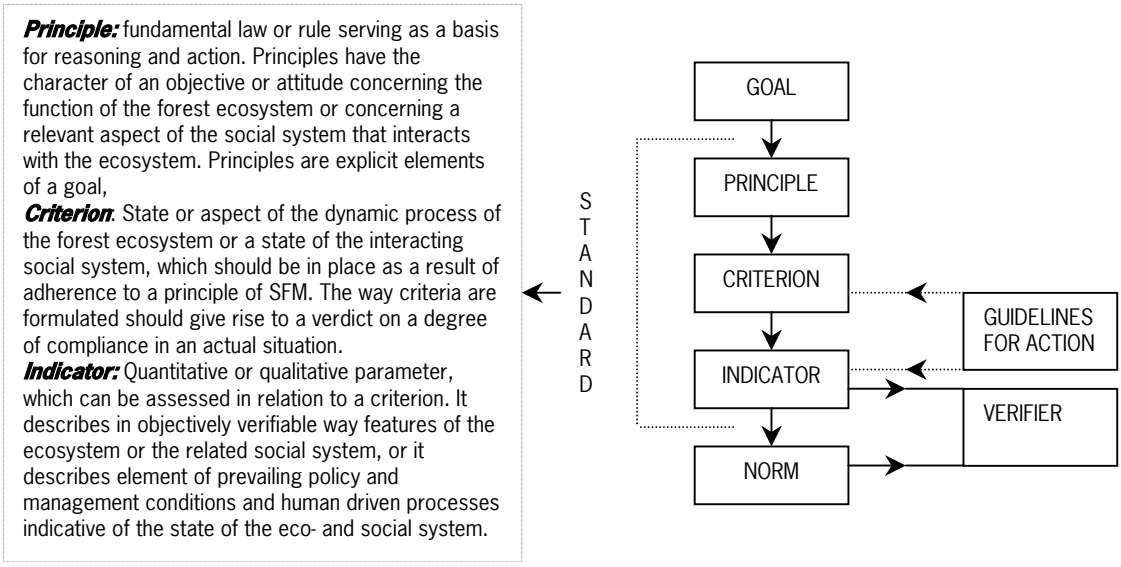

Figure 3. Hierarchical framework showing standard and definitions of PC&Is for SFM (Adapted from: Lammerts van Bueren & Blom, 1997)

The horizontal and vertical consistency of the framework is very important to provide clarity and allow for comparison of results of different projects using PC&Is. A standard is horizontally consistent if the parameters at one level do not have any explicit or implicit overlap or duplication, while at the same time all aspects are covered. Vertical consistency refers to the relation between parameters

appearing at adjacent levels. A standard is vertically consistent if the parameters are placed on the right hierarchical level, expressed in correct terms, and linked to appropriate parameter(s) on the higher hierarchical level. Two examples of linkages between PC&Is and verifiers are shown in Box 14. Consistency in the development of criteria and indicators among projects will facilitate joint learning, as it is easier to compare and communicate the results. Newly starting projects can use standards developed by similar projects that are running or finished already, so that the project team doesn't have to reinvent the wheel.

Box 14. Examples of linkages between PC&Is and verifiers for SFM (Lammerts van Bueren & Blom, 1997).

Principle 1: Long-term social and economic well being of forest workers and local communities shall be maintained or enhanced.

Criterion

1.1. Forest workers and local communities have their user rights well defined and secured.

Indicators

1.1.1. Tenure and user rights are clear to all stakeholders.

1.1.2. Area and percentage of forestland used for subsistence purposes.

Verifiers:

- Interviews
- Written procedures
- Company annual reports

Principle 2: The productive functions of the forest shall be maintained.

Criterion

2.1. The productive capacity of the ecosystem is maintained.

Indicators

2.1.1. Operation of low impact felling and skidding techniques

2.1.2. Silvicultural practices are adjusted to the specific ecology of the forest

Criterion

2.2. the productive capacity of the soil is maintained.

Indicator

2.2.1. Percentage of harvested area having significant soil compaction.

Since the mid 1990s much experience has been obtained with the application of C&Is for evaluating sustainable forest management. From comparative studies (Colfer *et al.*, 2001) it became apparent that one set of C&Is would never be globally applicable. They cannot be applied mechanistically. C&Is need to be developed in a consistent, iterative and participatory approach in order to suit the needs of adaptive management. They must be approached as flexible devices, adaptable to varying local conditions. And their development requires input from local managers to ensure that desired conditions can be agreed upon and monitored by relevant stakeholders (Colfer *et al.,* 2001).

Based on analysis and synthesis of the C&I field research, a set of C&I has been identified that can form the starting point for developing localised sets of C&Is for use in adaptive management schemes. This set is called the "Generic Template". A knowledge based system called CIMAT (Criteria and Indicators Modification and Adaptation Tool) has now been developed to support the process of developing locally adapted C&I using the Generic Template as a starting point. In CIMAT all the principles (6 for SFM), criteria, indicators, and verifiers of the Generic Template are represented as items that can be modified by the user. The modification can only take place when users explain their reason for the change. All the reasons in the system can be made dependent upon one another, they can be revised during modification, and they can be counter-argued by other users. CIMAT software simply yet rigorously foresees in a process of adaptation and modification of the Generic Template to local conditions, expectations and management objectives (Haggith, 2002). For more information, see http://www.cifor.cgiar.org/cimatweb/.

A practical example of the use of biologically-oriented criteria and indicators is given in Chapter 5.3.

4.4.4. Scenarios

Scenario methods differ from the earlier discussed tools for adaptive management because they focus on anticipating the future rather than on evaluating present conditions. Scenarios are studies of what might be. Unlike projections, scenarios do not indicate what the future will look like. Scenarios instead stimulate creative thinking in order to assist stakeholders to break out of established patterns of assessing situations and planning actions. This should assist them to better adapt to the future. Scenario methods are most appropriate under conditions where complexity and uncertainty are high, as is generally the case in community-based tropical forests management (Wollenberg *et al.,* 2001a). If the management of tropical forests were more simple and predictable, we could use straightforward projections based on current trends. Unfortunately, complexity and uncertainty are more characteristic of many situations, and so creative processes for anticipating change such as scenarios are useful.

Scenarios are of particular importance for creating a shared vision among stakeholders on what might happen in the future. Therefore, scenarios are of particular importance in the starting phase as well as phase A of the basic adaptive management process. Scenarios can make use of various media, such as pictures, photos, written stories, dramas, poems, videos, songs, graphs, sand drawings, geographical information systems (GIS), dances, mathematical equations, or any combination of these and other media. The media to be used should be determined on the basis of the users' capacities, preferences and resources (Wollenberg *et al.,* 2000).

Four types of scenarios are usually distinguished, i.e. vision scenario's, projection scenario's, pathway scenario's and alternative scenario's, see Box 15. Common to all scenario approaches is the aim of developing new images of the future. However, scenarios are more effective tools for learning when their purpose is clear. The purpose should guide the selection of methods. Two questions should be answered before selecting a certain scenario approach.

- What is the action or decision making context that the scenario(s) will help to inform?
- What kind of knowledge about the future and learning process is necessary to prepare for this action or decision?

