Master Management Plan for the Tropenbos-Cameroon research site

Pre-Mediation version

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Tropenbos-Cameroon
Documents 5

ABSTRACT

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A Master Management Plan (pre-mediation version) was prepared for the Tropenbos-Cameroon Programme research site (167 000 ha). This plan focuses on the strategic level of land use planning. Four management scenarios were elaborated based on suitability data for each land use type: an agro-forestry scenario, a timber production scenario, a conservation scenario and a "business-as-usual" scenario. Also, a methodology is proposed that may help stakeholders to take collective choices regarding the development of the site.

Keywords: land use planning, mediation, forest management, nature conservation, forestry, agriculture, tropical rainforest, Cameroon

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PRE-MEDIATION VERSION

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Tropenbos-Cameroon Documents 5

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2001

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SUMMARY

This Pre-mediation version of the Master Management Plan (P-MMP) for the Tropenbos-Cameroon Programme (TCP) research site aims to meet two expectations. First, it is to experiment and valorise the applicability of TCP results concerning the management of tropical rain forest. Second, TCP was asked to produce exemplary forest management plans for its research area, both at the strategic and tactical levels. This P-MMP focuses on the strategic level of land use planning of the 167 000 ha TCP area. It also proposes a methodology that may help all stakeholders to take collective choices regarding the development of the zone in which they are involved.

Land-use planning is the systematic assessment of land and water potential on the one hand, and economic and social conditions on the other hand, in order to allow the authorities to adopt the best land use option. The purpose is to select the land uses that will best meet the needs of the stakeholders while safeguarding resources for the future. This document starts by explaining how this problem may be tackled for the specific case of Cameroon tropical forest and with a description of the research methodology.

The second step is the collection and synthesis of available data regarding socio-economic and biophysical environments, mainly derived from TCP studies. The actual situation of the population, its activities and the main land use types are identified and described. The land evaluation and suitability classification developed by TCP resulted in suitability maps that become fundamental tools when time comes to decide which land use type offers the most advantageous alternative for a given area. The term Land Allocation Type (LAT) is used here to indicate a tract of land that is oriented towards a specific land use type with a leading management objective but that may support at the same time other (secondary) land use types. Except for some specific sites that can be dedicated to only one land use type, it appears that most of the TCP area is highly to moderately suitable for several land uses types.

This allows choices. The assumption is that the concerned stakeholders should carry out the arbitration between these different competing land allocation types. For this purpose, four management scenarios were elaborated based on the suitability data for each land use type: an agro-forestry scenario, a timber production scenario, a conservation scenario and a "business-as-usual" scenario. These are to be presented to the stakeholders as a base for discussion. Each scenario puts emphasis on one particular management option, however without totally excluding the other ones. The idea is not to choose one scenario over another one, but to provide stakeholders with four credible management alternatives, which advantages and drawbacks are explained. The procedure of explaining and negotiating the scenarios is called "mediation": based on the four scenarios, it is realised with the help of appropriate tools such as the Environmental Impact Assessment and GIS instruments.

This pre-mediation version is an intermediate outcome. It will be completed by: (1) a phase of mediation, where the management scenarios are presented and discussed among the relevant stakeholders; (2) the final version of the Master Management Plan, and (3) Forest Management plans at the tactical level. This report gives the different steps that may be followed to build up a Master Management Plan applicable to a large area with several actual/potential land use types and numerous stakeholders with widely different interests.

1. INTRODUCTION

The Cameroonian Ministry of Environment and Forests and the Dutch Tropenbos Foundation initiated the Tropenbos-Cameroon Programme (TCP) in 1992. The main objective of TCP is to develop methods and strategies for management of tropical rain forest directed at sustainable production of timber and other products and services. These methods have to be ecologically sound, socially acceptable, technically feasible and economically viable. A programme of fourteen interrelated research projects, concerning land use, ecology, forestry, and social aspects has been defined to reach this objective. The execution phase started in 1994. The applicability and dissemination of the results is also part of TCP objectives.

The programme document (Foahom and Jonkers, 1992) does not state that TCP should draw a management plan for the research site. This recommendation came later and was probably formulated to test the applicability of the TCP results on the spot. A workshop was held in Kribi on the 27 – 30 November 1996 to define the form and the substance of the management plan (Eyog Matig *et al*., 2000). The conclusion of this workshop was that TCP would write a forest management plan for a production forest localised inside the TCP area after a master management plan of the TCP area had been elaborated to identify the potential production forest(s).

Another workshop (Jonkers and Wessel, 1999) was held in Wageningen in 1998 to discuss the 'Progress of TCP towards planning sustainable forest management', and to clarify the concepts of forest management planning. The outcome of these reflections was that the conception of the master management plan should be done at a strategic level. Forest management plans will be realised at a more tactical level when the forests with specific objectives have been delineated in the area.

The elaboration of both management plans was incorporated in the Econ2 Project. The main objective of this TCP project is to 'develop an environmental impact assessment methodology'. This methodology is meant to facilitate the implementation of forest management plans. The final zoning of the area will be determined following discussions with the main stakeholders taking into account their needs and demands as well as the production capacities of the site.

The preparation and writing of a Master Management Plan (MMP) can be divided into two parts:

- The development of scenarios based on biophysical and socio-economic data, to be collected specially for this plan in the area, resulting in a Pre-mediation version of a Master Management Plan (P-MMP). These scenarios build the base for the negotiation with all stakeholders;
- The negotiations with all stakeholders based on this P-MMP, resulting in one scenario, to which all stakeholders agree. This scenario is then laid down in the Master Management Plan.

The P-MMP covers the whole research area (1,670 km^2) of the Tropenbos-Cameroon Programme. Fifteen thousand persons inhabit the area settled in 67 villages including nine Bagyéli pygmy settlements. The P-MMP is meant to be presented to the inhabitants and other stakeholders. It includes management proposals that will improve the development of the area in a sustainable way. The innovation of this MMP-procedure is that options are presented to the stakeholders instead of one plan conceived by "experts" only. These management options are in the form of scenarios that have to be discussed and analysed by stakeholders with the help of thematic maps and the environmental impact assessment methodology. This process is called mediation and should lead to one final MMP representing the needs of the stakeholders while respecting the ecological and economical capacities of the environment.

In this report the pre-mediation version of the master Management Plan is presented, describing four land-use options. It will be used by the Econ2 project, when developing methods for environmental impact assessment in tropical rain forest land in south Cameroon[1]. Any of the relevant stakeholders in the TCP research area such as MINEF, ONADEF, or a forest concessionaire may use this pre-mediation version for further elaboration and implementation of the finalised MMP.

After a brief presentation of the TCP research area in Chapter 2, the objectives of the MMP are presented in Chapter 3 while the methodology that was followed is described in Chapter 4.
Chapter 5 describes the biophysical environment of the area. These data were mainly obtained from the TCP land inventory and land evaluation study (van Gemerden and Hazeu, 1999: Hazeu *et al*., 2000).

The socio-economic aspects are presented in Chapter 6. Other TCP projects have provided here a large amount of relevant information. However it was necessary to complement these studies by an socio-economic survey covering the entire TCP area.

The land evaluation process is described in Chapter 7. The definitions of the land use types, and the land use requirements ending to land suitability for given land use types are derived from the studies undertaken inside the TCP land evaluation (Hazeu *et al*., 2000).

Chapter 8 deals with the zoning of the area and defines land allocation types that will allow different land uses on specific locations.

The management options are given in Chapter 9. Three scenarios (conservation, agro-forestry and timber production), emphasising different management options, are proposed and compared to the business as usual scenario.

The final zoning of the area should emerge after a mediation process involving the main stakeholders. Chapter 10 explains the proposed mediation process. In Chapter 11, an overview of further actions is given.

[1] A negotiation between stakeholders on the basis of the scenarios presented here, but covering only a part of the area was held in Kribi in August 2000. The procedure will be reported in the final report of the Econ2 project.

2. THE TROPENBOS-CAMEROON PROGRAMME

2.1. LOCATION OF THE RESEARCH AREA

The Tropenbos-Cameroon Programme (TCP) research area is located in south Cameroon, between 2°48’ - 3° 13’ East longitude and 10°24’ - 10° 51’ North latitude (Figure 2.1), at approximately 80 km east of Kribi, east of Bipindi, north of Akom II and south of Lolodorf. Administratively it is part of the South Province of the Republic of Cameroon and divided over the subdivisions Akom II, Bipindi and Lolodorf of the Océan division and the subdivision of Ebolowa of the Mvila division (Figure 2.2). The TCP area covers 1 670 square kilometres with a population of about 15 000 persons in 67 villages, including nine Bagyéli settlements.
For details on the borders of the TCP area, see Annex I.

2.2. HISTORY

The Cameroonian Ministry of Environment and Forest and the Dutch Tropenbos Foundation established the Tropenbos-Cameroon Programme in 1992. An agreement between the Governments of Cameroon and The Netherlands concerning the research programme was signed on July 24th 1992. The main objective is to develop methods and strategies for natural forest management directed at sustainable production of timber and other products and services for the tropical rain forest. These methods have to be ecologically sound, socially acceptable, and economically viable. A programme of fourteen interrelated research projects was proposed to meet that objective.

The research area was first delimited by two concessions of the logging company GWZ (Wijma-Douala SARL), one of 50 000 ha (N° 1 600) and the other one of 90 000 ha (N° 1 790). The research area was since extended to include other TCP research sites that were located outside these concessions and now reaches 167 353 ha.

The preparation phase, Phase 1, took place in 1991-1992. The research programme and the proposed projects are presented in Foahom and Jonkers (1992). The execution phase, Phase 2, was initiated in February 1993 and will end in December 2001. MINEF and the Tropenbos Foundation are responsible for the execution. Wageningen University and IRAD are responsible for the scientific co-ordination and for the implementation of the programme. ONADEF is the agency responsible to ITTO for the ITTO funded component of the Programme (ITTO project 26/92).

- The main financing agencies are (in alphabetic order):Common Fund for Commodities;
- DGIS;
- European Union;
- IRAD;
- ITTO;
- NWO;
- The Tropenbos Foundation;
- Wageningen University.

The implementing agencies are (in alphabetic order):
- ALTERRA (formerly Winand Staring Centre);
- IRAD;
- IRGM;
- ONADEF;
- University of Dschang;
- University of Leiden;
- University of Yaoundé I;
- Wageningen University.

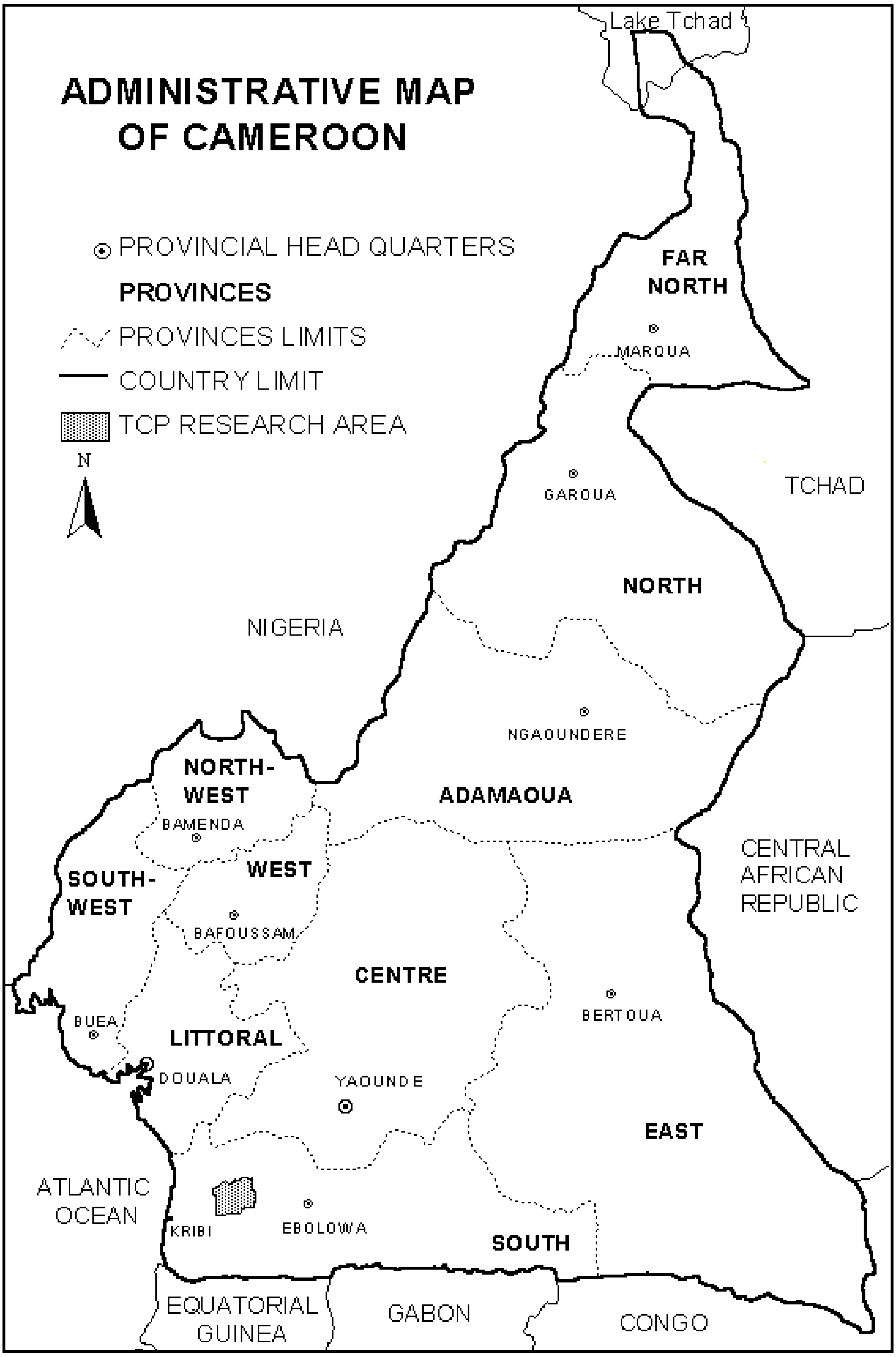

Figure 2.1: Location of the TCP research site.

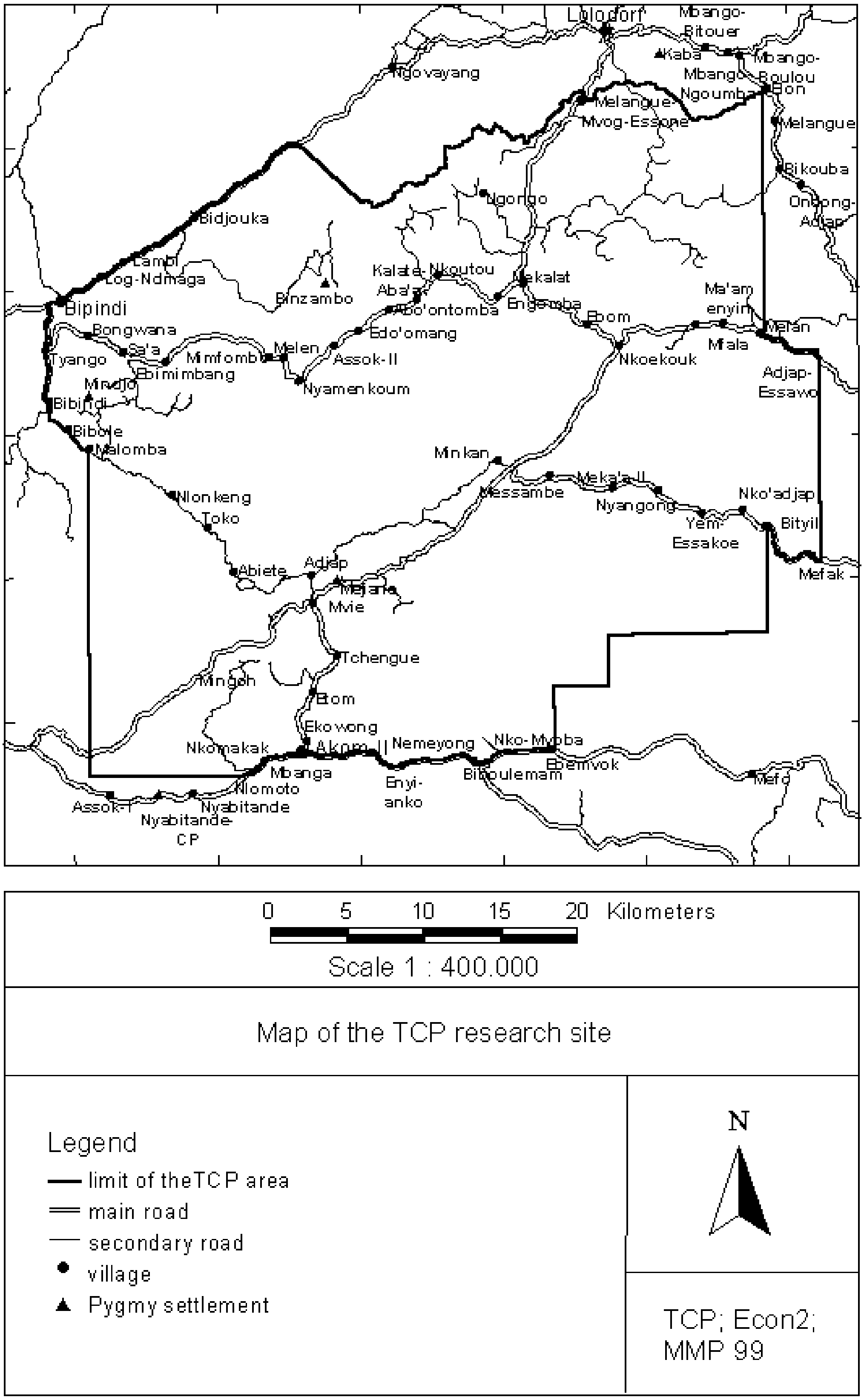

Figure 2.2: TCP research site.

2.3. TCP PROJECTS

Fourteen research projects have been defined, which study ecological, economic, technical, social and legal aspects of forest land use to identify constraints and opportunities for improvements, to develop appropriate technical logging and silvicultural methods and appropriate methods for forest management planning. During the execution, three projects were added.

The research projects are:

Forest land inventory and evaluation; agriculture

Lu1: Overall forest land inventory and qualitative ecological land evaluation.

Lu2: Shifting cultivation in evergreen forest: farming systems and soil degradation.

Ecology

Ecol1: Structure and species composition (biodiversity) of evergreen moist forest in southern Cameroon.

Ecol2: Functional aspects of the evergreen forest in southern Cameroon.

Ecol3: Plant animal relations: effects of disturbance on the regeneration of commercial tree species.

Forestry

F1: Logging, ecology and efficiency.

F2: Growth, regeneration and mortality in managed natural forest.

F3: Commercial potential of lesser-known species.

F4: Forest dynamics in evergreen forest, with special reference to actual and potential tree species.

F5: Plant insect relations, with special reference to pest of commercial tree species.

F6: Mycorrhiza association in tropical evergreen forest.

Economic and management

Econ1: A management model for efficient and sustainable timber production in south Cameroon.

Econ2: Environmental impact assessment of forest management in south Cameroon.

Social sciences

S1: People's perspectives on forest exploitation – villagers, pygmies, and changing relations with the forest.
Theme 1: Normative framework.
Theme 2: Sedentarisation.
Theme 3: Local knowledge.
Theme 4: Commoditization.
Theme 5: Non-timber forest products (NTFP).

S1bis: Options of integration of NTFP resources management in multiple use forest management in south Cameroon.

Carpe1: The sustainability of NTFP harvesting and management: the case of *Garcinia lucida* in the Bipindi – Akom II region (south Cameroon).

Carpe2: The role of community institutions in the management of NTFP in Cameroon.

Information on these research projects can be found in Foahom and Jonkers (1992), in the proceedings of the Forafri seminar (Nasi *et al.*, 1999) and in the proceedings of the TCP workshops (Foahom *et al.*, 2000) and the TCP symposium (Jonkers *et al.*, 2001). Results are published in the Tropenbos-Cameroon Series, the Tropenbos-Cameroon Documents, and the Tropenbos-Cameroon Reports, all available at the Tropenbos-Cameroon Programme (P.O.Box 219, Kribi, Cameroon) and the Tropenbos Foundation (P.O.Box 232, NL 6700 AE

Wageningen, the Netherlands). The annual reports of the Tropenbos foundation give an overview of all TCP publications.

The location of the most important research sites is indicated on Map 1 (TCP research site) of the cartographic annex.

3. RESEARCH OBJECTIVES AND APPROACH

Land-use planning is the systematic assessment of land and water potential, economic and social conditions, in order to select/adopt the best land use option. Its purpose is to select and to put into practice those land uses that will best meet the needs of the people while safeguarding resources for the future. At a large scale, such as the MMP, land-use planning is at a strategic level where the stakeholders have an important role to play inside the decision process.

The main objective is to draw a P-MMP that will present management and development options for the TCP research area that respond to the local populations', and other stakeholders', needs and demands on the one hand and preserve the ecological and biological production capacities of the land on the other hand. Different scenarios should be proposed and negotiated with stakeholders before a MMP in a final version can be drawn, that should represent a consensus of the different land management possibilities of the area.

Other objectives in relation with the P-MMP are:

- To develop a method for negotiating a MMP with the stakeholders using the Environmental Impact Assessment (EIA) methodology developed by TCP (Econ2);
- To help improving this EIA methodology;
- To contribute to the production of a MMP elaboration guide;
- To give basic elements to facilitate the implementation of land allocation proposals, especially concerning the location of production forests.

To reach these objectives, this document is oriented in a twofold direction:

- Methodology development: starting from the standard recommendations for managing tropical forest a renewed method for managing forest resources is developed and promoted. The sustainable use of this kind of ecosystem does not focus on timber only but attempts to enlarge the spectrum of the resources that should be taken into account in forest management. Moreover all stakeholders should be involved in the decision processes (see Parren *et al.*, 2001);
- Applied research, as one aim is to propose scenarios for a Master Management Plan for the TCP site. It is of interest to connect new methodological approaches to their potential achievement in reality. A constructive interaction between theory and practice should therefore result from this research approach (see final report Econ2 project).

This chapter is divided in two parts. First, a proposal for a renewed methodology of conceiving tropical forest management is compared to the conventional approach described in literature. Second, an application of this multiple-use management, following the Cameroonian regulations, is proposed for the TCP site.

3.1. A BROADER PERSPECTIVE FOR TROPICAL FOREST MANAGEMENT

Tropical forest management started with the exploitation of timber resources and the application of European silvicultural principles (Cailliez, 1991). This particular form of forest resources management was supposed to be organised on a "scientific" basis and according to explicit recommendations. This also required the intervention of "forest management specialists", mainly educated at forest engineering schools. But this European notion of what forest management should be does not take into account that tropical forests are a habitat where many "indigenous" people live and where they have developed and adapted ways of using natural resources (Bahuchet and de Maret, 1993; Wiersum, 1999). Therefore, and because of the complexity and the diversity of its resources, tropical forest is subject to different types of management systems that are to be combined towards a sustainable development of this ecosystem and of the people relying on it.

3.1.1. Two sets of paradigms for tropical forest management

Even if the concept of managing the forest for several types of users with different ways of using the same resources is now acknowledged, this plurality does not seem easy to put in practice. Most publications on tropical forest management still focus on sustained production of timber, even when integrating secondary benefits (FAO, 1990a). The present challenge is thus to move from this conventional forest management to a new approach capable of organising the multiple uses of multiple forest resources, in which all stakeholders participate. After characterising the main assumptions of these two forest management models, an attempt is made to outline the major trends in adapting conventional timber management to multi-resource management.

Conventional forest management relies on certain assumptions (ITTO, 1990):

- Timber is the main resource of the forest: this is the main tradable resource and is likely to provide the state and private economic actors with substantial financial benefits;
- Public authorities and logging companies are the main stakeholders of forest management (with marginal consultations of local populations): the state is the owner of the forestlands that are conceded for a while to logging companies;
- Based on the Faustman's rule and bioeconomics, the principal objectives are to reach a sustained yield for timber production and to establish an optimal rotation of the cutting (Catinot, 1997).Other benefits, such as Non-Timber Forest Products and biodiversity, may be included in the forest management model to improve the accuracy of the optimal rotation taking into account these secondary benefits: "*These multiple uses should be safeguarded by the application of environmental standards to all forest operations*" (ITTO, 1990, p. 3).
- These objectives are fulfilled by respecting a number of technical criteria and guidelines. The implementation of this model is mainly hindered by the lack of scientific data on ecological dynamics.

On the other hand, multiple-use forest management starts from a different scientific basis (Panayotou and Ashton, 1992):

- The forest is a diverse ecosystem, full of different resources from which the human population benefits directly or indirectly. The multiplicity of the forest resources is an essential variable for its management.
- Multiple stakeholders, whose interests and expectations are different, use this ecosystem. Their uses of the resources may be combined or may compete with each other. The plurality of the users of the forest resources is another crucial element for sustainable management.
- As a result, the use of the resources depends on ecological, technical and human characteristics (Lescuyer and Essiane Mendoula, 2001). Forest management appears to be at the intersection of natural and social dynamics.

3.1.2. From timber exploitation to multiple use of the forest resources

To assess the differences between timber-oriented and multiple-use forest management, a comparative analysis was made. In this comparison the emphasis is put on the specificity of and the additions by multiple-use management. Following Wiersum (1999, pers. com.), forest management may be conceived as a five-step procedure (see also Table 3.1):

<u>Step 1: Identification of a forest management organisation (Who?)</u>

The pluralism of stakeholders implies that forest management should not be restricted to a couple of actors. Rather, to obtain social acceptance, the forest management organisation should be designed and fully accepted by all parties.

The question, who may participate in the forest management organisation, must be explicitly answered. Not every forest user is legitimate (for instance, intruders) and a high number of actors would impede an efficient functioning of the management organisation. Therefore, principles for selecting stakeholders must be elaborated and agreed upon, so that not anybody can enter the forest management organisation. The process to appoint the individuals, who compose the organisation, must also be clear and must include a periodic revision. It is difficult to elicit preliminary general rules to define and establish a multiple-use organisation as it highly depends on local characteristics. However, one stake is to combine both official and traditional authorities so that the organisation commands respect to all. Another stake is that the expectations of all stakeholders are represented in the organisations, so that all voices can be heard. This organisation is to be seen by the national authorities as the one in charge of the management of a given forest. It is a direct application of the principle of *subsidiarité* that is now common in national legislation around the world.

Step 2: Identification of boundaries of Forest Management Units (FMUs) and of main management objectives (What?)

The contribution of objective data coming from various disciplines, such as social and economic sciences, biophysical sciences, etc. is necessary to get insights on the most convenient areas for specific resources' uses. What is questionable is the way this information is used in the decision-making process. Rather than justify FMUs with a single use, this information must be considered as input in the stakeholders' negotiation to delineate potential FMUs with multiple uses. Indeed, it is not common that one specific area is only suitable for one type of particular use (perhaps except fragile ecological zones); in most cases, a tropical forest may support timber exploitation, and nature conservation, and NTFP exploitation and even other uses. The choice between these different land use types should not be made based only on scientific data (for instance, how to compare between conservation and timber production suitability?) but should result from a discussion between stakeholders. The delimitation of the FMUs and the identification of their main management objectives aim at combining specific functions provided by the ecosystem and also at avoiding negative interactions between users.

Step 3: Identification of Forest Management Zones and of specific objectives per zone (Where?)

Multiple-use management does not mean that every use may be authorised everywhere. It is important to identify, within the multiple-use FMU, smaller areas where only one or a limited number of uses are permitted. Nature preservation, for instance, often cannot support any other use. This is not the case for timber production areas which may, in some extent, be combined with traditional local uses. Such production forests may be surrounded by agro-forestry buffer zones where more extractive practices may be considered. All the different uses should be organised and allocated according to precise geographical limits within the FMU. The task is not to split the multiple-use FMU into several single-use areas but to organise at a spatial scale the combination of the diverse resources' uses. The natural dynamic of the environment requires that such a Zoning Plan will be revised on a regular basis.

Step 4: Identification of specific management practices (How?)

In the case of a timber production area, the definition of the cutting cycle is important but should be conceived in accordance with the other forest uses authorised in this zone. For instance, damage to other resources than timber should be fully taken into account since those resources are important for other users. We can also imagine that the logging company commits itself not to cut highly valued NTFP species and even to protect them during logging (van Dijk and Wiersum, 2001). The other part of the deal might be that the local population abandons any slash-and-burn practice in the forest.

The aim of this management step is the elaboration of a forest management contract where all rights and obligations concerning the use of forest resources are clearly defined. This can only result from a discussion involving all stakeholders. This kind of agreement is the main output of the management organisation and should bind the stakeholders to follow their commitments. This management contract should be re-negotiated every year so that human pressure is matched with natural regeneration and in order to take into account the varying expectations of the stakeholders (Weber, 1996).

Step 5: Identification of control practices (What kind of control?)
In addition to the design of the management activities, a control system should be established to enforce the involvement of all stakeholders in managing and using the resources. Penalties have to be determined for all types of infringement. This control system is all the more credible and efficient the better it is supported by the official texts (Runge, 1986). This task of controlling the resources' uses in a FMU may rely on collaborative local structures that are more adapted and less expensive than official services. If needed, both modern and traditional courts should be requested, depending on the subject and the seriousness of the conflict and on the actors involved.

Table 3.1: Comparison between conventional and multiple use forest management.

Conventional forest management aimed at timber production	**Step**	**Multiple-use forest management**
One official management organisation Management conceded to the logging company Consultation of local population	**1**	Diverse management organisations (including joint/collaborative management schemes) defined and agreed by stakeholders
Boundaries delineated by a professional forest service on the basis of scientific data FMU with single priority use	**2**	FMU boundaries based on best professional judgement and then negotiated and agreed by local stakeholders FMU with multiple aims and uses
One homogeneous single-use forest divided in Forest Exploitation Units with same harvestable volume or same surface Potential biodiversity protection zones	**3**	Multiple zones per FMU with specific management aims
Identification of annual allowable cut and optimal rotation Technical norms / Silvicultural post-treatment Authorisation of some traditional use rights	**4**	Definition of specified use rights in specified zones and for specified periods Reduced impact logging (on ecosystem, NTFP-species,…)
Control on log production Control on FMU boundaries by officials	**5**	Control on quality management Joint/collaborative control systems

3.1.3. An approach shared by forestry and social sciences

According to the analysis above, a sustainable management of tropical forests should follow five major phases. Doing so, three overall levels of decision-making may be distinguished by both forestry and social sciences.

For forestry sciences (Bos, 1994; Filius, 1998), planning of forest management is composed of:

- Strategic planning, meaning the formulation of the objectives and strategies to achieve these objectives. Decisions should be taken on the boundaries of the forest ecosystem, the allocation of forest functions, and the people involved in this management.
- Tactical planning, where the emphasis is put on the management activities. Once the main objectives are established at the strategic level, the question of what to do in the field should be answered. Both authorised and not authorised activities are to be listed, schedules may be proposed, recommendations are expressed, etc.
- Operational planning, that concerns decisions on implementation. It deals with the execution of the management activities. The aim of operational planning is to determine how the management must be concretely applied. All forest practices should be organised according to the former strategic/tactical planning choices.

For social sciences, a management system of natural resources may be defined as a bundle of institutional arrangements between the forest's users concerning the resources. Ostrom (1990, p. 250) argues that "*institutional arrangements are the rules in use by a community to determine who has access to common-pool resources, what use-units authorised participants can consume and at what times, and who will monitor and enforce these rules*". These institutional arrangements fix certain "rules in use"[2], which guide the management of the resource. Three levels of rules in use may be identified (Ostrom, 1990; Ostrom *et al.*, 1994):

- The "constitutional choice" rules aim at defining the basic institutional arrangements for the community of users, notably regarding the identification of the stakeholders and of future management objectives. These constitutional choices are the act of foundation of the management system: "*the results of decisions made in a constitutional-choice rule-making game are the rules that are used for making initial agreements about constituting an enterprise and deciding on the key initial rules to be used in that enterprise*" (Ostrom, 1995, p. 152). These first rules serve also to detail the process of modifying the collective-choice rules.
- The "collective choice" rules organise the potential interactions between stakeholders and precise the principles of collective management. They also define the ways to change the operational rules by stating who may do what and how.
- The operational rules indicate the conditions that stakeholders have to fulfil to get access to the resource, the requirements of their management activities (area, time, technique and quantity) as well as the means of control and enforcement. The objective is to define practical rules that co-ordinate the users' behaviours so that the resource produces acceptable flows of benefits for each involved stakeholder.