For example, vision scenarios are useful in situations where forest communities need to be empowered to imagine achieving their goals, or to create a shared vision for a set of stakeholders. If there is a need to learn about the likely outcomes of current or proposed practices, projection scenarios are of particular value. And if there is a need to develop knowledge about a range of possible states, such as to develop contingency plans, assess risks or determine tradeoffs among different desired endpoints, alternative scenarios are the best approach to use (Wollenberg *et al.,* 2000).

Box 15. Four different approaches to scenarios (Wollenberg et al., 2000)

- ***Vision scenarios***: the purpose is to enable stakeholders to articulate their hopes, to build awareness about these hopes and to empower them to think it is possible to achieve them. The method requires eliciting only one scenario, which is usually a snapshot view of some point in the future.
- ***Projection scenarios***: these scenarios are very similar to vision scenarios, with one important exception. They show a single snapshot image of the future according to the stakeholders' expectations rather than their desires. The purpose is to help them learn what is likely to occur if current trends continue.
- ***Pathway scenarios***: the purpose of pathway scenarios is to help people determine how stakeholders can get from the present to a desired condition. Pathway scenarios combine elements of vision and projection scenarios. The key difference of pathway scenarios from other approaches is that the learning focuses on open-ended problem-solving and creating strategies for dealing with the constraints and opportunities for achieving a future goal, rather than on trying to internalise the possibility of a particular future.
- ***Alternative scenarios:*** the purpose of alternative scenarios is to broaden stakeholders' thinking about the future to account for uncertainty by exploring not one, but a range of possible futures. These scenarios help stakeholders to cope with uncertainty, not by eliminating it, but rather by framing it and understanding the range of associated implications. The methods rely on elements of the vision, projection and pathway methods. The key difference with these methods is that alternatives-based scenarios treat the future as unknowable. Risk is assumed to be an important aspect of making decisions in the present. Multiple scenarios are generated to show what could happen because of these risks.

As a tool for anticipation, people can use any of the scenario approaches to adapt their current mental model to changing circumstances. The scenarios contribute towards social learning by stimulating multiple stakeholders to develop new and shared mental models. Adaptation of mental models is the key aim of using scenarios. During times of rapid change or complexity, existing mental models include assumptions that are no longer valid or habits of observations that prevent seeing new relationships. Scenarios introduce hypothetical possibilities that spur people's imagination and enable them to adjust their mental habits. The potential for anticipatory learning and adaptation is higher when multiple scenarios are explored and the relationships among events, resources, and actors involved in these scenarios are well understood. Thus, using alternative scenarios will enhance adaptivity and learning. The effectiveness of scenarios in practice remains to be tested (Wollenberg *et al.,* 2001a). To facilitate the process of using and testing scenarios in community forest settings, Wollenberg, Edmunds & Davids (2000) prepared a guide for users.

The level of detail and data collection necessary for building scenarios varies from case to case. All scenario approaches can be implemented with relatively simple, low-cost participatory rapid appraisal methods (see Table 5). Most commonly the scenario approach has focused on the use of graphical illustration created through group processes to illustrate a vision or present conditions. They have been used as empowerment, awareness, and planning tools. Alternatively, the scenario approach can be implemented with more-detailed sampling, data collection, modelling, and analysis (Wollenberg *et al.,* 2001a). An example of an actual use of scenarios in developing adaptive forest management is given in Chapter 5.4.

Table 5. Examples of participatory rapid appraisal methods relevant to scenarios (derived from: Wollenberg et al., 2000).

1. Possible futures Stakeholders brainstorm about what they think might happen in the future. The facilitator sets a timeframe (any amount of time for which there is an interest, perhaps as little as one week or as much as several generations) and asks the participants either to draw pictures individually or compose one as a group. Alternatively, people can express their ideas through words that are written on cards or pictures on flipcharts and then clustered. The group discusses the implications of the different possible futures elicited, the probability of each happening and the conditions that would give rise to each future (After: Slocum & Klaver, 1995).	**2. Story with a gap** A facilitator or the stakeholders themselves provide a story about their current conditions, such as how someone wanted to get a good price for a particular forest product of how someone wanted to overcome a pest problem in a tree. They then tell the end of the story with a desirable ending (or undesirable ending depending on what lessons must be learned). The group discusses different types of actions and situations that might occur in the middle of the story. The goal is to link the story's beginning and end. The group reflects upon the types of actions suggested and the possibilities for implementing them (After: Narayan & Srinivasan, 1994).
3. Guided imagery The stakeholders relax and close their eyes while a facilitator leads them in imagining a walk through their village, home, field, forest or other location where change is desired. The stakeholders try to visualise what they would like to see as they pass through different points in the location (a well, a meeting place, a path, a field, a river etc.) or what they expect to be doing (what they are carrying on their backs, what catches their eye, makes them feel good, etc.). After the walk is completed, the stakeholders share with one another what they saw and discuss the implications for actions that they would like to take (After: Borrini-Feyerabend, 1997).	**4. Force field analysis** The stakeholders reflect about their current situation and the kinds of problems that they face. These are visualised and drawn on a piece of paper. They are then asked to draw a picture of their desired future. The stakeholders then compare both pictures and discuss the forces that encourage or discourage changing from the present condition to the desired one. They use this understanding of the positive (e.g. resources available) and negative forces (constraints) affecting their goals to strategise about the best actions to take to accomplish their goals. These actions should be consistent with the forces and reinforce the positive forces (After: Narayan & Srinivasan, 1994).

4.4.5. Environmental impact assessment

Environmental impact assessment (EIA) can be defined as an assessment of the expected impacts of a planned activity on the environment (Morris & Therivel, 2001). Impact prediction is fundamental to EIA, and the likely impacts of a project or set of management activities should be considered for all environmental components (e.g., population, landscape, climate, soil, flora, fauna, etc.). In order to predict the impacts of a development it is also necessary to consider changes in the baseline conditions that may occur in its absence. These can be assessed in relation to the current baseline conditions and information on past, present and predicted conditions and trends.

In the case of adaptive management processes, EIA can be used as a tool in which stakeholders (in a participatory approach) can systematically indicate their judgement about the likely impacts of different management activities on the social and biological environmental. Stakeholders are often well-aware about the effect that certain management activities might have on various environmental components. The use of EIA techniques facilitates the ranking of effects of different management activities and thus facilitates the selection between certain management alternatives. Therefore EIA tools are of particular importance in the phases A and B of the adaptive management process.

There are several standard techniques that can be used for impact prediction, such as checklists, matrices, flowcharts, mathematical models, maps, and geographical information systems (GIS). The use of matrices and GIS will be briefly described below.

Matrices are the most commonly used method of impact identification in EIA. Simple matrices are merely two-dimensional charts showing the environmental component (or types of impact) on one axis and management alternatives on the other. An action likely to have an impact on an environmental component is identified by placing a cross in the appropriate cell (see Table 6, simple matrix). The main advantage is the incorporation of cause-effect relationships. Time-dependent matrices include a number sequence to represent the time scale of the impacts (e.g. one number per year). The magnitude is represented by a number (see Table 6, time-dependent matrix). Magnitude matrices (see Table 6) go beyond the mere identification of impacts by describing them according to their magnitude, importance and/or time frame (e.g. short, medium, or long term) (Glasson *et al.,* 1999).