Table 3.2 gives an overview of what these rules may clarify.

Table 3.2: The rules in use.

	Rules in use
Constitutional level	Who may be involved in the management? Which are the future objectives for the forest? Who is entitled to define/change the collective rules?
Collective level	Who does participate to the setting of the operational rules? How to proceed for defining/changing the operational rules?
Operational level	Who has access and may extract forest resources? How is the organisation of the resources' uses? Who does control and penalise?

These two hierarchical analyses as proposed by forestry and social sciences may be applied to the five-step forest management model presented in Section 3.1.2 and Table 3.1. The first two phases, defining who and what is concerned by the management, refer to the level of strategic planning and require some constitutional choices to be made (see Table 3.3). Once these basic decisions are taken, the last three steps correspond to tactical and/or operational planning and aim at organising and implementing the uses of the forest resources in the field. They are to be revised on a regular basis so that the forest management, embodied in the forest management organisation, may react to social and natural dynamics and ensure a sustainable use of the forest over the long run.

3.2. MULTIPLE-USE MANAGEMENT OF FORESTS: BASIS FOR APPLIED RESEARCH

This new method of conceiving and implementing forest management for tropical forest is to be tested on the TCP site. The purpose is to improve the design of this approach and to validate or invalidate its relevance. The main assumption is to work out a multi-resources management,

[2] The definition of a "rule" is given by Schlager and Ostrom (1992, p. 250): "*generally agreed-upon and enforced prescriptions that require, forbid, or permit specific actions for more than a single individual*".

which would take into account the diverse interests of all stakeholders. As a consequence, the participation of all user groups is crucial from the beginning to the end of this management process. This forest management approach should also abide by the national regulations and laws regarding forest and nature and the international treaties etc. Cameroon has co-signed.

Table 3.3: The three approaches to forest management combined.

Steps	**Level forestry sciences**	**Rules social sciences**
1 Identification of forest management organisation	Strategic	Constitutional
2 Identification of boundaries of FMUs and of main management objectives	Strategic	Constitutional
3 Identification of forest management zones and of specific objectives per zone	Tactical	Collective
4 Identification of special management practices	Tactical/operational	Collective and operational
5 Identification of control practices	Operational	Operational

3.2.1. A potential application in Cameroon

The first two phases of strategic planning deal with the formulation of a (forest) land-use plan. In Cameroon, it would take the form of a Master Management Plan. This document defines among others the stakeholders who should commit themselves in the forest management and proposes boundaries and objectives for the identified Forest Management Units. On this basis, the last steps of forest management, focussing on tactical and operational planning, aim at formulating an internal management plan for each FMU, that is to say to elaborate a Forest Management Plan (FMP) for each classified forest.

Step 1: Identification of a forest management organisation

As mentioned in the national guidelines (MINEF, 1998a), the selection of the forest management stakeholders should deal with many groups of users. Certainly, the State, the logging companies, and the local population are the most concerned, and they are always involved in such a decision-making process. But others stakeholders should also be considered: Bagyéli groups, nature conservation NGOs, development projects, etc.. Furthermore, most of these stakeholder groups are heterogeneous in the sense that they are composed of diverse subgroups. For instance, local population includes several lineage, outside elite, official authorities, etc. and consequently, cannot be considered as one single homogeneous stakeholder group (see also Biesbrouck, 2001; van den Berg, 2001). Hence, it is of crucial importance to develop and decide on criteria for listing the stakeholders entitled to participate to the forest management.

As several stakeholders are involved in forest management, they all must agree on a common management organisation. This may be an existing organisation that is able to take into consideration other stakeholders' interests. It may also give the opportunity to create institutions of common use of the resources at the FMU level.

Step 2: Identification of boundaries of Forest Management Units (FMUs) and of main management objectives

This question aims at identifying the geographical boundaries of the forest to be managed and their specific objectives. This is the very purpose of the Master Management Plan (MINEF, 1998b). On the basis of what has been proposed by the official Zoning Plan (Côté, 1993), the MMP purposes are (1) to design priority allocation of forestlands; (2) to propose a meso-zoning of forestlands; (3) to proceed with a classification of permanent forests. This land-use planning is the systematic assessment of land and water potential, and economic and social conditions, in order to adopt the best land use option. This is to be done on the basis of scientific data and through discussion within the management organisation.

The outcome is the delineation of a number of permanent forests, each constituting an FMU. For each FMU, a priority management objective (production, protection, etc.) has been designated and a particular sub-group of users has been identified. The next step is the elaboration of Forest Management Plans for each permanent forest.

Step 3: Identification of Forest Management Zones and of specific objectives per zone

Assigning a priority use to a permanent forest does not necessarily mean that no other use may be applied in this FMU. A micro-zoning of the FMU gives the opportunity to combine multiple uses provided that they are confined to specific areas and for specific periods.

For instance, in the case of a production forest, the FMU must be divided in several Forest Exploitation Units (FEUs) which are exploited successively. We can therefore imagine that traditional users' rights are permitted in a FEU as long as the FEU is not under exploitation and that after timber has been extracted these rights can be executed again. Similarly, it is often recommended that some biodiversity protection areas be maintained within production forests. The detailed zoning of a FMU is to be discussed and decided on by the involved stakeholders to develop a real multiple-use forest management supported by the stakeholders.

Step 4: Identification of specific management practices

The definition of a micro-zoning of the forest lands helps to combine the users' practices within and between the specialised zones of the FMU. The stake is a decentralised and conditions-specific management of forest resources by designing concrete modes of using the forest in association with the priority use elicited by the MMP. This requires that all stakeholders, on the basis of the geographical boundaries of the FMU and of its specialised zones, define together their respective rights and obligations in using the forest resources. Such a management contract, binding the users' practices, must be revised periodically to allow adaptation due to changing circumstances and new insights.

Step 5: Identification of control practices

The FMP should also mention how to control the respect of the stakeholders' commitments. This control task may be given to a joint structure and not necessarily to public authorities only. Examples of such local organisations are available in Cameroon with the *comité villageois-forêt* ('village forest committee'), and the *Groupement d'Intérêt Communautaire* (Community Interest Group'), that may be enlarged to include representatives of other stakeholders. Local management committees as proposed by the ministerial order 00122/MINEF/MINAT of April 29th 1998, dedicated to one specific permanent forest may also be considered for such task.

Formal penalties should be established and may depend both on traditional courts (for instance concerning conflicts between villagers) or official courts.

3.2.2. Recapitulation of research objectives

Not all aspects of the procedure to develop this multi-resources management will be tackled in this document, as it deals only with a P-MMP for the TCP site. Rather, this description constitutes a complete overview of what tropical forest management may be, especially in Cameroon. Therefore, the present document should be considered as a framework for applied research with some potential concrete outcomes and with a potential continuation towards a Master Management Plan and Forest Management Plans. Specific objectives may then be expressed.

An important objective is to develop a MMP pre-mediation version presenting management options for the TCP area that respond to stakeholders' needs and that take into account the ecological and biological production capacities of the land units. Different scenarios will be proposed and these should be negotiated with stakeholders before a final version, representing a consensus of the different land management possibilities of the area, is produced. A meso-zoning map of the land allocation proposals should accompany this final version.

Another purpose of this research is to elaborate on the current guidelines for MMP in Cameroon and to propose an improved methodology for deciding on forestland allocations. The TCP site can serve as a practical case.

Lastly, another important topic in this forest management process is the involvement of stakeholders. To have any chance to be sustainable, the MMP should be negotiated by all participants who should reach an acceptable compromise on the multiple use of the resources. In this case, such a discussion will focus on the delineation of the permanent forests and on their assignments. Concepts derived from participatory approaches, as well as tools like Geographical Information System (GIS) and Environmental Impact Assessment (EIA), provide some insights to conceive an original mediation process for MMP.

4. METHODOLOGY

First of all, a documentation review of what has been done in the TCP area was undertaken. The results and available documents of the other TCP research projects were basically exploited. The next steps that were undertaken throughout the elaboration process of the Pre-mediation version of Master Management Plan (P-MMP) and that should be carried out when a Master Management Plan is drawn are briefly described in this chapter. Figure 4.1 illustrates the procedure followed.

4.1. COLLECTION OF BIOPHYSICAL DATA

The biophysical information was collected from existing documentation with complementary studies or inventories on particular points. Data on aspects such as climate, geology, and hydrology that do not change on the short term were taken from existing documentation (van Gemerden and Hazeu, 1999; Franqueville, 1973; Letouzey, 1968, 1985; Olivry, 1986). Especially the results of the Lu1 project were intensively used.

Aerial photographs (1984-1986) were used to get information and to produce preliminary maps on landform, vegetation, and land use. Field surveys, including soil sampling were then realised to verify the accuracy of the photo-interpretation and draw up the landscape ecological map. This work was realised within the Lu1 project (van Gemerden and Hazeu, 1999). The map is composed of 14 land mapping units (LMUs). LMUs are based on landform, altitude and soil, and on vegetation characteristics. The actual land use, mainly the degree of disturbance by shifting cultivation, was estimated.

The fauna has not been systematically surveyed in the area. The available information from documentation and other TCP projects (van Dijk, 1994; 1999) was used.

Information on timber exploitation was collected from the logging companies and the records of MINEF.

4.2. COLLECTION OF SOCIO-ECONOMIC DATA

Several local surveys on socio-economic aspects have been carried out in the TCP site, mainly as part of the S1 project, which studies relations between local populations and the forest. Complementary information covering the whole TCP area was needed to obtain a comprehensive overview of the social aspects. It appeared essential to know how many people are actually living in each village, what their main activities are, their land utilisation and their relation with the forest or the natural resources.

The additional socio-economic surveys were done in three steps:

1) A meeting, open to all villagers, was organised in every village of the TCP area. These meetings were to gather general information on the village but also to explain to the villagers why and how the surveys would be carried out. Bantu villages as well as Bagyéli settlements were covered.
2) A census of the whole population, to find out how many people live in the TCP area, was undertaken by visiting each family of every village, by counting each member and recording his or her age and sex.
3) More detailed information on people’s activities was collected throughout a household survey undertaken among a number of representative families (12% of the families of the TCP area).

4.3. LAND EVALUATION

Land evaluation is a crucial step for a management plan, as it describes the suitability of all individual tracts of land for all relevant land uses.

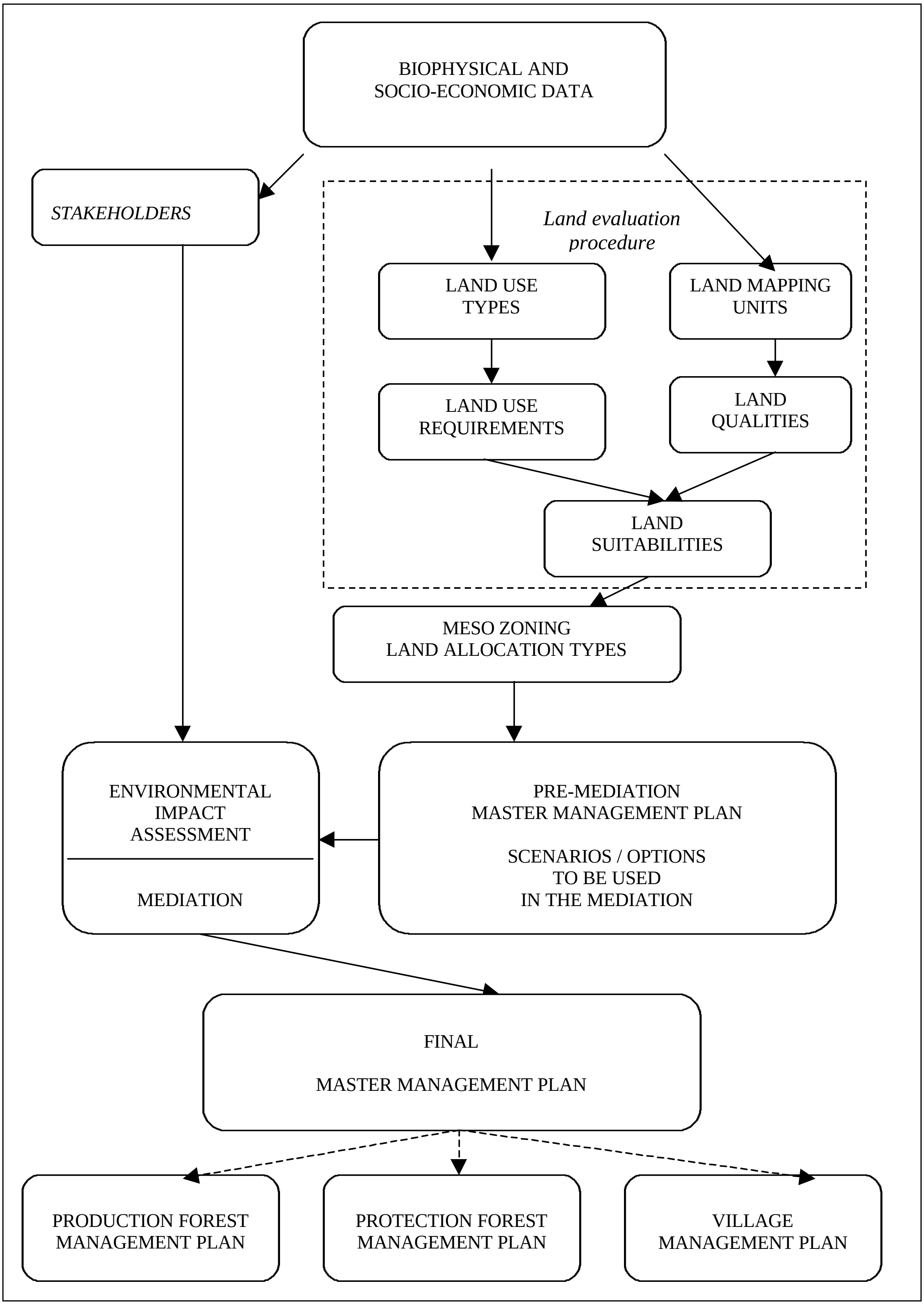

Figure 4.1: Elaboration of the MMP procedure.

The land evaluation procedure followed is the one developed by Touber *et al.* (1989). It is important to note that "*A land evaluation procedure does not determine future land use. It merely provides data as a basis on which land use decisions can be taken*" (Bos, 1994). In this sense the suitability maps produced by the Lu1 project are not management proposals but important tools that will support managers and decisions makers in their recommendations.

It is necessary to identify the relevant Land Use Types (LUTs) right from the beginning. Five main LUTs of the TCP area have been identified and described. For each of these LUTs, Land Use Requirements (LURs), have been identified. The LUR expresses the necessary conditions for a successful implementation of a LUT.

The Land Mapping Units (LMUs) defined by Lu1 are characterised by a combination of vegetation, soil, landform, and altitude, and are used as the basis of spatial variation. Land Qualities (LQs) have been determined for each LMU.

The matching process of the Land qualities of Land mapping units to the Land requirements of the Land use types leads to Land suitability classifications illustrated by suitability maps per LUT (Hazeu *et al*., 2000). The land evaluation procedure is presented in Figure 4.1 and is discussed in more detail in Chapter 7.

4.4. MESO-ZONING, LAND ALLOCATION

Zoning is the step where the study area is divided into characterised units inside which LUTs are assigned. The prefix meso is used here to emphasis the difference between three levels of zoning. The MMP zoning is an intermediate level between the macro zoning of the Zoning Plan (Côté, 1993) and the micro zoning that will occur in the forest management plans. Usually a land unit support more than one land use type, therefore the concept of Land Allocation Type (LAT) is introduced to facilitate the zoning of multiple use land units. Six Land Allocation Types are defined as broad areas in which specific LUTs can be undertaken.