Table 6. Example of impact matrix (simple*, time-dependent**, and magnitude***) (Adapted from: Lescuyer, 2002).

Types of impact	**Management alternatives**			
	Production (3 years)**	**Protection (3 years)****	**Agroforestry (3 years)****	**Unchanged (3 years)****
Economic impacts				
Employment	X* 221** □***	000** ▪***	X* 333** ▫***	X* 421** ▪***
Net local incomes	X* 211** □***	X* 234** ▪***	X* 123** ▫***	000** ▪***
Net public incomes	X* 133** ▫***	000** ▪***	X* 214** ▫***	000** ▪***
Net national benefits	X* 114** □***	000** ▪***	X* 112** ▫***	000** ▪***
Environmental impacts				
Water regulation and supply	000** ▪***	X* 234** □***	X* 432** ▫***	000** ▪***
Erosion control	000** ▪***	X* 231** □***	X* 123** ▫***	X* 432** ■***
Climate and air quality	X* 223** ■***	000** □***	000** ▫***	X* 332** ▫***
Food and raw materials production	X* 123* □***	000** ▪***	X* 223** □***	X* 123** ▫***
Flora & fauna diversity	000** ▪***	X* 234** □***	X* 433** ▪***	X* 321** ▪***
Flora & fauna quality	X* 234** ■***	000** □***	X* 332** ▪***	000** ▪***
Social impacts				
Village basic equipment	X* 334** ▫***	000** ▪***	X* 122** ▫***	000** ▪***
Road/transport system	X* 122** □***	000** ■***	X* 223** ▫***	000** ▪***
Traditional tenure system	000** ▫***	X* 213** □***	000** ▫***	000** ▪***
Intra-village relationships	000** ▫***	X* 133** ▫***	X* 321** ▫***	X* 234** ▫***

** *Time-dependent matrix: magnitude is represented by numbers from 0 (none) to 4 (high).*

*** Magnitude matrix : □large positive impact ■ large negative impact
▫ small positive impact ▪ small negative impact

GIS and the generation of maps are commonly used for deciding upon community based management activities. GIS can be simply described as computer databases where the information is spatially referenced in the form of maps. For impact prediction GIS are obviously most suited to dealing with the spatial dimension of impacts. At the simplest level of analysis they can be used to make quantitative estimates of aspects, such as the forest area lost by a certain management activity, the length of a road which passes through a biodiversity rich area, or the number of archaeological finds lost to a certain development. More sophisticated predictions will require some form of modelling to represent or simulate the behaviour of the environment (Morris & Therivel, 2001).

Because of their complexity, responses of ecosystems to impacts are notoriously difficult to predict. Consequently, ecological assessment requires a high level of expertise and judgement. However, it can involve a substantial amount of mapping, and the facilities available in GIS can be very valuable. To have a reasonable chance of understanding an ecosystem's current and likely behaviour it is important to have:

(1) a knowledge of the spatial relationships of its components (species, communities and environmental systems), i.e. to know *what* is *where* and *what spatial patterns exist*;
(2) an understanding of the factors that explain these relationships, i.e. *why is it there?* This will depend on a combination of present and past factors, and so may require
(3) a knowledge of at least recent trends, i.e. *what has changed*?

In GIS overlay mapping, data are represented as layers (several map sheets) each with a particular theme that describes the environment under study. GIS can thus help to provide answers to the questions first two questions stated above. For example:

- layers showing distributions and ranges of species, locations and extents of habitats and sites, and patterns of environmental parameters such as geology, soils, hydrology, or land use can clearly demonstrate spatial relationships;
- spatial relationships, e.g. between species and habitats or habitats and environmental patterns, often go a long way to explaining why it is there;
- layers created from past maps or records can illustrate what has changed, and help to explain the present patterns and relationships.

In addition, GIS mapping can be useful in attempting to answer some impact prediction questions (*what happens if?*). For example, it can demonstrate locations and dimensions of:

- predicted impact areas, including "buffer zones" along linear projects;
- habitat fragmentation, including sizes and isolation of remaining habitat patches;
- new barriers to species dispersal, including the project itself (buildings, roads, etc) and barriers created by habitat fragmentation (Morris & Therivel, 2001).

GIS maps have proven popular tools and useful for planning local management of natural resources in the tropics (Gonzalez, 2002; Lescuyer, 2002). The strength of GIS lays in its strong visualisation capacities[1]. Predicted impacts of certain activities are literally projected on maps. GIS is also a strong tool for joint learning. Gonzalez (2002) used GIS when working together with local farmers in the Philippines. He reported that local farmers were enthusiastic about using information technology. They were excited about the thought of learning more about their own environment and when they saw their communities in relation to the region as a whole they realised their inter-connectedness, as well as their neglect. They became aware of the levels of deforestation and its relative distribution across the study areas and expressed the wish to fight deforestation in their own areas (Gonzalez, 2002).

Although, GIS have proven to be a popular and useful tool for natural resources management in the tropics, one must be aware of its potential dangers. Negative impacts on group dynamics, due to

[1] Hence, GIS maps can also be well-used in scenario approaches

different levels of familiarity with or access to such technology must be avoided (Wollenberg *et al.,* 2000). GIS can also be sensitive to differences in power relations. GIS experts can manipulate data in such a way that the final decision taken by for example local communities is going to be in his/her advantage. Further, GIS is an expensive tool as it requires GIS experts and rather advanced technological facilities. However, with modern advances in GIS and computer technology, the possibilities for practical field-level use are quickly improving. An example of the use of GIS and EIA in practical work situations is illustrated in Chapter 5.5.

5. CASE-STUDIES

5.1. INTRODUCTION

This chapter describes a number of case studies to illustrate the practical use of different tools in adaptive natural resources management. The examples of tools illustrated by the case-studies in this chapter are indicative only, as there are more tools to increase adaptivity and learning. The case-studies were selected because they prove how the use of the tools which were discussed in Chapter 4.4 can practically be used in the adaptive management process. The examples given concern case studies in various tropical regions tropical regions in Africa, South-America and Asia. They show how adaptive management can be applied to different kinds of ecosystems ranging from the dry tropical forests in Zimbabwe to wet tropical forests in Peru. The case studies also illustrate that adaptive management is dependent on a number of factors, such as for instance, the political setting, the (historical) relationships between the social actors or stakeholders, power relationships and the ecological circumstances. They also illustrate that adaptive management can serve various purposes, such as biodiversity conservation, a sustainable gas development project, governance of common property resources and the design of sustainable and efficient management plans. And all examples vividly show that adaptive management concerns both ecological-technical and social aspects as well as the complicated dynamics within and between them.

5.2. COMMUNITY-BASED NATURAL RESOURCES MANAGEMENT IN PAPUA NEW GUINEA[2]

This case illustrates the uses of a conceptual model (see Chapter 4.4.2) in preparing a community-based adaptive management plan.

Background of project

n Wildlife Management Area (WMA) in Papua New Guinea (PNG) industrial logging, mining and oil drilling are increasing threats to biodiversity. These threats are compelling because the companies that would like to access the natural resources are offering the local residents who own these resources, relatively large amounts of money compared to their current incomes. Landowners are willing to sell their properties in order to meet the growing need for cash. To offset growing cash needs of landowners, a team comprising of members of the Research & Conservation Foundation as well as the Wildlife Conservation Society established several locally owned and operated research, ecotourism and handicraft production enterprises, in the late 1980s. The main assumption or hypothesis behind it was that the establishment of viable enterprises that depend on site biodiversity will lead to biodiversity conservation and sustainable use of natural resources by Crater Mountain WMA landowners.