4.5. MANAGEMENT OPTIONS

Within a conventional top-down approach one "ideal" Land Allocation Plan (LAP) defined by experts would be presented to the authorities and local population for validation or minor amendments. This MMP does not have the intention to impose a unique overall management proposal for the TCP area. Based on TCP research and considerations, it appears preferable to define different management options that take into account the needs of the stakeholders as well as the ecological potentialities. These options should be presented to the stakeholders as scenarios; each illustrated by a map. Each scenario emphasises one management option as a unique or the most important one. The objective is not to choose one scenario but to evaluate the constraints and benefits of each one to reach one *consensus*, land allocation plan, which is satisfactory for, and is accepted and supported by all stakeholders. This consensus-plan may differ from the initial scenarios.

4.6. ENVIRONMENTAL IMPACT ASSESSMENT

Environmental Impact Assessment is a step particular to the TCP approach of elaboration of management plans, which was probably not used before in Cameroon. The objective of Environmental Impact Assessment (EIA) is to evaluate the economic, ecological, and social impacts of a management option, before implementing it. The impact evaluation of each scenario will assist the decision-makers or participant stakeholders in evaluating the management alternatives from which they will choose. The EIA methodology used will be the one developed by the Econ2 project.

4.7. MEDIATION

Mediation is the stage where the management alternatives for the MMP are presented to the stakeholders. The results of TCP social science research and the knowledge of the TCP area should be used to identify the right stakeholders. The procedure of elaboration of the MMP and the consequences of the management options need to be presented and explained to the stakeholders. Suitability maps and scenario maps as well as the environmental impact assessment matrices are important tools for the mediation. Meetings have to be organised at different levels attempting to reach the maximum of relevant concerned people so that they may express themselves on the subject.

4.8. FINALISATION OF THE MMP

A consensus should be reached at the end of the mediation process. The final version of the MMP then has to be drawn up representing this consensus about the management options retained for the area. One final land allocation plan will be included in the MMP. For the TCP research site, this could be done by one of the stakeholders involved (i.e. MINEF according to the law or some other institution based on a mandate by MINEF).

Afterward, as indicated in Figure 4.1, the elaboration of management plans for specified forest or land units can be carried out. The scale of these forest management plans will be larger, the level of detail more precise and the level of decision more definite.

5. ASPECTS OF THE BIOPHYSICAL ENVIRONMENT

5.1. CLIMATE

The climate of the TCP research area is humid tropical, classified as Aw according to Köppen (1936), and is typical for south Cameroon. It is influenced by the North-South movements of the Intertropical Convergence Zone. Although rainfall occurs almost throughout the year, four seasons are clearly distinguished; two rainy seasons from September to November and from April to May and two drier seasons from December to March and from June to August. This gives a bimodal diagram for the rainfall distribution (see Annex II). According to van Gemerden and Hazeu (1999), the rainfall pattern in the TCP area is likely to resemble those of Lolodorf and Ebolowa, rather than the one of Kribi, which is not bimodal, because of the geographic position of the site. As these figures show, the average annual rainfall tends to decrease as one moves from the coast inland (from Kribi with 2836 mm per year to Lolodorf and Ebolowa with 2096 and 1719 mm respectively) (see Table 5.1 and Annex II).

The air temperature varies little over the year with minimum monthly values of 25° C and 22.9° C in August and maximum values of 27.5° C and 25° C in March in Kribi and Ebolowa respectively. The relative humidity is high throughout the year with minimum monthly values varying between 70% and 78% in Kribi and between 62% and 74% in Ebolowa. Wind speeds are generally low (less than 4 m/s) and its main direction is west to southwest (Olivry, 1986).

Table 5.1: Monthly means of rainfall (R) and temperature (T) at Kribi, Lolodorf and Ebolowa meteorological stations

Meteorological station	**Kribi**		**Lolodorf**		**Ebolowa**	
Longitude	9° 54’ E		10° 44’ E		11° 09’ E	
Latitude	2° 56’ N		3° 14’ N		2° 55’ N	
Altitude	13 m asl		440 m asl		609 m asl	
Month	**R (mm)**	**T (°C)**	**R (mm)**	**T (°C)**	**R (mm)**	**T (°C)**
January	92.1	27.2	43.7	n.a.	44.5	24.5
February	118.0	27.4	75.6	n.a.	74.0	25.0
March	200.7	27.5	180.6	n.a.	174.7	24.7
April	260.5	27.3	262.5	n.a.	212.1	24.7
May	343.2	26.8	283.8	n.a.	220.0	24.4
June	274.1	26.1	184.9	n.a.	151.2	23.7
July	111.9	25.2	57.8	n.a.	47.5	22.9
August	230.5	25.0	75.8	n.a.	67.0	22.9
September	501.6	25.3	268.7	n.a.	199.1	23.4
October	491.8	25.7	375.2	n.a.	308.4	23.6
November	200.8	26.4	208.8	n.a.	183.6	24.0
December	94.2	27.0	59.5	n.a.	59.1	24.2
Yearly	2919.4	26.4	2076.9	n.a.	1741.2	24.0
Nb of years of observation	45	33	9	-	48	34
Period	1953-1998	-	-	-	1950-1998	-
Source	TCP Data	Olivry, 1986	Olivry, 1986	-	TCP Data	Olivry, 1986

5.2. GEOLOGY

Geologically, the TCP area belongs to the Precambrian shield, which is the most significant geological formation in Cameroon. The shield consists for a large part of metamorphic and old volcanic rocks. Gneisses, micaschists, and quartzites are the most common metamorphic rocks found whereas diorites and gabbro represent volcanic intrusions (Franqueville, 1973).

Recent studies on the geology of south Cameroon discerns two rocks series within the TCP research area: the Ntem complex and the Nyong series. The Ntem complex is comparable to the Calcium-magnesium complex. The Nyong series consist of meta-sedimentary rocks, which are composed of migmatites, gneiss, quartzites, and amphibolites. In addition, in the Lolodorf region, some small lenses of ferro-magnesium rocks are found, such as amphibolites, diorites and gabbro, forming discontinuous bands with a general NE-SW direction (Toteu *et al*., 1994; Bilong, 1992; both cited in van Gemerden and Hazeu, 1999).

5.3. LANDFORMS

Studies on the landform in the TCP research site have been carried out by van Gemerden and Hazeu (1999). These authors used characteristics such as relief intensity, slope steepness, slope length, and drainage density to distinguish seven different landforms at reconnaissance scale in the area (see Map 2: Landforms, in the cartographic annex). These seven landforms can be summed up as follows:

Dissected erosional plains (pd)

These landform types are found at altitudes below 280 m asl which corresponds essentially to the west part of the TCP research area. They are relatively flat and lack prominent elevations or depressions and cover about 8% of the total area. The main rivers running through the TCP research area, such as the Lokoundjé, Tchengué, and Moungué, are located within the dissected erosional plains.

Uplands (u1 and u2)

Two types of uplands could be distinguished in the TCP research area: moderately dissected uplands with rolling relief (u1) and strongly dissected uplands with hilly relief (u2).
The first uplands type (u1) has moderately steep (10-20%) slopes of 100 to 200 m long. It covers large areas in the central and northern parts of the TCP research area. The u1 uplands are situated between altitudes 350 and 500 m asl, and share boundaries with the dissected erosional plains and the strongly dissected uplands with hilly relief. They are generally oriented in a NE-NW direction. The moderately dissected uplands with rolling relief covers about 27% of the TCP research area.

The second uplands type (u2) has a hilly relief, two to three interfluves per kilometre and moderately steep slopes (10-30%) of 150 to 300 m long. They are strongly dissected uplands with a hilly relief, and are the most common landform encountered, occupying 39% of the study area. They are confined to a 120-700 m altitude range.

Hills (h1 and h2)

Two types of hills are found within the area: isolated hills (h1) and complexes of hills (h2). Both hill types are characterised by erosion, particularly rock falls and sheet erosion.
The h1 landforms have steep slopes (30%) of 120 to 300 m long. Even though they cover only 9% of TCP research area and are scattered throughout the site, they are well visible and give a characteristic aspect to the landscape, especially in the uplands of the central region.

The landform h2 is a complex of moderately steep to steep (20-40%) hills, which are strongly dissected with relatively short slopes (200-350 m) and relatively low relief intensities (80-200 m). Altitude varies between 500 and 700 m asl. These hill complexes are mainly situated in the transition zone between the uplands of the central region and the mountains in the eastern part. They are absent in the northwest of the TCP research area. They cover 9% of the area.

Mountains (m)

Mountains are complex dissected plateaux or massifs, which are isolated and rising above the surrounding landscape. The outside slopes are very long (> 400 m), very steep (30 to over 60%) with a relief intensity higher than 250 m. The inside slopes are moderately long (250-400 m), steep (30-60%) and have a relief intensity of 125-250 m. The mountains are restricted to the eastern part of the TCP area with altitudes above 500 m asl covering some 7% of the area.

Valley bottoms (v)
Valley bottoms are poorly to very poorly drained, nearly flat to flat depressions between interfluves. The slopes are between 0 and 2%. Large valley bottoms, wider than 250 m, are separately mapped and cover approximately 1% of the TCP area. Most valley bottoms are 50 to 150 m wide, which is too narrow to be mapped separately at 1:100 000 reconnaissance scale. They have been included in the dissected erosional plains or the uplands. The valley bottoms are found predominantly in the southeast part of the area and the western lowlands.

5.4. HYDROLOGY

The hydrography of TCP research area, as the one of the whole south Cameroon, is characterised by a highly developed draining system, essentially due to the humid climate. The hydrographic network of the TCP research area is composed of seven main rivers, the Lokoundjé, Tchengué, Kienké, Moungué, Biwome, Sonkwé and Messambe (see Map 1, TCP research area in the cartographic annex). These rivers flow broadly in a NNE-SSW direction. Many smaller streams belonging to this network flow perpendicularly to these main rivers. Areas surrounding smaller rivers are generally swampy and waterlogged throughout the year due to a continuous supply of water.

The discharge patterns of the rivers are influenced considerably by the seasonal rainfall. Maximum values of this discharge patterns occur in October and May whereas minima are observed generally during February and August (Olivry, 1986). The monthly average discharges of some rivers of the area have been measured for long-term period (Olivry, 1986). These values for Lokoundjé river at Lolodorf range from 8 m^3/s in February to 65 m^3/s in October. During the same period, values for Kienké and Lobé range from 16 m^3/s to 121 m^3/s and 21 m^3/s to 284 m^3/s respectively. The total length of the Lokoundjé is 216 km and its watershed covers an area of 5 200 km^2. The Kienké and Lobé rivers are 130 km long each and their watershed cover respectively 1 435 and 2 305 km^2.

5.5. SOILS

The soils in the TCP research area have been subdivided into four main soils types based on drainage and texture in both topsoil and subsoil. Each soil type was given the name of a village in a part of the TCP research area where the corresponding soil type dominates (see Map 3: Soils in the cartographic annex).

Well drained, deep to very deep, yellowish brown to strong brown clay soils, classified as Xanthic Ferralsols (FAO, 1990b), are dominant in the area. These well-drained soils are further subdivided according to clay content in topsoil and subsoil into:

- Nyangong soils, which are very clayey soils with no or gradual increase in clay content with depth. The clay content of the subsoil ranges between 50 and 80%.
- Ebom soils, which are clay soils with a gradual to strong differentiation in clay content between topsoil and subsoil. The clay content of the subsoil ranges between 35 and 60%.

Moderately well drained soils also occur. These are:

- Ebimimbang soils, which are moderately deep to very deep clay soils with sandy topsoils. The clay content of the subsoils range between 20 and 45%.

Poorly to very poorly drained soils are restricted to the valleys:

- Valley Bottom soils, which are moderately deep to very deep soils, locally stratified and with variable textures in topsoil and subsoil.

The Nyangong soils are deep (100-150 cm) to very deep (>150 cm), well drained, yellowish brown to strong brown clays. These Xanthic Ferralsols soils are developed mainly on fine grained, pyroxene rich gneisses and granites, at altitudes above 500 m asl. Nyangong soils are characterised by a high clay content, which can reach 80% in the subsoil.

The Ebom soils are deep to very deep, well drained, brownish yellow to strong brown clays. They are typical characterised as Acri-xantic Ferralsols and are mostly developed on gneiss and migmatite rock materials. They are common at altitudes between 350 and 500 m asl in the uplands and isolated hill slopes in the central and the northern regions of the TCP research area.

The Ebimimbang soils are classified as Acri-plinthic Ferralsols. They are moderately deep (50-100 cm) to very deep and moderately drained to well drained, yellowish brown sandy clay loams to sandy clays. Ebimimbang soil types are developed on coarse-grained gneisses and migmatites. They generally occur at altitudes below 350 m asl corresponding to the dissected erosional plains, uplands and isolated hills.

The Valley Bottom soils, are moderately deep (50-100 cm) to very deep, poorly to very poorly drained. The soil profiles are stratified showing alternations of sand, loam, and clay layers. Sand however is dominant. These soil types are found throughout the area regardless the altitude, but particularly in the valley bottoms of the dissected erosional plains and rolling uplands.

Relevant physical characteristics (texture, bulk density, water retention) and chemical characteristics of the soils of the different regions of the TCP research area are presented in Annex III.

Annex III shows that soil fertility in the area is very low, partly due to the high level of acidity, particularly in Nyangong and Ebom. These low pH values facilitate the fixation of iron and also of phosphorous in phosphate aluminium compounds which plants cannot take up. High aluminium concentrations in the soil solution are toxic to many crops. The Cation Exchange Capacity, which determines the capacity of a soil to retain and to release nutrients subsequently, is low to moderate but will drop rapidly with declining organic matter levels. In fact, in these soils, the contribution of the clay fraction to the CEC is very limited since the dominating clay mineral is Kaolinite.

The vegetation biomass stores a large part of the nutrient capital. In a stable environment, these nutrients stocks remain intact. But removal of the vegetation in a severe way may interrupt the nutrient cycle and export a part of the nutrients out of the system through harvest, leaching, and erosion.

5.6. VEGETATION

According to Letouzey (1968; 1985), the TCP research area belongs to the Guineo-Congolian domain of dense humid evergreen forests and for the larger part belongs to the Biafran Atlantic district (low and medium altitude). Only along the fringes, elements of the low and medium altitude Littoral Atlantic district may be found. Individual small summit areas belong to the submontane zone of the Guineo-Congolian domain. The majority of the TCP research area being located in the Atlantic Biafran forest zone rich in Caesalpiniaceae, the vegetation can be characterised as *evergreen tropical moist forest* with many species of the Caesalpiniaceae family.

Detailed vegetation surveys have been undertaken within the TCP research area (van Gemerden and Hazeu, 1999) over about 20 ha. A total of 490 species belonging to 76 families have been identified. Among these families, Euphorbiaceae (47 species), Caesalpiniaceae (43 species), Rubiaceae (29 species) and Annonace*ae* (18 species) were the most important. The vegetation is classified into seven distinct plant communities as shown in Table 5.2. A brief description of the physiognomy and the composition of these communities is given below.

Maranthes-Anisophyllea community (I)
The *Maranthes-Anisophyllea* community includes submontane primary and old secondary forests. Its distribution within the TCP research area is restricted to hill and mountain tops surpassing 700 m asl. In the UNESCO classification of vegetation (1981), this vegetation can be typified as tropical ombrophilous submontane forest. Structurally it looks like Letouzey's *Forêts montagnardes* although species composition is distinctly different. The *Maranthes-Anisophyllea* community apparently is a transitional vegetation between the moist Atlantic forest zone and the drier Guineo-Congolian semi-deciduous forest zone.

Table 5.2: Vegetation types of the TCP research area. (van Gemerden and Hazeu, 1999)

Denominations	Interpretation
I *Maranthes-Anisophyllea* community	Submontane primary and old secondary forest; altitude > 700 m asl; well drained soils
II *Polyalthia* community group	Primary and old secondary lowland forests; Altitude < 700 m asl
IIa *Podococcus-Polyalthia* community	Altitude 500-700 m asl; well drained soils
IIb *Strombosia-Polyalthia* community	Altitude 350-500 m asl; well drained soils
IIc *Diospyros-Polyalthia* community	Altitude < 350 m asl; moderately well drained soils
III *Carapa-Mitragyna* community	Swamp forest; Most common on low altitudes; valley bottoms
IV *Xylopia-Musanga* community	Young secondary forest; Throughout area but most common on low altitudes
V *Macaranga-Chromolaena* community	Thicket on recently abandoned fields and Cacao plantations; throughout area but most common on low altitudes

The physiognomy of this forest is characterised by the absence of emergents. Its vertical structure presents three distinguished layers in which the tree layer forms an irregular canopy generally at a height of 15-20 m, occasionally reaching 35 m. The canopy is often climber infested and the presence of epiphytic mosses is characteristic. The shrub layer is 3-7 m high. The herb layer is a closed and may reach a height of one meter.