In the early 1990s considerable debate existed about the effectiveness of the Crater Mountain project teams' methods (establishing eco-enterprises) to achieve conservation goals. As little systematic analysis of the methods and results of this approach had been conducted, the team wanted to set up a monitoring system. This system should allow them to better evaluate whether socio-economic development objectives being implemented in the Crater Mountain WMA may be resulting in increased biodiversity conservation action by landowners.

Project site and local community

The Crater Mountain WMA covers an area of 2700 km^2. The site ranges from sea level to 3000m in elevation. Primary forest covers the lower elevations, while alpine scrub and grasslands occur higher

[2] Johnson, A., Igag, P., Bino, R. and Hukahu, P. (2001) Community-Based Conservation Area Management in Papua New Guinea: Adapting to Changing Policy and Practice. In: Buck, L. *et al.* (eds.), *Biological Diversity: Balancing Interests Through Adaptive Collaborative Management.* CRC Press LLC, Boca Raton, USA. Chapter 18, pp 351-367.

up. Crater Mountain is home to over 200 bird species, of which 49 are endemic to the region, and 84 mammal species, of which 15 are endemic. The social landscape of the WMA is extremely complex. Land is owned by 22 clans of the Gimi and Pawaian language groups, who have settlements near four airstrips. There are no roads in this remote mountainous WMA. Each clan manages its land independently of the others. Traditional rivalry and sorcery is ongoing between the clans. The population of the WMA is 3000 people, an average density of one individual per square kilometre. Delivery of government services, health and education is limited in the WMA.

Stakeholders

The Crater Mountain project team was formed by the Research & Conservation Foundation and Wildlife Conservation Society. The team works in partnership with numerous national and international NGOs, the government of PNG, and the local landowners. The team includes biologists, small business developers, community development volunteers, scientists, and support staff.

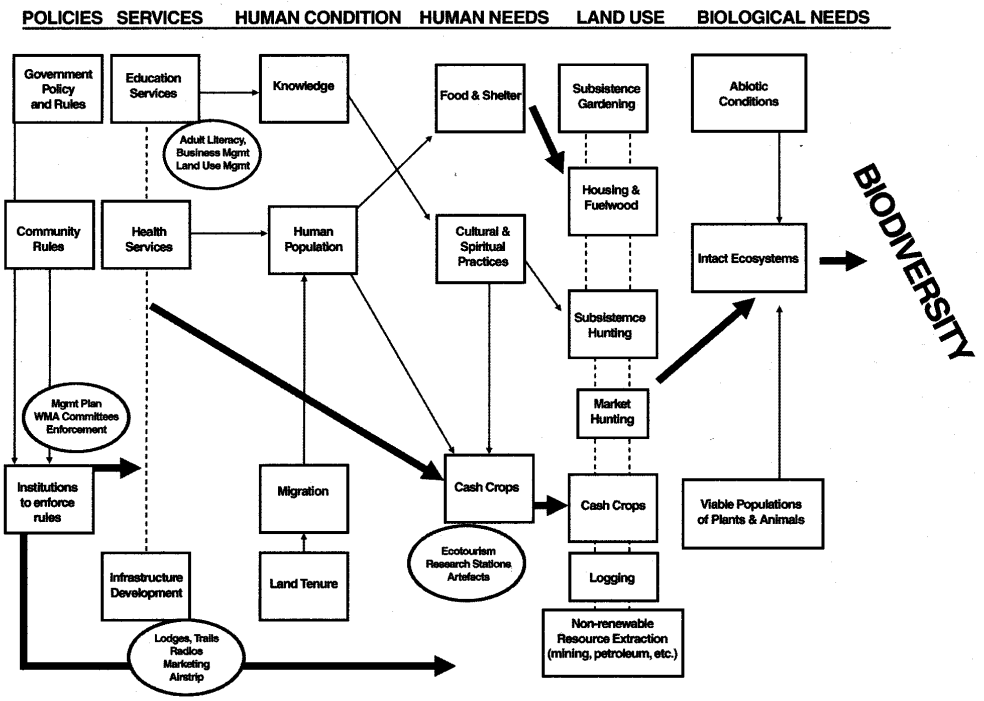

Figure 4 Conceptual model showing the conditions in the Crater Mountain WMA (after Johnson et al., 2001)

Methods used

The project staff developed a conceptual model of the conditions in Crater Mountain WMA. After developing the conceptual model (see Figure 4) the team identified key areas within the model where its interventions may have the highest probability of positively influencing factors that may, in turn, lead to the target condition "biodiversity conservation". These "intervention areas" are indicated as circles on the model. Key assumptions were made regarding the intervention and formalised into project objectives (see Box 16). To monitor and evaluate the project progress, indicators were selected that would work as "gauges" to measure the state and change in environmental and socio-economic conditions at the site over time. Indicators were selected on the basis of the project objectives. For each indicator the project team identified (1) the methods to collect the data, (2) which project staff or community members would implement the method, and (3) when and where the monitoring would take place. This resulted in the Crater Mountain WMA Monitoring plan.

Box 16. Crater Mountain WMA project objectives regarding intervention areas.

1. To increase the income of clans from the establishment of eco-enterprises.
2. To increase the capacity of WMA residents who work in the eco-enterprises.
3. To increase the number of decisions and actions that integrate monitoring results in the management plan.
4. To increase national involvement within the WMA as teachers and trainers, to build national capacity and to replicate the process, if successful.

Project outcome

The preliminary monitoring results with regard to the first project objective (Box 16) showed that annual clan income from eco-enterprises was higher in "Haia" clans than "Maimafu" clans. The main source of income in Haia clans in 1997 was derived from the biological field research station. Involvement of Haia clans in eco-enterprises was related to the location of these eco-enterprises on their grounds as well as social aspects such as traditional rivalry and sorcery and marriage bonds between the different "Haia" clans. Due to these issues, five out of ten "Haia" clans do not have substantial economic incentives for biodiversity conservation. As a result a proposed large scale logging concession is now being considered by these clans. The project team considers focusing on income-generating activities such as eco-tourism on the grounds of these clans to avoid unsustainable practices.

To monitor whether a change in the use and abundance of natural resources may result from a change in clan income from eco-enterprises, monitoring of export and wildlife in the WMA villages of "Haia" and "Maimafu" clans was implemented during 1997. Cassowaries (large terrestrial birds), are the main species of wildlife that were used (71%). About 90% of captured cassowaries were juveniles, which is not surprising since the adult birds are considered very dangerous for humans to handle. Landowners reported that the current harvest of cassowary chicks is from clan-designated hunting areas within the lands they control in the WMA. Since little land mapping has been done, it is not clear if designated non-hunting areas, which are set aside by each clan, are sufficient in size to serve as a viable population source to sustain this rate of harvest. Therefore a workshop with WMA management committees was held to conduct trend mapping of exploited species. Residents described and charted how the availability of hunted wildlife had changed since the time of their grandparents. Workshop participants concluded that the hunting of some wildlife species is now unsustainable and this is related to increasing human populations in the area. Another monitoring result was that there is a slight correlation between benefits from eco-enterprises and wildlife uses. "Haia" clans, which have the highest economic benefits from eco-enterprises, use less wildlife and vice-versa.

In response to these preliminary monitoring results the project interventions and monitoring activities were adapted. The modified activities are presented in Box 17.

Box 17. Modified project interventions and monitoring activities of the Crater Mountain WMA project.

- To conduct further participatory planning with WMA communities to design and test traditional, and non-traditional methods, of regulating wildlife harvest that may be applied to the overexploited species identified by project monitoring in 1997;
- To conduct preliminary Global Positioning System mapping of hunting and non-hunting zones on each clan's land to gauge the feasibility of present land use to provide for conservation of exploited species;
- To place an emphasis on monitoring the village consumption of wildlife for food, in addition to captive and export animals, to understand better the full extent of wildlife use in the WMA;
- To focus existing wildlife transects on the monitoring of heavily utilised wild cassowary populations;
- To focus community conservation education on discussions about the linkages between natural resource use and the viability of both WMA eco-enterprises and traditional subsistence livelihoods;
- To analyse available monitoring data collected on clan spending of cash income to understand change in eco-enterprise activity;
- Potentially to test training methods with interested families on the topic of household budgeting of cash income to meet cash needs.

Elements of adaptive management

Although it was too early for the project team to prove or disprove the main hypothesis on the basis of monitoring results, the monitoring program provided a framework from which assessment of changes across a range of socio-economic and biological variables that are operating in the protected landscape could be started. Baseline monitoring results have provided the project team with increased understanding of site conditions as well as the responses of WMA residents to project activities. The results have caused the project team to ask further questions, refine project activities, and focus monitoring methods, from within the context of the road map provided by the conceptual model. The project team considered the conceptual model as an essential tool for uniting an interdisciplinary, multinational project team in ongoing focused discussion and planning, when working in a complex conservation and development project such as the Crater Mountain WMA project. The project team has on a number of occasions formally revisited and revised their model and is constantly working to develop their organisational learning capabilities (Salafsky *et al.*, 2001).

5.3 Adaptive management for biodiversity conservation and gasa development in the Camisea River Basin, Peru[3]

This case illustrates the use of biological indicators in planning an adaptive multipurpose resource management plan.

Background of project

In 1996, Shell Prospecting and Development Peru (SPDP) began a natural gas exploration project in the Lower Urubamba region of Amazonian Peru near the Camisea River. SPDP initially intended to construct 4 well sites, a gas processing plant and two pipelines to transport gas and liquid condensates to the coast. SPDP's large-scale gas development poses a major threat on the forests in the area, with potential irreversible effects on biodiversity. SPDP decided to take a novel approach regarding development of energy resources, emphasising long-term societal and environmental benefits in addition to financial gain.

Project site and local community

The forests of the Lower Urubamba region extend across 600 km^2 from the Amazon Basin to the foothills of the Andes Mountains. This area is homeland to indigenous people, and is also rich in biodiversity. The tropical forests in this region are among the most biologically diverse forests in the world. The Camisea river valley is situated between Manu National Park, a UNESCO Biosphere Reserve, and the Apurimac Reserve Zone. The rugged terrain, steep hills and tangled mass of vegetation make access difficult and travel slow. The irregular topography affects the characteristics of the forest by promoting landslides and frequent treefalls, which create diverse vertical stratification.

Stakeholders

SPDP invited the Smithsonian Institution's Monitoring and Assessment of Biodiversity Program (SI/MAB) to assist in developing a framework to integrate science and biodiversity conservation with exploration and development of natural gas resources. Both SPDP and SI/MAB consulted with stakeholders living within the project area and with interested external organisations, see Table 7. Both one-to-one dialogues between stakeholders and regular stakeholder workshops were organised for reviewing the various concerns of the stakeholders, developing and calibrating strategies and building consensus for all phases of the project. Community gatherings, periodic workshops and consultation with representative groups, such as elders, women and indigenous federations involved local communities in the process.

[3] Dallmeier, F., Alonso, A. and Jones, M (2002) Planning an Adaptive Management Process for Biodiversity Conservation and Resource Development in the Camisea River Basin. *Environmental Monitoring and Assessment* **76 (1)**:1-17.

Table 7 Stakeholders involved in the Camisea river basin project

Stakeholders SI/MAB	Stakeholders SPDP
Local, national and international scientific experts and institutions with knowledge on the region Government agencies Representatives of local communities National and international NGOs National and state universities	Local, national and international groups and agencies with interests in social issues, environmental concerns, human rights, indigenous people and other issues

Methods used

SPDP and SI/MAB used an adaptive management framework as the foundation for this multifaceted, interdisciplinary project. They followed the four primary steps in the adaptive management process: (1) design management and monitoring objectives (2) implement management, (3) assessment and monitoring and (4) evaluation and decision-making. Each step was periodically reviewed to assure that the appropriate information feeds the next level.

Aims and objectives

The key goal for SPDP and SI/MAB was the design and implementation of operations with a minimum impact on biodiversity. The main problem was that very little information on local biodiversity was available. Literature reviews and consultation with international experts and local communities regarding the region's biodiversity were executed to gather information relevant to biological indicators. Prior to the gas development activities, field assessments were necessary to identify species composition, frequency of encounters and population densities at the study site.

Through the stakeholder workshops and consultation process, critical biodiversity issues related to the operation were identified. These included selection of the gas plant location, strategies for reforestation in the pipeline route, helicopter effects on game species and the effect of roots on the pipeline. The project's site-specific objectives are listed in box 18.

Box 18. Site-specific project objectives in Camisea project (After: Dallmeier *et al.,* 2002)

- Identification of key habitats using cartographic information and aerial and satellite images
- Description of forest structure, composition and diversity in areas near well sites and control areas
- Determination of current conditions (species composition, frequency of encounters, population densities) of 6 taxonomic groups and design a monitoring program for each of them
- Gathering and understanding indigenous knowledge on the species and their uses
- Identification of potential effects of SPDP operations on biodiversity and mitigation of such effects

In addition, specific management objectives were defined in order to plan a monitoring program. SPDP elaborated objectives to build the gas production fields through highest international standards in all operations, thus attempting to minimise the impact of operations on the environment and native communities. The objectives were linked to all operations and areas of influence; from the well sites to in-field flow lines, the gas plant and the pipeline. Some examples of determined management objectives are listed in box 19.

Box 19 Examples of specific project management objectives in Camisea project (After: Dallmeier *et al.,* 2002)

1. The amount of land that could be deforested at each well site should not exceed 4 hectares in size, while the pipeline right-of-way should be cleared but then reforested with native species.
2. Maintaining forest communities around the areas of influence of the project (wells etc.) in line with populations of species in control areas.
3. Increase the mean density of species (by 65% over the next 5 years) along the areas surrounding the well sites, airport and pipeline through revegetation using native species

Selection of indicators and monitoring

Four monitoring processes were used in the project (see box 20). Standardized monitoring protocols were used to facilitate comparisons among different projects. The sampling objectives were based on the project needs for a comprehensive study. A quantitative monitoring system was selected amongst others based on estimates of the frequency and abundance of species. Much attention was paid to a sound sampling design, the parameters for sampling, and the necessary level of precision. Sampling for this project consisted of systematic, random and stratified methods for different taxa. Permanent sample plots were made for vegetation monitoring. Data collection was completed under consistent standards, data management was executed to high accuracy standards and data analysis ensured that the monitoring objectives were effectively addressed. Reports detailing the findings and recommendations from data analysis were presented in a format that enabled others to make their own interpretations.