In the canopy layer, abundant species are *Scorodophloeus zenkeri, Carapa sp., Monopethalanthus spp., Uapaca guineensis, Santiria trimera, Allanblackia kisonghi, Anisophyllea polyneura, Baphia lepitobotryx, Coelocaryon preussii, Maranthes glabra,* and *Tetraberlinia bifoliata.* The shrub layer is mainly composed of saplings of forest trees and of species such as *Garcinia lucida, G. mannii, Treculia obovoidea* and *Scorodophloeus zenkeri.* Climbers like *Haumania danckelmaniana,* and *Ancistrophyllum secundiflorum* are frequently found. The herb layer is dominated either by seedlings of forest trees or by herbs. Common species in this lower layer are *Diospyros hoyleana, Cola hirsuta, Halopegia spp., Mapania amplivaginata,* and *Palisota mannii.*

Podococcus-Polyalthia community (IIa)
The *Podococcus-Polyalthia* community is a primary and old secondary lowland forest type situated between 500 and 700 m asl. It is found mainly in the southeastern zone of the area covering the slopes of the Bigalanda mountain range. According to the UNESCO classification of vegetation (1981) this community is a Tropical ombrophilous lowland forest. The distribution of this community in the TCP research area coincides with the eastern part of Letouzey's (1968; 1985) Atlantic Biafran forest with Caesalpiniaceae.

The physiognomy of this community group is characterised by four strata. The emergent one is open (20-30% cover) and formed by large trees of more than 55 m height. *Klainedoxa microphylla* and *Monopethalanthus spp.* frequently dominate this stratum. In general the tree layer forms a canopy at 25 to 40 m. Frequent species are *Pycnanthus angolensis, Uapaca guineensis, Strombosia sp., Dichostemma glaucescens, Plagiostyles africana, Santiria trimera, Alstonia congensis, Hymenostegia afzelii, Desbordesia glaucescens* and *Scyphocephalium mannii.* The shrub layer is between two and ten meters high. It is relatively open (40-60% cover). In this stratum shrubs as well as saplings of forest trees are present. Species frequently found are *Ptychopetalum petiolatum, Polyalthia suaveolens, Cola hirsuta, Scaphopetalum blackii, Plagiostyles africana, Voacanga sp., Dialium sp., Coffea sp.* and *Grossera sp.*. The herb layer is relatively open (40-50% cover). It is formed of broad-leafed herbs and seedlings of trees, palms and lianas. Species frequently encountered are *Haumania danckelmaniana, Palisota mannii, Halopegia sp., Calamus deeratus, Cola hirsuta, Rhektophyllum sp., Cercestis ivorensis* and *Trachyphrynium braunianum.*

Strombosia-Polyalthia community (IIb)
This plant community is situated between 350 and 500 m asl. It is found in the central part of the TCP research area. According to the UNESCO classification of vegetation (1981) this community is a Tropical ombrophilous lowland forest. The distribution of this community in the TCP research area is strictly confined to Letouzey's Atlantic Biafran forest with Caesalpiniaceae.

Its physiognomy is similar to that of the *Podococcus-Polyalthia* community. The vertical structure is made up of four layers. The emergent layer is formed of large trees of 45-55 m in height. The floristic composition is heterogeneous although *Erythrophleum ivorensis* is the most frequent species. The tree layer appears at heights of 25 to 35 m. It is formed mostly of species such as *Plagiostyles africana, Coula edulis, Staudtia kamerunensis, Treculia obovoidea, Coelocaryon preussii, Polyalthia suaveolens, Strombosia pustulata and Erythrophleum ivorensis*. The shrub layer is dense (70-80%) and variable in height (3-8 m). It consists of sapling of trees and shrubs. Lianas are scarce. The most frequently observed species are *Treculia obovoidea, Scaphopetalum blackii, Ptychopetalum petiolatum* and *Carapa sp.*. The herb layer cover is 40%. Its height is 0.4 to 0.7 m and it is composed of broadleafed herbs (*Rhektophyllum, Palisota mannii…),* seedling of shrubs and trees *(Pentaclethra macrophylla, Treculia obovoïdes…*) and thorny lianas (*Calamus deeratus, Haumania danckelmaniana).*

Diospyros-Polyalthia community (IIc)
This community is a primary to old secondary forest. It is found at altitudes below 350 m asl, in the northern part of the TCP research area. According to the UNESCO classification of vegetation (1981) this community is a Tropical ombrophilous lowland forest. The distribution of this community in the TCP area includes the area designated by Letouzey for the Atlantic Biafran forest rich in Caesalpiniaceae and the Atlantic Biafran forest with Caesalpiniaceae still abundant.
Its physiognomy is similar to the one of the other two communities of the *Polyalthia* community group. This forest shows four strata. The emergent stratum has an irregular cover and an average height of 45 m. The most common species of this layer include *Desbordesia glaucescens, Klainedoxa gabonensis* and *Distemonanthus benthamianus*. Contrary to the emergents, the tree layer is dense and is 20 to 35 m high. Among of the more common species, *Plagiostyles africana*, *Coelocaryon preussii*, *Staudtia kamerunensis* and *Pycnanthus angolensis* could be mentioned. The shrub layer is open where the canopy is closed but can be dense in the vicinity of gaps. *Rinorea kamerunensis, Diospyros suaveolens, Calpocalyx dinklagei* and *Tabernaemontana crassa* are among the common species. The herb layer is also open to dense (in gaps). The most common species in this layer are *Haumania danckelmaniana, Cercestis ivorensis* and *Stylochiton zenkeri.*

Carapa-Mitragyna community (III)
The *Carapa-Mitragyna* community is a swamp forest. It is found in valley bottoms and along creeks and rivers throughout the area between 40-700 m asl. The vegetation of this community is broad-leafed tropical ombrophilous swamp forest and broad-leafed tropical ombrophilous alluvial forest (UNESCO, 1981).

It has three main layers. The tree layer is open (60% cover) and the canopy is situated at 35-40 m. Common species found in this layer are *Coelocaryon preussii, Mitragyna stipulosa, Strombosia sp., Uapaca guineensis, U. venussii,* etc. The shrub layer is often open and reaches a height of 2-7 m. The most common species are *Anthonotha macrophylla, Elaeis guineensis, Carapa sp., Diospyros preussii, Trichilia heudelotii* and *Raphia sp*. The herb layer is very irregular. Frequently occurring species are *Palisota mannii, Halopegia azurea*, and *Sarcophrynium prionogonium*

Xylopia-Musanga community (IV)
This community is a young secondary forest. It is the typical fallow vegetation in shifting cultivation areas and is found near villages and along the main access roads. The vegetation can be typified as evergreen broad-leaved woodland (UNESCO, 1981). The distribution of this community corresponds to Letouzey's remnants of strongly degraded evergreen forests;

The tree layer forms an open (40-50%) canopy at only 15-25 m. It is composed of *Musanga cecropioides, Pycnanthus angolensis, Coelocaryon preussii, Funtumia elastica, Xylopia sp.*, etc.. The shrub layer is 2-7 m high. It is a closed layer formed mostly by thorny trees or stilt roots species. The most common species are *Fagara macrophylla, Xylopia sp., Alchornea floribunda, Anthonotha macrophylla* and *Megaphrynium secundiflorum*. The herb layer is rather open and 50 cm high. Representative species of this lower layer are *Stylochiton zenkeri, Thaumantococcus sp.* and *Stipularia africana*.

Macaranga-Chromolaena community (V)
The *Macaranga-Chromolaena* is found in the vicinity of roads and villages and is strongly related to recent agriculture activities. The vegetation can be typified as evergreen broad-leaved thicket (UNESCO, 1981). Letouzey (1985) incorporates these recently abandoned fields in the type remnants of strongly degraded evergreen forests.

The tree layer is very open (20-40%) and very low (8-15 m). The most frequent species are *Musanga cecropioides*, *Albizia zygia, Pycnanthus angolensis, Anthocleista vogelii* and *Elaeis guineensis*. The most characteristic feature of the vegetation of this community is the very dense and high shrub layer (up to 5 m). The vegetation is overgrown by *Chromolaena odorata*. Other non-woody species are *Costus violaceus, Aframomum albo-violaceum* and *Megaphrynium secundiflorum*. Characteristic woody species of the shrub layer are *Funtumia elastica, Macaranga sp., Rauvolfia macrophylla, Elaeis guineensis* and *Fagara macrophylla*. Many residual agriculture crops are present such as *Musa parodisiaca, Manihot esculenta, Colocasia sp*. and *Carica papaya*. The very open (20%) very low (20-40 cm) herb layer is composed of herbs, ferns and seedlings from the majority of plants encountered.

5.7. FAUNA

At the time of writing, few studies concerning fauna had been undertaken in the TCP research area. Van Dijk (1999) conducted a survey on non-timber forest products in the area identifying the consumed species. A number of 48 mammals are reported as hunted by villagers in the TCP area. Of course this list (see van Dijk, 1999), based mainly on consumed animals, is not exhaustive. The most commonly trapped or shot mammals are the giant rat (*Cricetomys gambianus*), the African brush-tailed porcupine (*Atherures africanus*), the blue duiker (*Cephalophus monticola*), the tree pangolin (*Manis triscuspis*), the moustached monkey (*Cercopithecus cephus*) and the greater white-nosed monkey (*Cercopithecus nictitans*). The elephant (*Loxodonta africana*), the hippopotamus (*Hippopotamus amphibious*), the leopard (*Panthera pardus*) and the African long-nosed crocodile (*Crocodilus cataphractus*) have disappeared from the area. Gorillas (*Gorilla gorilla*) and chimpanzees (*Pan troglodytes*) may still occurs in the area, but are seldom if ever captured (van Dijk, 1994). According to Vivien (1991), about 132 species of mammals can be encountered in the humid forest zone of Cameroon.
Van Dijk (1994) also recorded in the study area a number of 71 fishes and crustaceans. Most commonly consumed fishes include *Clarias camerunensis, Barbus cemptacanthus, Gymnalabes typus, Barbus batesi* and *Labeo annectans.* From the 18 species of reptiles recorded, the most

hunted are the Gabon viper (*Bitis gabonica*), the hingeback tortoise (*Kinixys sp.*), the spitting cobra (*Naja nigicolis*) and the Nile monitor lizard (*Varanus niloticus*).
Many bird species are present in the area. Unfortunately, thorough studies concerning the avifauna have not been carried out. Nevertheless, a preliminary species list reveals the presence of 96 bird species (van Gemerden and Hazeu, 1999).
De Winter and Gittenberger (1998) state that the TCP area might be the most species-diverse locality known in the world with respect to land molluscs. They found 97 species of land snails in a square kilometre study area located in the Biboo-Minwo catchment.

The fauna has a substantial social, economic and cultural influence on the livelihoods of forest dwellers. Almost all animals mentioned above are seriously threatened due to commercial hunting practices. Several techniques of hunting are used. The most commonly utilised are shotgun and traps. Trenning (1998) studied the spatial distribution of trapping particularly around the village of Nyangong and found that eleven types of traps are used in the village.

5.8. LANDSCAPE ECOLOGICAL UNITS

Four altitude zones, seven different landforms, four main soils types and seven broadly defined plant communities form the basis of the reconnaissance landscape ecological map of the TCP research area (van Gemerden and Hazeu, 1999). The legend of this map is based on altitude, landform, soil and vegetation, and has a hierarchical structure. A total of 14 main land mapping units (LMUs) are discerned. Each LMU is represented by a code, which is a combination of five ecological zones (A to E, see Map 4: Ecological zones of the cartographic annex) and the predominant landform (v, pd, u1, u2, h1, h2 and m, see Section 4.4). The soil and vegetation characteristics of each landform unit within a particular ecological zone are given. The 14 main LMUs are further subdivided according to the disturbance caused by shifting cultivation, resulting in 34 mapping units. The five ecological zones identified, based on soil drainage and altitude criteria, are presented in Table 5.3. The 14 main land mapping units are given in Table 5.4. Each LMU can be subdivided according to the degree of disturbance by shifting cultivation (u: undisturbed; l: low disturbance; h: high disturbance).

Table 5.3: Ecological zones

Zone	Soil drainage	Altitude
A	Well drained	> 700 m asl
B	Well drained	500 - 700 m asl
C	Well drained	350 - 500 m asl
D	Moderately well to well drained	< 350 m asl
E	Poorly to very poorly drained	

Table 5.4: Description and surfaces of the main land mapping units.

Code	Description	area	
		ha	%
Ah1	Isolated hills above 700 m asl, well drained soils	880	0.5
Am	Mountains above 700 m asl, well drained soils	100060	6.0
Bh1	Isolated hills between 500 and 700 m asl, well drained soils	3820	2.3
Bh2	Complex of hills between 500 and 700 m asl, well drained soils	13890	8.3
Bu1	Rolling uplands between 500 and 700 m asl, well drained soils	5400	3.2
Bu2	Hilly uplands between 500 and 700 m asl, well drained soils	19700	11.8
Ch1	Isolated hills between 350 and 500 m asl, well drained soils	4520	2.7
Cu1	Rolling uplands between 350 and 500 m asl, well drained soils	31270	18.7
Cu2	hilly uplands between 350 and 500 m asl, well drained soils	25070	15.0
Dh1	isolated hills below 350 m asl, moderately well drained soils	3310	2.0
Du1	rolling uplands below 350 m asl, moderately well drained soils	11260	6.7
Du2	hilly uplands below 350 m asl, moderately well drained soils	12620	7.5
Dpd	Dissected erosional plains below 350 m asl, moderately well drained soils	23950	14.3
Ev	valley bottom; poorly to very poorly drained soils	1600	1.0
Total		167350	100.0

The surface areas of the main land mapping units are presented in Table 5.4. The 14 main LMUs are illustrated on Landscape ecological map (Map 5 of the cartographic annex). Because of the scale (1:200 000) it was not possible to map the 34 LMUs indicating shifting cultivation disturbance. For that level of detail, one should refer to the Lu1 Landscape ecological map at scale 1:100 000 (see van Gemerden and Hazeu, 1999).

6. SOCIO-ECONOMIC ENVIRONMENT

A socio-economic survey, covering the whole TCP research area, was undertaken by the Econ2 project from January to April 1999. Most information used in this chapter comes from the survey report "*Enquête socio-économique 1999, zone de recherche PTC* *et al*. (1999) and is not referred to specially each time. Information has also been provided by other TCP research projects, mainly the S1 project.

Sixty-seven villages, including nine Bagyéli settlements, are located in the TCP area:

- 23 in the subdivision of Akom II;
- 16 in the subdivision of Bipindi;
- 6 in the subdivision of Lolodorf;
- 22 in the subdivision of Ebolowa.

The largest villages are Akom II (944 persons) and Bidjouka (912 persons) and the smallest ones are Bagyéli settlements with less than 20 persons: Mindjo, Nyabitande PS, Bizambo, and Ngongo. Most villages are old settlements installed at the beginning of the last century. Each village has a chief who is normally elected and accepted by the villagers and then recognised by the administrative authorities. In most cases, the houses are built along the roads giving a linear pattern to the villages.

The subdivision headquarters provide the services that are normally expected:

- Health centre;
- Traditional tribunal court (*Tribunal coutumier*);
- MINEF agent (*chef de poste forestier*);
- MINAGRI sub-division agent;
- Agriculture popularising agent (*Agent vulgarisateur du PNVA*);
- Others.

A human occupancy map was drawn up (see Map 6: Human occupancy, of the cartographic annex) indicating the approximate limits of the village territories. This map has no legal value. The limits were traced on 1:50 000 topographical maps of the area during village meetings with the chief and other villagers (elders and young people) without any field delimitation. The villagers' statements were sometimes difficult to transfer on the map, and therefore a superficial field verification was carried out. In some cases the same area is claimed by more than one village. The purpose of this map is to have an idea of the territory occupied or used by a given village. This information is needed when specified management proposals are to be implemented.