For instance, during the baseline monitoring in the project planning phase, potential indicator species were identified in 6 taxonomic groups (vegetation, aquatic systems, arthropods, reptiles and amphibians, birds and mammals) for use in monitoring, because sampling all components of biodiversity is an impractical and costly task. Over a 2-year period, a biodiversity monitoring team conducted biological assessments of the 6 taxonomic groups at five sites located within the study area. Sampling was conducted during the wet and dry season in plots within 300 meters of the wells and at control areas up to 1 km away to determine impact of gas development activities on biodiversity.

Box 20. Different monitoring processes used in Camisea project (After: Dallmeier *et al.,* 2002)

1. Baseline monitoring: first set of measurements in the monitoring program that sets the standard against which future changes are evaluated, providing for before-and-after comparison.
2. Implementation monitoring: Quantitative feedback on whether operations are carried out as planned, acts as a form of quality control to audit the degree of compliance with previously established standard and guidelines.
3. Effectiveness monitoring: assessment of the impact of the operations and evaluation of how effective the operational controls were in meeting the needs and expectations of the management plan.
4. Validation monitoring: addresses the validity of pre-defined assumptions.

Project outcome

A broad range of options that included location, timing and technology were developed by SPDP from the beginning and were addressed in conjunction with the emerging lessons from biodiversity monitoring. Critical decisions concerning the option included location of a gas plant and the cost of helicopter versus road access, both of which were evaluated to ensure that they were economically, environmentally and politically feasible. Project design changes, addressed in the planning phase, were accepted once consensus was achieved. Stakeholders were informed of the implications of the baseline biodiversity assessments.

Elements of adaptive management

Biodiversity studies were considered as providing information for better identification of means to reach the operational goals. Through evaluation of the assessment data, SPDP managers received timely feedback from the effects of various practices. Evaluation was a conscious tool for improved management and was used to inspect ongoing actions and to provide guidelines for enhancement. Such evaluation created the opportunity to decide whether there was a need to adjust practices to the assessment program. In case these evaluations indicated that biodiversity trends were as expected, the management practices were continued without substantial alterations. Where significant changes in the trends were observed, SPDP managers and decision-makers designed new practices, which were expected to provide better results.

An overall conclusion to be drawn from the Camisea project is that biodiversity assessment is a critical concern for major development projects. An early investigation of the actual biodiversity status and a carefully designed monitoring process can have a significant impact on the final project design. In the Camisea project, adaptive management principles proved to be useful for ensuring that the results of monitoring a predefined sets of biological indicators were incorporated into management decisions. This enabled refinement of new activities and assisted in the improvement of biodiversity conservation.

5.4. Forging new institutional arrangements for common property resource management in southern Zimbabwe[4]

A case to illustrate a scenario process for exploring the roles of different stakeholders in local forest management

Background of the project

In Zimbabwe in the 1980s, following the thrust for decentralisation, the district councils were appointed as the organisations to maintain and manage natural resources. Through a series of by-laws they could regulate resource use. Although these councils are closer to the people than the central state and were therefore expected to be able to more effectively deal with natural resource conservation and development for local needs, initially little changed in the prevalent resource use practices. Local people had little say in the drafting of by-laws on natural resource use and conservation, and the enforcement mechanism for controlling resource use remained ineffective. In order to contribute towards a more effective management several experimental projects were set up. One of those projects concerned a 3-year participatory research project in two micro-catchments in Chivi district in southern Zimbabwe. This project was set up by three development organisations and involved the development of an innovative management systems of the local natural resources, many of consisting of common pool resources. Through participatory institutional analysis and review of experiences elsewhere in the world, it became apparent that one of the key problems to be solved concerned the relationship between the local communities and the district council. Essentially, there existed a mismatch in the institutional setting of natural resource management. The most effective local systems for natural resource management were based on traditional systems and focussed user groups. Whereas the district council and its local structures, with an array of by-laws, schedules of fines and enforcement mechanisms, were relatively ineffective but had the legal mandate for resource management. In April 2000, the researchers convened a meeting of the district council to examine the possibilities of re-orientating resource management organisations. The objective was to see whether anything could be achieved within the current legislative framework.

Stakeholders

The possibility of hosting a meeting on natural resource management was initially discussed with the chief executive officer of the Chivi rural district council (RDC), who expressed enthusiasm for the idea. To involve local people at the meeting with the RDC, it was decided to first have meetings at the community level to adequately prepare the community members for the district-level meeting and to give them confidence to articulate their views amongst the district officials. These meetings generated much enthusiasm. The hope from the participants was that there would be more such meetings. Most of the village representatives had never had a chance to discuss such issues before with district authorities. In the final session at the district level the chief executive officer of the Chivi rural district,

[4] Campbell, B., Mandondo, A., Lovell, C., Kaznayi, W., Mabhachi, O., Makamure, T., Mutamba, M. & S. Sibiza (2000) *Forging new institutional arrangements for common property resource management – a case study from southern Zimbabwe*. CIFOR, Bogor, Indonesia; Institute of Environmental Studies, University of Zimbabwe; Centre for Ecology and Hydrology, UK.

administrators, technocrats, councillors, village representatives and researchers of three organisations were present.

Methods used

The methodology used for preparing an improved approach to local-level management of natural resources was the "scenario building" approach. This approach allowed participants to build visions of the future. Prior to the district-level meeting, in each micro-catchment a large all-day community meeting was held during which preliminary community visions were developed on how these catchments should be used and maintained. These meetings were followed by three smaller and shorter meetings in each catchment, to select participants to represent the community at the district-level meeting, to develop the community visions further and to prepare the presentations. Researchers facilitated these meetings. At the initial all-day meeting the large group of about 100 villagers (in each catchment) was subdivided into three groups: older men, women and younger men, with the older men's group looking at governance issues in general, the women's group focussing on water issues, and the younger man's group focussing on grazing issues. Role-plays were used, as it was thought that this would allow the more sensitive views to be expressed. In the final session at the district-level meeting, visions were presented by each of five sub-groups. While four of the subgroups were constituted by a random mixture of individuals and covered different topics (water, woodlands, livestock and grazing, and enforcement mechanisms), one groups comprised officials of the RDC and some councillors. This group discussed their vision of the role of the RDC and the role of the community, and summarised their views in a presentation to all the participants at the meeting.

Project outcome

For anyone familiar with the current planning and implementation procedures of the RDC, the vision (see table 8) can only be described as revolutionary. It represents a shift from a command and control mode of operation to a fully devolved participatory mode. The role of the RDC is seen as being a facilitator and being supportive of community initiatives, providing arbitration when necessary and co-ordinating activities amongst villages. In considering this outcome of the workshop, it might be thought that although the excitement of workshops may lead to creative plans, but that the implementation of commitments made at workshops may not be possible. In this case, however, it is expected that the future will see some concrete action. At the workshop, the RDC sub-group made the suggestion that a pilot governance project be initiated on a particular issue that is troubling communities, namely on the raising and use of fish in dams. The current situation is that the fish in the dams are being exploited as an open access resource, giving little incentive to mange the resource, e.g. By introducing breeding stock. In follow up discussions with the RDC officials, the RDC remained enthusiastic and wanted to expand the pilot project to other resources and more communities. Researchers and facilitators are currently in the field attempting to select and define the pilot study, and convening community meetings to establish a proposed rule system for the selected resources.