6.1. SERVICES AND INFRASTRUCTURE

An overview of public facilities in the area is given in Table 6.1.

Table 6.1: Number of services and infrastructures present in the villages

Subdivision	Health centre	School	Electri-city	Football field	Water supply		Church		Cassava mills
					villages	units	villages	units	
Akom II	5	15	12	8	8	25	18	55	11
Bipindi	2	8	0	9	2	20	12	30	0
Lolodorf	0	2	1	2	0	0	4	7	0
Ebolowa	2	12	0	15	5	5	20	45	0
Total	9	37	13	34	15	50	54	137	11

Roads
The roads of the TCP site are very degraded (status 1999), some bridges are broken, and if TCP (and other NGOs) had not maintained some roads, some villages would have been completely isolated. This situation has a negative effect on the possibilities for commercialisation of the products of the area.

Electrification
Ebolowa is providing electric power to Akom II, the villages located along the road from Ebemvok to Assok I (except Biboulemen and Nemeyong) and the villages located along the road from Akom II to Abiété. Bidjouka and Lambi obtain electricity from solar energy.

Telecommunication
None of the villages have access to telephone or other radio ways of communication. Radio-Lolodorf broadcast programmes, sometimes covering forestry subjects, received by nearby villages.

Water supply
Akom II, Nkomakak and Ekowong benefit from a water distribution network installed in 1997 by the Japanese co-operation, which has also drilled some deep wells and installed some hand pumps in the villages of Nyabitande, Tchengue, Mbangué, Enyi anko and Nemeyang. Bidjouka has a water reservoir and a water distribution network for the village, installed by Scanwater. Usually those water networks are free of charge, which means there is little maintenance and no provisions for major breakdowns. In the other villages some isolated wells are available, otherwise people obtain water from nearby streams and rivers.

Education
More than 50% of the villages have a primary school. Bagyéli settlements except one, Nko Mvomba, do not have a school. For secondary schools students have to go to Akom II, Bipindi, Lolodorf or outside the area to Kribi or Ebolowa. Nyangong also offers the first secondary classes.

Religion
The dominant religions are Protestantism and Catholicism. Islam and animism are also practised. One or more churches are present in most villages.

Health
Only few villages have health centres *(dispensaires*): Nlomoto, Nkomakak, Ebemvok, Akom II and Nlonkeng in the Akom II subdivision; Bipindi and Bidjouka in the Bipindi subdivision; Nkoekouk and Nyangong in the Ebolowa subdivision. They are usually not very efficient, characterised by a lack of trained people and medicines.

Recreation
Recreational structures are non-existent except for football fields in most of the villages.

Industrial activities
Cassava mills are found only in Akom II. There are no other industries or mining activities.
It is proposed that the Chad-Cameroon pipeline and road will pass along the northern part of the TCP area. The location of the proposed pipeline, which is taken from the COTCO report (1999), is shown on Map 1: TCP research site (see cartographic annex).

Shops and markets
Small shops are usually found in the villages. The quantity and the diversity of the products available increase with the size of the village. There are very few markets in the area. Six have been counted in the Akom II subdivision and only one in the Ebolowa subdivision. People sometimes have to travel very long distances to reach active markets.

Organisations
There are few organised groups in the area. They usually are agriculture mutual aid groups associated with savings groups (*tontines*). Some registered community interest groups (GICs, *Groupe d'intérêts communautaires*) with specified working objectives exist and also a small number development organisations.

SAILD and Planet Survey are active NGOs based in Lolodorf, which have made studies on the Bagyéli people with an objective to improve their way of living and make them settle. *Les petites sœurs de Jésus* (Roman Catholic nuns) are present in Mingoh.

6.2. DESCRIPTION OF THE POPULATION

Different types of information were collected through two socio-economic surveys carried out in the TCP zone between February and April 1999. A census of the whole population was provided the total number of inhabitants as well as the main characteristics of the 67 villages. A more detailed socio-economic survey among a representative sample of the population (364 households) gave quite precise data regarding their main activities (Lescuyer *et al.*, 1999). These answers could be extrapolated on a statistical basis. The information presented below was derived from these surveys.

6.2.1. Demographic data

Two main groups represent the population of the TCP area:

- The settled villagers: mainly Bantus, including Boulou, Ngoumba, and Fang ethnic groups. The Bassa ethnia is also present. They mainly live along the roads and their main activity is agriculture: shifting cultivation and cacao plantations.
- The Bagyéli pygmies live in the forest and practice mainly gathering and hunting. Shifting cultivation may be practised on a small scale. The Bagyéli represent only 2% of the total population.

The total population is composed of 14 393 persons[3] in 2959 family units. The average number of persons per village is 217. The population density for the TCP area is 8.6 inhabitants per km^2. Table 6.2 gives the number of persons and family units per village.

The size of the family units is small, averaging five persons per family, the extremes being 31 and 33 persons in two families of Mbanga and Toko. Three hundred twenty seven families (11%) have only one member and 1870 families (63%) have from two to six members. Household leaders are usually men but also women (22% of total households leaders). The mean age of the household leader is 52 years.

The number of Bantu children going to school is very high, close to 100%; on the other hand it is very low for Bagyéli children, nearing 0%.

The foremost activity practised in the TCP area is food crop cultivation, which is carried out mainly by women. The next important activity is cacao plantation, done by men. The other activities observed are hunting, fishing and gathering. An important proportion of the inhabitants generates income from a paid employment or pension.

The principal activity is considered as the one on which people dedicate most of their time. The survey (Lescuyer *et al.*, 1999) gives the following proportions of the population according to their main activity:

Crop cultivation	62%
Agriculture plantation	7%

[3] The persons absent from the village, at the time of the survey, for more than one month have not been counted meaning that youngsters going to school outside of the village have not been counted.

Hunting	3%
Fishing	2%
Gathering	1%
Others	25%

Table 6.2: Population numerated in the TCP area.

Sub-division	Name of village	Number of Children	Number of women[1]	Number of men[2]	Number of persons	Number of families
AKOM II	ABIETE	64	93	90	183	39
	AKOM II	373	468	476	944	188
	ASSOK I	77	139	111	250	66
	BIBINDI	43	62	68	130	26
	BIBOLE	16	39	35	74	20
	BIBOULEMAM	47	89	88	177	42
	EBEMVOK	148	245	182	427	91
	EKOWONG	59	65	70	135	28
	ENYI'A NKOL	102	150	156	306	58
	MALOMBA	50	65	89	154	32
	MBANGA	81	116	111	227	47
	MEFANE	32	37	29	66	11
	MINGOH BS*	43	53	44	97	12
	MVIE	170	209	212	421	83
	NNEMEYONG	108	152	153	305	55
	NKO MVOMBA BS[3]	29	36	36	72	18
	NKOMAKAK	176	246	274	520	107
	NLOMOTO	162	219	183	402	73
	NLONKENG	58	75	53	128	27
	NYABITANDE	152	186	175	361	78
	NYABITANDE BS [3]	8	6	9	15	2
	TCHENGUE	45	68	95	163	27
	TOKO	52	61	82	143	30
23 villages	**TOTAL AKOM II**	**2095**	**2879**	**2791**	**5670**	**1161**
BIPINDI	ASSOK II	70	102	108	210	50
	BIDJOUKA	362	463	449	912	202
	BIPINDI	219	231	270	501	110
	BIZAMBO BS[3]	5	7	9	16	3
	BONGWANA	45	76	51	127	22
	EBIMIMBANG	124	189	184	373	102
	EDO'OMANG	27	40	37	77	14
	LAMBI	194	242	235	477	83
	LOG NDIGA	143	163	167	330	61
	MELEN	46	73	66	139	32
	MIMBIATE BS[3]	6	14	9	23	5
	MINDJO BS[3]	2	6	5	11	4
	MINFOMBO	34	43	40	83	15
	NYAMINKOM	27	55	52	107	33
	SA'A BS [3]	5	10	13	23	7
	TYANGO	120	227	185	412	69
16 villages	**TOTAL BIPINDI**	**1429**	**1941**	**1880**	**3821**	**811**
LOLODORF	MBANGO BITOUER	183	228	217	445	88
	MBANGO BOULOU	87	104	92	196	34
	MBANGO KABA BS [3]	12	13	19	32	8
	MBANGO NGOUMBA	37	45	34	79	14
	MELANGUE MVOG	35	41	47	88	17
	NGONGO BS [3]	1	9	11	20	6
6 villages	**TOTAL LOLODORF**	**355**	**440**	**420**	**860**	**167**

1 The number of women includes adults as well as girls younger than 15 years
2 The number of men includes adults as well as boys younger than 15 years
3 BS: Bagyéli settlement

Table 6.2: Population numerated in the TCP area (continued)

Sub-division	Name of village	Number of Children	Number of women[1]	Number of men[2]	Number of persons	Number of families
EBOLOWA	ABO'O NTOMBA	36	46	34	80	20
	ADJAP ESSAWO	136	173	161	334	49
	BIKOUBA	36	43	43	86	20
	BITYILI	13	13	19	32	8
	EBOM	168	201	210	411	99
	ELON	59	99	74	173	32
	ENGOMBA	88	100	103	203	37
	KALATE ABA'A	122	143	122	265	54
	MA'AMENYIN	43	77	81	158	46
	MEFAK	119	139	127	266	48
	MEKA'A II	79	81	97	178	39
	MEKALAT	56	80	76	156	29
	MELAN	36	50	44	94	19
	MELANGUE BIYENG	58	82	84	166	34
	MESSAMBE	53	57	68	125	26
	MFALA	83	87	118	205	36
	MINKAN	62	62	62	124	27
	NKO ADJAP	10	12	11	23	5
	NKOEKOUK	157	230	195	425	95
	NKOUTOU	61	71	56	133	25
	NYANGONG	142	162	159	321	54
	YEM ESSAKOE	36	38	46	84	18
22 villages	**TOTAL EBOLOWA**	**1653**	**2046**	**1996**	**4042**	**820**
TOTAL TCP research area		**5532**	**7306**	**7087**	**14393**	**2959**

1 BS: Bagyéli settlement
2 The number of women (men) includes adults as well as girls (boys) younger than 15 years old.

6.2.2. Income data

An important economic parameter is the income level of a population. It is shown that the income is derived from three main sources:

- Exploitation of natural resources, with agriculture contributing as much as 32% to the average total income, and hunting, gathering and fishing 15%;
- Paid activities: salaries and pensions amount to 22% of the average total income;
- Other types of income (gifts, small dealings, etc.).

Table 6.3 shows the classes of income according to each type of activity.

Table 6.3: Division of income over various classes, as generated from different sources, as percentage of the total from that source.

Source	Classes of income (FCFA)						
	< 20 000	20 000 - 50 000	50 000 - 100 000	100 000 - 200 000	200 000 - 500 000	> 500 000	Total
Agriculture	37%	11%	15%	14%	16%	7%	100%
Hunting	80%	7%	6%	4%	2%	1%	100%
Fishing	95%	2%	1%	1%	0%	1%	100%
Gathering	74%	9%	6%	6%	4%	1%	100%
Salaries	86%	1%	1%	2%	5%	5%	100%
Pensions	94%	0%	0%	1%	3%	2%	100%
Gifts	79%	10%	6%	3%	1%	1%	100%
Others	69%	8%	5%	6%	6%	6%	100%

As a whole, the annual mean income per household is estimated as 470 000 Fcfa and the annual median income is around 250 000 Fcfa. This difference indicates a quite broad spectrum of incomes within the TCP area, as indicated in Table 6.4.

Table 6.4: Distribution of the earned mean annual income over the classes of income.

Class of income (FCFA)	**< 20 000**	**20 000 – 50 000**	**50 000 - 100 000**	**100 000 – 200 000**	**200 000 – 500 000**	**> 500 000**	**Total**
Percentage of population	6	8	13	19	23	31	100

6.3. LAND TENURE SYSTEM IN THE TCP AREA

The local population makes use of natural resources according to implicit or explicit rules, most often related to what is called their "traditions". Understanding those rules and patterns is an important stake to propose a sustainable and integrated management of the forest. Most researchers of the S1 project, each of them working with one particular ethnic group, have addressed this complex topic. Despite some differences in land tenure systems between Bagyéli and Bantu people as well as between Bantu people themselves several overall common features may be presented:

- Property rights are conditioned by forest land types. Table 6.5 presents the Bulu perception of the natural environment (van den Berg, 1999). A similar division between agricultural land and forestland is made by the Ngoumba (Tiayon, 1999). This typology is likely more complicated for the Bagyéli, especially regarding forest ecosystems. As mentioned by Biesbrouck (1997), the forest is rather considered by Bagyéli as a stock of wild forest products while Bulu seem to perceive the forest mainly as a stock of agricultural land.

Table 6.5: Forest Land Types according to the Bulu

Si (Land)			
Si Mëfup (agricultural land)		Afan (forest)	
Afup (field and plantation)	Ekotôk (fallow land)	Mfôn Afan (old secondary forest)	Fut Afan ("primary" forest)

- Land tenure and tenure of other forest resources should be distinguished: for instance, trees can be "owned" directly and independently to rights to land. The ownership of particular resources in forest or in fallow land may be explained by former practices, such as planting of a tree, discovery of a small river, etc. One consequence is that "*there is not a congruence between village residence and membership and rights to resources adjacent to the village settlements. Rights acquired during earlier phases of migration in other settlements are not lost when a group has moved to their present day villages at the roads*" (von Benda-Beckmann *et al.*, 1997, p. 19). Therefore, use of forest resources cannot be explained only through geographical entities.
- Kinship entities should be preferred to geographical entities to understand land tenure dynamics. Rights on forest resources are vested at different levels of social organisation. In the case of Bulu, three different levels of organisation seem to be relevant: the village, the sub-clan and the patrilineage (van den Berg, 1999). The same goes for Bagyéli: "*every Bagyéli is labelled both as belonging to a base-camp (geographical position) and as a member of a kin-group, namely of a section ("houses") of father's and mother's patri-clans. These entities overlap each other only partly. As Bagyéli derive their collective rights to forest resources from kinship ties, and kinship networks stretch over large distances, each section of forest can be used by a group of people which is more encompassing than the current residents of the camp in the immediate vicinity*" (Biesbrouck, 1999, p. 32).
- Rights to resources and to spaces are multiple, complex and circumstantial. For instance, "*Bagyéli rules for the access to forest resources can best be pictured as a complex of interlocking mutual rights, each individual having (a) inherited rights […], (b) rights derived from relations via women […], (c) the possibility to acquire temporary rights to particular valued resources by having/creating a '*

with someone holding the rights of exploitation, (d) the possibility to exploit 'open access' resources" (Biesbrouck, 1997, p. 3-4). Every land tenure system should be analysed and studied through the kinship system. This kinship system in a segmented society is a fluid and flexible concept, offering one individual many possibilities to explain his behaviour (as a household leader, as a member of a lineage, as a member of a clan, etc.). As a result, resources and spaces are subject to multiple, overlapping rights, held by different social entities. These social groups are numerous in the TCP area, as most villages contain people from three to four different clans, while one patrilineage in one village may contain up to 20 more or less independent segments (von Benda-Beckmann *et al.*, 1997).

Due to their complexity and fluidity, only small-scale surveys may analyse land and forest tenure systems. This requires one to gather information on kinship system and on the village's history of using forest resources. It seems difficult to carry out such a detailed task in the framework of the MMP as it constitutes only meso-level planning, as preparation for a forest management plan. However, this information on forest/land tenure systems is necessary to conceive realistic forest management alternatives and to receive support of the local population. Therefore, this topic should be addressed in the design of Forest Management Plans, requiring deeper anthropological and geographical surveys at the village level[4].

6.4. MAIN ACTUAL LAND USES

6.4.1. Shifting cultivation

The population in the TCP area depends on agriculture for subsistence and cash revenues. Shifting cultivation is the principal agricultural system used. The traditional shifting cultivation (clearing and burning virgin forest) is more and more giving way to what may be called "rotational fallow" (Nounamo and Yemefack, 1997). Shifting cultivation as understood in that sense takes place in a strip of land in which a cultivable area is cleared. The trees are felled, the area is burned, food crops are cultivated during a few (2 - 5) years and then the land is left in fallow during a longer (3 – 15 years) period before the whole process starts over again.

According to Nounamo and Yemefack (1997) and field observations, the garden fields are located near the houses or roads. Next, there is a strip of forest, kept for immediate needs of forest products (fuel wood, construction wood, NTFP, etc.) in which animals stray. Cacao plantations and then the food crop fields and the fallow, which borders the forest, are beyond this strip. The "rotational cultivation strip" usually does not exceed a distance of five kilometres from the main roads or houses because of the time it takes to reach them. Also it appears that when the demand for cultivation land increases, the tendency is to intensify the cultivation systems and to cut down fallow periods instead of opening new fields in the forest (Tiayon, 1999).

The mean annual area used for food crops is 1.28 ha per household and it is estimated that 0.23 ha/person/year is used for food crops (Lescuyer *et al*., 1999). Nounamo and Yemefack (1997), among others, estimate the total area, including fallow, used by a mean size household (five persons) for food crops at approximately 10 ha. More accurate studies should be carried out to evaluate this rotational area with more certainty. The principal food crops encountered in the TCP area are cassava (*Manihot esculenta*), macabo (*Xanthosoma sagittifolium)*, plantain (*Musa spp*.), groundnut (*Arachis hypogeae*), maize (*Zea mays*), and cucumber (*Cucumeropsis mannii*). The other crops of less importance are yam (*Colocasia antiquosum*) and fruit trees such as avocado (*Persea americana*) and plum (*Dacryodes edulis*). Shifting cultivation is basically oriented towards domestic use, only the surpluses are commercialised.

[4] as elaborated in the various pilot studies of the S1 project, notably concerning the intertwinement of different local leadership positions, see van den Berg and Biesbrouck (2000).

Shifting cultivation is the most widespread agricultural land use in the TCP research area (van Gemerden and Hazeu, 1999). The area occupied by all agricultural systems (shifting cultivation, perennial crops, garden fields) was estimated from aerial photographs at 1:20 000 scale of 1984-1986. The map (see Map 7: Shifting cultivation intensity, of the cartographic annex) produced by Lu1 (van Gemerden and Hazeu, 1999) gives an area covered by high and low intensity cultivation systems of 51 180 ha, which represents 30% of the TCP area (Table 6.6). The zones of high density of cultivation are located adjacent to the big villages, along de roads Bipindi - Bidjouka, Bipindi – Ebimimbang – Nkoutou, Akom II – Mvié, and Akom II – Ebomvok.

Table 6.6: Disturbance due to cultivation (van Gemerden and Hazeu, 1999)

Degree of intensity		**Area**	
	Code	ha	%
Undisturbed	u	116 173	69
Low intensity	l	29 823	18
High intensity	h	21 357	13
Total		167 353	100
Subtotal low and high intensities		51 180	31

The figures concerning shifting cultivation given by van Gemerden and Hazeu (1999) are higher than the ones met in the recent socio-economic survey (Lescuyer *et al*., 1999). The area under cultivation (food crops, cacao plantations and one year fallow) found from the survey is 6 729 ha. This difference can be explained by few reasons.

- The Lu1 maps was done from aerial photos at 1:20 000 scale and it is normal that patches of forest, which were too small to discern as such, were included in the shifting cultivation area.
- People tend to forget or don't have an exact notion of the areas they have cultivated some years ago. The socio-economic survey did not permit to estimate the total area in fallow, which was probably taken into account by the photo-interpretation.
- The socio-economic survey did not bring out all agricultural plantations, such as oil palm, that were most probably included in the shifting cultivation maps of Lu1.
- It can be supposed that the cultivation area has diminished since 1984.

6.4.2. Agricultural plantation

There is no large-scale industrial plantation as such in the TCP area. The agricultural plantations are included in the shifting cultivation zone. Local populations are mainly if not exclusively exploiting cacao plantations (covering 625 ha of the area, according to Lescuyer *et al*., 1999). The mean area of cacao plantations is 0.3 ha (Lescuyer *et al*., 1999). These plantations are often old and very poorly maintained due to the low prices of cacao during the last years. Recently, other types of plantations such as oil palm, pineapple, or plantain have taken some expansion. These plantations are introduced by *élites* who do not live permanently in the villages. These people were underrepresented or omitted in the socio-economic study, which was oriented towards inhabitants of the TCP area.

6.4.3. Animal husbandry

Animal husbandry is not very developed in the area. Animals stray freely around the habitations and the proximate fields. Poultry is the most common, 67% of households have an average of three chickens. Pigs and goats are also owned by some 25% of the families, sheep are rare, encountered in only 12% of the households.

6.4.4. Forest exploitation

The area was logged several times in the past. Recently the whole area has been logged except for the hilly and mountainous regions, which are mainly located in the eastern part of the area, and for those areas, which are heavily disturbed by shifting cultivation. The Dutch company

Wijma-Douala SARL (GWZ) was the main logging company operating in the area during the 1980s and 1990s. The area and the logging period of the recent licences or sales of standings (*vente de coupe*) are presented in Table 6.7 and Figures 6.1 and 6.2. The data were collected from records held in the forest delegation of the Mvila division and the forest delegation of the South Province in Ebolowa (Ngibaot, 1997) and also from GWZ. According to the available information, GWZ has cut in concession N°1 600 an average of 0.8 tree/ha and 7.83m^3/ha. The main species exploited are: Azobé (*Lophira alata*, 60% of the extracted volume), Padouk (*Pterocarpus soyauxii*), Tali (*Erythrophleum ivorense*), Bibolo (*Lovoa trichilioides*), Kossipo (*Entandrophragma candollei*) and Bongo H (*Fagara heitzii*).

Table 6.7: Recent logging licences and sales of standing: areas and periods of cutting

N° of licence or sales of standing	**Area**	**Period of cutting**
	ha	Year
1600	50 732	1985-1992 1995-1997
1790*	80 494	1992-1997
1790 add	10 312	1992-1997
1153	2 413	1995-1996
1154	2 616	1995-1996
1222	2 404	1995-1996
1223	3 136	1995-1996
1224	1 923	1995-1996
SEPFCO	2 838	1995-1996
Total area	**156 868**	

*The total area of the concession 1790 was 80 494 ha but only 60 650 ha were effectively exploited.

Other known logging activities are:

- 1972-1973: logging as openings for the construction of the principle roads of the area; Bipindi-Ebimimbang-Ebom, Akom II-Adjap, and Mefak-Minkan;
- 1978: Nyangong road construction;
- 1985: Bipindi area by Bois hydraulique.

6.4.5. Non-Timber Forest Product exploitation

For the rural populations, collecting Non-Timber Forest Products (NTFPs) has always been part of their activities. NTFPs contribute to their subsistence economy and provide food, medicines, building material and household and agriculture equipment. In the TCP area, van Dijk (1994; 1995; 1999) has intensively studied the abundance and distribution of NTFP species (mainly plant species) and carried out an economic and ecological assessment of some NTFPs. Njebet Ntamag (1997) has identified six vegetation types, in which NTFPs are collected: fallow lands, cacao plantations, food crop plantations, home gardens, swampy sites and forest. It is estimated that gatherers or hunters may sometimes walk very long distances (5-10 km) to collect products, but an important part of NTFPs are not extracted from natural forests, but from anthropogenetic vegetation types such as secondary forest, young fallow vegetation and cacao plantations (van Dijk, 1999). These habitats are generally located close to villages and cultivated lands (less than three km from the houses). Mainly women practise collection of NTFP. The collection of NTFPs seldom has a negative impact on the environment. Most NTFPs are used for household consumption, and relatively few products are sold on local or urban markets (van Dijk, 1999).

6.4.6. Sacred places

It is recognised that sacred places, where people conduct spiritual or religious ceremonies, exist in the forest. It is believed that these sites do not occupy much space but are of great importance for the people who use them. They are supposed to be dispersed all over the TCP area but it is difficult to locate them and draw them on maps. People do not talk easily about them, very few families affirmed using sacred places during the socio-economic survey. It will become important to localise them more accurately when elaborating forest management plans, for example to prevent destruction of those sacred places by logging.

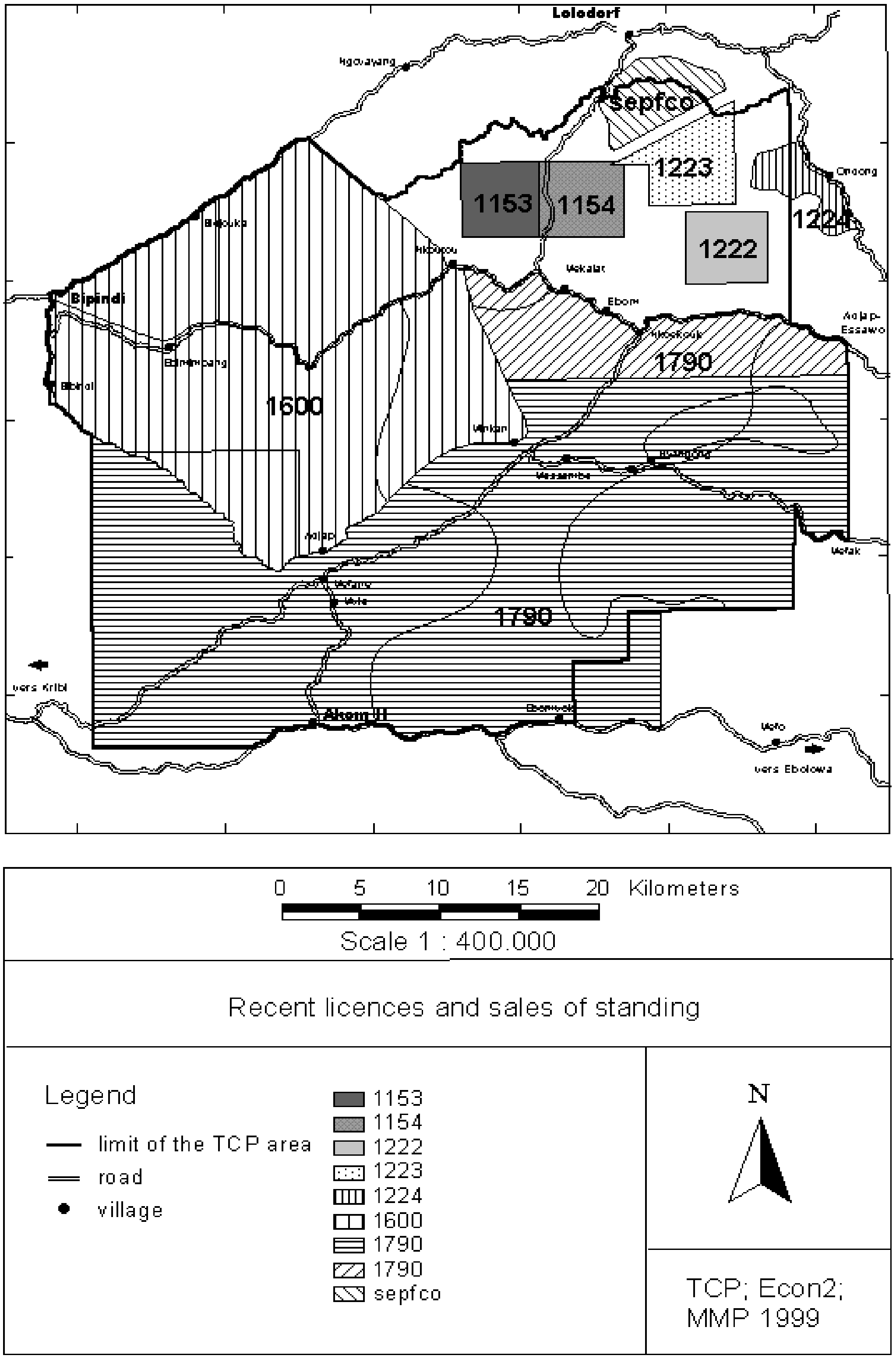

Figure 6.1: Recent logging licences and sales of standings.

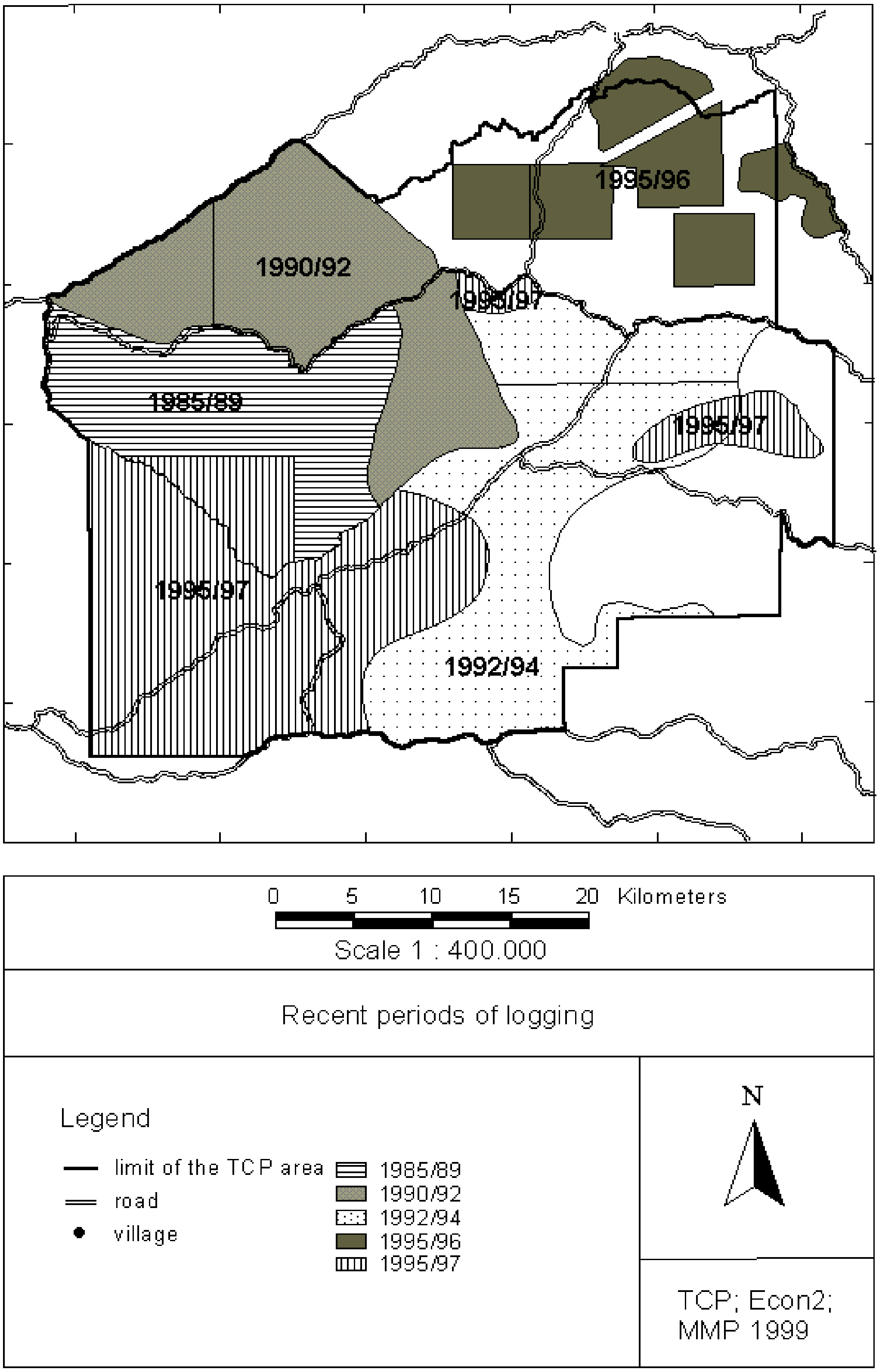

Figure 6.2: Recent periods of logging.

6.4.7. Research sites

TCP has initiated many research projects in the area. Some studies are still going on and periodic observations or measurements are made in permanent study plots. The main study plots are shown on Map 1: TCP research site, of the cartographic annex. They are:

- The three catchments studied by the Lu1 and Ecol2 projects. One is located north of Mvié, a second one south of Nyangong and the third one north of Ebom covering 1729 ha;
- An area of 3002 ha north of Ebom where the F2 project conducts its studies;
- Some small-size spots followed by the F6 project;
- Two sampling plots (one of them being outside the TCP research area) followed by the S1bis project covering an area of 325 ha[5].