Table 8. A vision of the roles of the community and RDC in the management of natural resources

Governance issue	Community roles	RDC roles
Formation of rules and constitutions	Propose laws, rules and constitutions	Rationalise and adopt the proposed rules and constitutions
Enforcement of rules	Employ monitors and apply sanctions	Arbitration, review system, train monitor
Fines, levies, royalties	Set levels, impose and collect	Approve and monitor
Distribution of revenue	Propose distribution systems for revenue, prepare budgets	Negotiate, approve and monitor
Research and development projects	Prioritise projects, identify participants	Co-ordinate among villages, support project applications
Maintenance (e.g. Bore holes, dip tanks)	Implement and pay for it	Monitor and evaluate
Land use planning	Produce plans	Facilitate, co-ordinate among villages, approve
Monitoring and evaluation	Undertake monitoring and evaluation	Facilitate, co-ordinate among villages, approve

Successes and problems encountered

Various conditions have contributed towards the development of a progressive vision:

1. The continuous and long-term involvement of researchers
   Researchers were present at all stages of the process to document the feelings of participants and to explore the undercurrents of the various meetings. The visions emerged from a meeting which lasted one afternoon, but could not have happened without a much longer-term process of engagement between the researchers and the key stakeholders. The research project had been on-going for 18 months prior to the district-level meeting, and the chief executive officer had been a member of the project steering committee. The idea for a meeting to be hosted by the RDC on governance had been broached by one of the researchers more than eight months prior to its occurrence. The long period of engagement was also at the village level. Two researchers had been living continuously in each of the micro-catchments for periods up to one year prior to the meeting.
2. Before starting the project in-depth institutional studies were made. These studies covered national legislation and the push to decentralise, the formulation and implementation of by-laws at the district level, and the numerous local level organisations for the management of woodlands and water. These studies gave the researchers insights as to possible intervention points for institutional change.
3. Community confidence was built up prior to the district level meeting
4. The district meeting was carefully planned with due attention to considerations about the agenda and language. The draft agenda for the district-level meeting had the communities presenting their visions in the morning, while that for the RDC was going to be presented in the afternoon. Although RDC meetings are usually conducted in English , the district-level meeting was conducted in shona to enable all community members to participate.

Problems encountered were:

1. The process was lengthy. The full visioning process, up to the presentation of visions at the district-level meeting, took about three days of time for some villagers (in meetings and preparation).
2. There were no simple terms in the local language to express what vision entailed. In addition, because of the very pessimistic outlook of villagers about the future, it was not easy to move towards a positive vision. The initial vision, especially those expressed in the village meetings, were very negative.
3. There was a tendency for domination by experts and local leaders. Despite attempts to maintain the representation of community views in the community's vision there were constant attempts by certain stakeholders to derail the process. Attempts to dominate the Romwe community vision by a powerful personality in the village (the ex-councillor) was prevented by taking the person for a walk to discuss "important" issues. In one of the sub-groups at the district level meeting and extension worker pushed the vision away from a community-inspired vision about governance towards a technocratic vision.

5.5. A participatory, adaptive approach to the development of master plans for forest management in Cameroon[5]

This case illustrates the use of geographical information systems (GIS) and environmental impact assessment (EIA) for developing an adaptive forest management master plan.

[5] Lescuyer, G. (2002) Tropenbos' Experience with Adaptive Management in Cameroon. In: Oglethorpe, J. (ed.) *Adaptive Management: From theory to practice*. IUCN, Gland, Switzerland and Cambridge, UK. pp 1-14.
See also Lescuyer, G. et al. (2001) *Community involvement in forest management: a full-scale experiment in the South Cameroon forest*. Overseas Development Institute, London, UK, Rural Development Forestry Network Paper No. 25c.

Background of the project

The Tropenbos Cameroon Programme (TCP) was founded on a co-operation agreement between Tropenbos Foundation/ Wageningen University in the Netherlands and the Ministries of Environment and Research in Cameroon. The aim of the TCP was to develop sustainable and efficient management plans and practices for a tropical rainforest area where local use of forest resources and commercial logging co-exist. One particular study dealt with the question how an adaptive management programme in this environment could be designed and implemented. The challenge was to combine the national guidelines for forest management and new participatory management tools to develop a management plan which was acceptable to all stakeholders.

The national guidelines of the Cameroon forest law defines three planning scales for forest management. The first phase of the forest management planning process consist of the preparation of the regional zoning plan. This involves a macro-planning procedure aimed at identifying quality and quantity of forest resources, determining priority agricultural and forests-related land uses, and indication of boundaries to specialised forest lands. According to the national guidelines at least 30% of the national territory should remain forested. The second phase in the forest management planning process consists of the development of master plans (MPs) at the sub-regional level. These mps aim to further detail the zoning plan by proposing meso-zoning of forest lands, indicating priority allocation of forest lands, and providing a classification of permanent forests. In the third phase of the forest management planning process these MPs are elaborated in a set of detailed forest management plans (FMPs). These FMPs indicate the boundaries of specific forest blocks and the authorised uses and users in each of these blocks. According to the Cameroon forest law, this planning process should be carried out in a decentralised fashion and with involvement of all relevant stakeholders. The aim of the process is to recognise the pluralism of viewpoints about managing forest resources in order to conceive adaptive, effective and sustainable forest management. The study reported here focused specifically at the development of an adaptive forest Master Plan.

Project site and local community

The TCP research site is located in southern Cameroon and covers an area of 1,670 km^2. The area belongs to the Guineo-congolian domain of the humid evergreen forests. Four altitudinal zones, seven different land forms, four main soil types, and seven defined plant communities composing of 490 species, form the basis of the landscape ecological map of the research area. The forest area contains of many precious tropical timber species and has been selectively logged several times.

The TCP area comprises of four administrative sub-divisions and 66 villages, including nine pygmy camps. The total population is composed of 14,370 people and the population density for the whole area is 8.6 inhabitants per km^2. Two different population groups have been identified. The majority consists of sedentary villagers mainly represented by the Bantu people from three main ethnic groups. They mainly live along the roads and their main activity is agriculture: shifting cultivation and cacao plantations. The second population group consists of Bagyeli pygmies who live in the forest and practice hunting and gathering activities. They only practise shifting cultivation on a very small scale. They represent only 2% of the total population.

Stakeholders

Seven groups of stakeholders were identified for the decision-making procedure regarding the mp:

1. The local Bantu population: every village provided some representatives, who expressed the populations' views during the process.
2. The Bagyeli groups: the views of these people were expressed in the absence of bantu people, due to predominance of Bantu over Bagyeli. Associations working with Bagyeli expressed their views as there exists no social hierarchy in the Bagyeli group.
3. Decentralised authorities: these include sub-prefects, mayors and '*chefs de groupement*'. Their place in the negotiations was crucial as they represent an intermediate level whose functions is

both to organise the application of the national policy at the local level and to integrate villagers' claims in this application.

4. Specialised authorities: these include two public institutions: the Ministry of the Environment and Forests (MINEF) represented by forestry agents in the field, and the national office for forest development.
5. Private economic actors: essentially these are logging companies whose aims are profitable resource exploitation while contributing to the economic development of isolated villages through the many secondary benefits of exploitation, such as road maintenance, employment, trade, etc.
6. National and international NGOs related to nature conservation or rural development, they represent the international community's concerns.
7. The TCP research project: TCP was regarded as a research stakeholder, with a good overview and insight in the various aspects of regional land-use and sustainable forest management.

Methods used

TCP adopted a so-called intermediary participatory process (see Box 21) for decision-making on the content of the master plan for forest management. During this process first several scenario's for potential meso-scale zonation of the forest lands were made by professional experts. However, these plans were not considered as expert blue-prints, but rather as scenario's which could be presented in visualized form to stakeholders and which could serve as a basis for further discussion and negotiation. Thus, the process was designed in order to recognise and integrate the pluralism of viewpoints of different stakeholders about how best to allocate the forest resources and manage them in effectively and sustainable manner.

Box 21. Intermediary Participation Process (Lescuyer, 2001)

Official Zoning Map
↓
Ecological & Socio-economic Data
↓
Working out of potential scenarios by "experts"
↓
Negotiations of scenarios by concerned stakeholders (with help of GIS and EIA)
↓
Collective choice of the definitive Master Plan

For the development of the scenarios the TCP team used three main sources of guidance and data:

1. The Cameroonian laws regarding the management of natural resources, which address three main issues of conservation of nature, sustained production and development of local villages.
2. The official zoning plan made in 1993. According to this zoning plan the tcp area should comprise of a permanent forest estate with production forest (7.4% of the area), protection forest (22.5% of the area), and council forests (10.1% of the area) as well as non-permanent forest lands (including habitation, shifting cultivation, industrial cultivation, agroforestry, community forests comprising 60% of the area).
3. Biophysical data (vegetation, land use, landform, etc.) And socio-economic (settlement patterns, demographic conditions, traditional land tenure conditions, land use) information collected by the TCP project.

Using the land classification methodology the TCP developed four basic scenarios for the Master Plan (see Box 22). The aim of the subsequent discussion and negotiation phase with the stakeholders was to select one of these scenarios or a compromise between them as a basis for developing an actual

plan. To facilitate the decision-making process among the stakeholders, two major tools were used, i.e. geographical information systems (GIS) and environmental impact assessment (EIA).

Box 22. Four basic scenarios for TCP Master Plan (Lescuyer, 2001)

1. *Agroforestry scenario:* This places the emphasis on the agroforestry zone in which shifting cultivation, plantations, and community forests can expand. The width of the agroforestry strip could extend to 5 km along all roads. This scenario also proposed forest in the middle of the zone. In comparison to the Zoning Plan and to the landscape ecological map, the integral ecological reserve remains and the critical erosion areas are protected against intensive exploitation.
2. *Timber production scenario:* The emphasis here is on the forests dedicated to timber exploitation. Three areas of production forest are located in the centre of the site along a southeast- northwest transverse. Another area is proposed to the north of the site. The minimum cultivable area, the integral ecological zone, the protected areas, and the research zones will remain the same.
3. *Nature conservation scenario:* Here the emphasis is given to the conservation of the natural habitat. The minimum cultivable area is respected, while one production forest remains and the rest of the zone is protected against all intensive exploitation.
4. *Business as usual scenario:* The scenario considers the evolution of the TCP area without forest management. It is presented as a reference base when the other scenarios are analyses and compared to the actual situation.

GIS-derived maps were used to show the geographical location of the various suggested management units within each scenario. The EIA methodology was used to provide the stakeholders with a means to systematically compare the impacts of each MP scenario. For this purpose, an impact matrix was prepared (see table 6) showing the expected impact of each scenario on various environmental conditions. This simulation-based tool has originally been developed as a specialist tool to predict and to assess the expected impacts of technical measurements on the natural environment. In the project it was used for two purposes. In the first place it provided a means to confront the stakeholders with the comparative impacts of the various scenario's. In the second place, stakeholders were given the opportunity to indicate their perceptions of the seriousness of the various impacts. This enabled to develop a set of locally-derived weighing factors which could be used in summing up the overall impact of each scenario. Thus, both the GIS and EIA facilitated the participation of the various stakeholders by showing them the social and natural consequences of the various alternative management plans.

The discussion and negotiation on the scenario's was organised in two steps. First a series of village meetings were organised to familiarise villagers with the project and to allow them to select a village representative. Next a general workshop was organised with representatives of al stakeholder groups. During this workshop, first a discussion round was held by four separate groups of stakeholders (Bantu villagers, Bagyeli people, local administrators, external interest groups). Each group could thus become familiar with the MP scenarios and could offer comments and improvements. The outcome of each group meeting was a map with a preferred scenario. After this first preparatory step towards the multi-stakeholder negotiation a follow-up meeting was held for joint discussion with all concerned stakeholders. In the initial group meetings negotiations had taken place in relatively homogeneous groups, but in this follow-up meeting different stakeholders had to confront each other's viewpoints on the forest management strategy. This joint meeting resulted in the expression of a common agreement on the most satisfying MP alternative.

Project outcome

As a result of the iterative process of negotiation amongst stakeholders on alternative forest management scenario's, at the end the integrated group meeting with all stakeholders a final proposal for the MP was selected. However, before it can be implemented, it has first to be authorised by regional authorities and subsequently be sent to the ministry for official ratification.

Both the GIS-derived maps and the EIA impact matrices proved to be helpful instruments for providing information during the discussion and negotiation process between the various stakeholders. Overall,

the visual impact of the GIS maps were considered of greater relevance for providing the information than the cognitive information provided by the EIA impact matrices.

Elements of adaptive management

The characteristic features of this participatory approach towards the preparation of a master plan for forest management shares many similarities to the features as defined for adaptive management. In the place, this approach to forest management planning consisted of a balanced approach which integrated both national concerns about forest strategy as well as local interests and opportunities of managing forest resources.

Moreover, during the discussion and negotiation process attention was given to the perspectives of stakeholders on both natural and social phenomena and their dynamics. The use of EIA tools was instrumental in obtaining a better understanding of the impacts of desired activities on environmental conditions. And the iterative and multi-level negotiation process aimed to build step by step a compromise that satisfactorily fulfils each of the stakeholders' aspirations. It allowed a balanced approach towards stakeholders' participation in designing the master plan. The purpose of the mp negotiation process was not only to adapt the expert-developed MP scenario's to local conditions, but also to help stakeholders express and define their own opinions regarding an effective and actual set of actions for the sustainable management of local forests.

Finally, the various tools in the planning process were not used in a linear manner, but in an interactive manner. They were used in a process of permanent exchange of information and feedback. The quantified information from the EIA approach was primarily used to support the stakeholder negotiation process and to strengthen the consensus in decision-making. Both the GIS and the EIA methodology contributed to solving disputes and to facilitating the reaching of agreement on the nature and content of the desired Master Plan.

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