The non-permanent sample plots of the Lu1 and Ecol1 projects are also indicated on Map 1: TCP research site, of the cartographic annex.

[5] Some of the permanent sample plots may overlap explaining why their total is higher than the area indicated elsewhere, e.g. in Table 6.7.

7. LAND EVALUATION – LAND SUITABILITY

The Tropenbos Foundation has developed a common methodology: "Inventory and evaluation of tropical forest land" (Touber *et al.*, 1989), contributing to a systematic and interdisciplinary research approach for land evaluation and subsequently sound land use planning. Lu1 project researchers have used this method to inventory and evaluate the potentialities of the TCP research site (Hazeu *et al.*, 2000). Land use types (LUTs) were identified and described. Then the specific land use requirements (LURs) for the five main LUTs were defined. The land qualities (LQs) and land characteristics (LCs) of the land mapping units (LMUs) were also determined. The combination of the Land qualities of Land mapping units to the Land requirements of the Land use types leads to Land suitability (LS) classifications illustrated by suitability maps per LUT (Figure 4.1).

This chapter presents the process followed by the Lu1 researchers for the purpose of explaining how the suitability maps were built up. Each step is briefly presented and for more details, one should refer to the report "Suitability evaluation of the forest land in the Bipindi – Akom Lolodorf region, Southwest " by Hazeu *et al*. (2000). This report includes eight suitability maps (see Map 9 - Map 16 of the cartographic annex), and these maps were used as basic references for the meso-zoning (Chapter 8) of the TCP area and for defining scenarios (Chapter 9). They will also be of great help to the stakeholders during the mediation (Chapter 10). The suitability maps are not an objective and a finality of their own; they should be considered as fundamental tools for the managers and decision-makers.

7.1. LAND USE TYPES

Five LUTs have been identified and described by Hazeu *et al*. (2000) as the most important ones in the TCP area:

- Conservation of biodiversity;
- Collection of NTFP;
- Production of timber in natural forests;
- Shifting cultivation;
- Plantation agriculture.

The systematic description of each LUT includes objective, output, markets, labour and capital input, the technology involved, infrastructure needs, and scale of operations. The descriptions by Hazeu *et al*. (2000) are summarised below. Other Land use types, such as sacred forests and research sites, have been identified inside the TCP research area. They have not been treated in the land suitability classification because of the limited spatial or temporal extent. They are treated in Section 8.2.

7.1.1. LUT Conservation of biodiversity

Tropical rain forests are the species richest and structurally the most complex terrestrial ecosystems in the world. The variety and uniqueness of the genetic reserve (gene pool) contributes to the functioning of these forests. Human actions generally have a severe negative impact on biodiversity. Conservation of diversity within species, between species and of ecosystems is internationally recognised as a priority for management and nature conservation (e.g. Lammerts van Bueren and Duivenvoorden, 1996).

The primary objective of the LUT “Conservation of biodiversity” is conservation of biodiversity and habitat protection for all species with emphasis on endangered species. The forest areas designated for conservation of biodiversity are more or less primary ecosystems that contain high species diversity or species of special concern.

The main benefits of conservation of biodiversity are non-tangible. Conservation of biodiversity preserves the genetic variation of the flora and fauna species of the forest ecosystems and more particularly contributes to the survival of rare and endangered species. Conserving genetic variation and preventing the extinction of species are provisions for the functioning of ecosystems and of human well being. The permanent forest cover preserved by the conservation of biodiversity contributes to regulation and maintenance of many ecological, physical and chemical processes and cycles (e.g. microclimate, hydrological and nutrient cycles, oxygen-carbon dioxide balance and protection against erosion). The areas designated for the LUT Conservation of biodiversity may play an important role for scientific research on species diversity and forest ecosystem functioning. Moreover, it may serve educational, cultural and spiritual functions. The scenic beauty of these forests could, in time, attract tourists.

Conservation of biodiversity in (strictly) protected areas can and should be complemented by efforts made in other areas. Ecological sustainable production of timber and non-timber forest products provides suitable habitats for many forest species.

7.1.2. LUT Collection of non-timber forest products (NTFPs)

The people living in the TCP research area depend for their livelihood to a considerable extent on forest products. The forest in their direct surrounding provides food, construction materials, agricultural and household utensils, medicines, etc., and nearly their complete protein supply is from forest products. Most NTFPs are collected for subsistence needs and the local market. Only a few products are sold at the national and even international markets (van Dijk, 1999).

The primary objective of the LUT “Collection of NTFPs” is sustainable extraction of NTFPs by local people for subsistence and cash revenues. In addition, it is recognised that the forest vegetation plays an important role in the cultural perception of the communities in the TCP research area.

The sustainable extraction of NTFPs ensures the continued presence of forest near human settlements. In addition to the tangible benefits, the major non-tangible benefit is the wellbeing of these forest dwelling communities, which depend on the forest to maintain their livelihood strategy as well as their culture.

Because of the low intensity of extraction and the wide array of species involved, this LUT also contributes to conservation of genetic variation and habitat protection of endangered species, erosion control and watershed protection, and regulation and maintenance of ecological, physical and chemical processes and cycles. The low extraction level is an absolute condition for this LUT.

7.1.3. LUT Production of timber in natural forest

Timber is economically an important product for Cameroon. The annual production is estimated at 2.8 million cubic meters which represents 20% of Cameroon’s export revenues and provides direct employment of 33 000 persons. Timber harvesting contributes about 6.7% of the Gross National Product (GNP) based on the statistics of 1995/96 fiscal year (Eba’a Atyi, 1998). The forests provide timber for the local and export market.
Approximately 55% of the timber is processed in Cameroon. Although most forests in the TCP area have been logged-over several times, they still hold a considerable potential for timber production.

The production of timber in natural forest, as described in this LUT, covers the exploitation as well as the regeneration period of the forests. The management is aimed at both presently traded timber species and species that provide timber with good technical properties but are at present lesser known on the national and international markets.

Depending on species composition and diameter distribution, the production of timber in natural forest stands may involve silvicultural treatments like enrichment plantings and liberation thinning. The main basis of the silvicultural system, however, is natural regeneration. To ensure the functioning of the forest ecosystem, parts of the timber production forest are to be excluded from all silvicultural interventions. The vegetation cover of the timber production forest is permanent. The physiognomy and species composition resembles a natural forest and therefore the timber production forest provides a suitable habitat for many forest species. In combination with strictly protected areas, the timber production forest can contribute considerably to conservation of biodiversity and habitat protection of endangered species.

The permanent forest cover of the production forest contributes to regulation and maintenance of many ecological, physical and chemical processes and cycles (e.g. microclimate, hydrological and nutrient cycles, oxygen-carbon dioxide balance, and protection against erosion).

The primary objective of the LUT “Production of timber in natural forest” is sustainable production of timber for the national and export markets. Timber production will take place in a polycyclic silvicultural system with a felling cycle of at least 25 years. Logging activities are concentrated on timber species already being exploited in West Africa and a number of lesser-known but technically good timber species.

Sites vulnerable to erosion and along watercourses are excluded from harvesting. Timber harvest and extraction should be based upon reduced impact logging methods, and should be integrated in the silvicultural management of the stands. This means that attention should be focused on the remaining stand, not only on the harvested trees. Other conservation measures are focussed at habitat protection of endangered and keystone species (hunting may be restricted or forbidden), and the protection of the timber production estate to illegal incursions of shifting cultivation and plantation agriculture.

The effectiveness of the management for the sustainable production of timber and the impact of secondary uses thereupon is measured by monitoring the species composition of the forest (flora and fauna) and diameter distribution of timber species.

7.1.4. LUT Shifting cultivation

The system of shifting cultivation is adapted to the local environment and can be a sustainable land use option. Problems may, however, arise when changes occur in the socio-economic environment. The LUT shifting cultivation, as treated in the Lu1 land evaluation study, therefore distinguishes two types. The first type is adapted to low population pressure. This type is similar to the shifting cultivation systems in use in the TCP region. The second type is adapted to a situation in which the fallow periods are shortened due to increased pressure on land. The adaptations made are to compensate the negative influences of the shortened fallow period and to safeguard the physical sustainability of the system. With increasing pressure on the land available for shifting cultivation (access to land is limited by the customary rights; population pressure is increasing; technology level may improve) the fallow period becomes shorter and may in the end disappear at all. This land use type corresponds with the *Chromolaena* fallow type of shifting cultivation whereby the fallow time is 3 to 5 years. At the end of the fallow period the land is covered with bush, dominated by *Chromolaena odorata*. At this stage, more research on the *Chromolaena* fallow is needed to estimate the sustainability of this system. In the P-MMP, only one shifting cultivation type is considered, the forest/bush fallow type.

In large parts of the Tropenbos-Cameroon Programme research site, the pressure on land is low. Remote sensing materials from the 1984 and 1996 and field observations indicate that shifting cultivation has been confined to more or less the same zone. The shifting cultivation system in these areas is characterised by forest fallow (>15 years) or bush fallow (7-9 years) (pers. comm. M. Yemefack).

The primary objective of the LUT “Shifting cultivation with forest/bush fallow” is the sustainable production of agricultural crops by the local population. In general, (old) secondary forest is cleared for cultivating ngôn (*Cucumeropsis mannii*), cassava (*Manihot esculenta*), macabo (*Xanthosoma sagittifolium*), groundnut (*Arachis hypogea*), and plantain (*Musa spp.*). Crops are cultivated for approximately two years after which the tending gradually stops. The fallow period is meant to restore the nutrient balance of the soil through the regeneration of forest vegetation. The agricultural produce is for subsistence and cash revenues from local markets.

Clearing (felling, burning) of a forest fallow or a bush fallow is traditionally done by men, using axes and machetes. Occasionally chain saws are hired. Clearing a forest fallow takes more time than clearing a bush fallow.

7.1.5. LUT Plantation agriculture

The traditional plantation crop in the TCP area is cacao (*Theobroma cacao*), which is grown next to food crops. Recently, oil palm plantations (*Elaeis guineensis*) have been established by *élites* and there seems to be a tendency that the area under oil palm is expanding. Other plantation crops planted in monoculture in the area, although only in few places, are pineapple (*Ananas comosus*), and Hevea (*Hevea brasiliensis*).

The objective of plantation agriculture is to earn revenues from the sale of products. Another objective is to get a permanent (ownership) claim on the land.

7.2. LAND USE REQUIREMENTS

Land Use Requirements (LURs) are necessary or desirable conditions of the land for the successful and sustained practice of a given LUT. For a more detailed description of the LURs, one can refer to Hazeu *et al*. (2000).

Three categories of requirements are distinguished (FAO, 1984; Touber *et al.*, 1989):

- Growth requirements refer to the land conditions necessary for survival and growth of the goods that concern the LUT; crops for shifting cultivation, trees for timber production or habitat quality for protection of fauna;
- Management requirements are the conditions necessary or desirable for successful management of the defined land use;
- Conservation requirements refer to the preservation of resources and natural values. They refer to the effects of management activities on soils, hydrology, and vegetation. Also the relative need for conservation, i.e. the adverse effects that would result if no protective measures were taken, is included in this category.

An overview of the land use requirements and their importance for the various land utilisation types of the land evaluation study (Hazeu *et al.*, 2000) is presented in Table 7.1.

7.2.1. Requirements related to growth

Growth requirements considered relevant for land evaluation are drainage condition, soil depth, nutrient availability, and tree species and total species composition. The availability of moisture is not included as a separate limiting factor, as the climate is such that sufficient moisture is virtually always available. For similar reasons, toxicity and salinity are not included.

The LUR **Drainage condition** is important for the availability of oxygen and moisture to plants. In the TCP area, lower topographical positions (valley bottoms) have imperfectly to very poorly drained soils, whereas on the slopes soils are well to moderately well drained.
Drainage is an important LUR to take in consideration for the LUTs shifting cultivation and plantation agriculture.

Table 7.1: Relative importance of Land Use Requirements (LURs) for Land Utilisation Types (LUTs) in the TCP area (adapted from Hazeu *et al*., 2000).

Land Use Requirements (LURs)	**Land Utilisation Types (LUTs)**				
	Biodiversity conservation	NTFP extraction	Timber production	Shifting cultivation	Plantation agriculture
(1) related to growth					
Drainage condition	-	-	+	++	++
Soil depth	-	-	+	++	++
Nutrient availability	-	-	+	++	++
Timber species	-	+	++	-	-
Non-timber forest products	-	++	-	-	-
Habitat quality	++	++	-	-	-
(2) related to management					
Workability	-	-	+	++	++
Terrain condition	-	+	++	+	++
Size of management unit	+	+	++	-	++
Accessibility	-	+	+	++	++
(3) related to conservation					
Tolerance to soil erosion	-	-	++	++	++
Diversity, rareness and uniqueness of flora	++	-	-	-	-
Diversity and rareness of fauna	++	+	-	-	-

- = not important; + = important; ++ = very important

The LUR **Soil depth** is expressed as the rootable depth whereby the percentage gravel or stones in the soil is taken into consideration (Touber *et al.*, 1989). The soil depth determines the soil volume available for roots for water extraction and nutrient uptake.
This land use requirement is relevant for the LUTs shifting cultivation and plantation agriculture.

Nutrient availability is mainly determined by pH, Cation Exchange Capacity (CEC), base saturation (BS) and organic matter content (OM). Low values of these characteristics indicate low soil fertility. The organic matter content of the topsoil is one of the most important characteristics determining the fertility of soils in the humid tropics.

The LUR nutrient availability is important for the LUTs shifting cultivation and plantation agriculture. The shifting cultivation cropping system is adapted to the low inherent soil fertility. In light of intensification of agriculture as a result of increasing population or demands for agricultural produce, nutrient availability becomes more important. It can, however, be influenced by management practices.

The LUR **timber species** refers to the potential of land to produce timber. It is expressed by abundance of specific timber species, growth rates, and predicted yields. Both potential timber production, for instance in young plantations and logged-over forests, or actual timber yields, like mature plantations and natural forest stands, are assessed.
The LUR timber species is important for the LUT production of timber in natural forest and for NTFP collection.

The LUR **non-timber forest products** (NTFPs) refers to the abundance and diversity of non-timber forest commodities (both of vegetal and animal origin). Again both actual and potential yields are to be assessed. The actual suitability is strongly influenced by land use history.
The requirement is relevant for the LUT extraction of NTFPs by local population. It may also serve as secondary objective in the LUTs production of timber in natural forest and shifting cultivation.

The LUR **habitat quality for flora and fauna species** refers to the availability of food, water, and resting-places, and the distance to human settlements and activities. Habitat quality in the land evaluation study (Hazeu *et al*., 2000) is estimated on the basis of the requirements of large

mammals. This group of species has low population densities and large home ranges and safeguarding their needs is assumed to cover the habitat requirements of many (smaller) forest dependant species. Gorilla (*Gorilla gorilla*), chimpanzee (*Pan troglodytes*), mandrill (*Papio sphinx*), and collared mangabee (*Cercocebus torquatus*) are used as such ‘umbrella’ species.
The LUR habitat quality is especially important for the LUTs protection of biodiversity and extraction of NTFPs by the local population.

7.2.2. Requirements related to management

Management requirements considered relevant in the land evaluation study are workability, terrain conditions, size of potential management unit, and accessibility.

The LUR **Workability** refers to the texture, drainage, structure, and consistence of the soil. Workability expresses the ease to work the land and the suitability to cultivate certain crop types, e.g. tubers. In the TCP region, only soil texture varies significantly and the workability in the study is therefore based on this parameter.
This requirement is especially relevant for the LUTs shifting cultivation and plantation agriculture.

The LUR **terrain condition** reflects the suitability of the land for mechanised operations. It is valued by the absence of steep slopes, swampy areas and rock outcrops.
This requirement is especially important for the LUTs production of timber in natural forest and plantation agriculture. For shifting cultivation and extraction of NTFPs by local population the terrain conditions play a role as well.

The LUR **size of management unit** is defined by surface area needed for ‘economic’ management of a LUT. In land uses with mainly production-oriented objectives, the size of the management unit is primarily based on an economic optimisation of the management system. For conservation purposes, the management unit should be sufficiently large to support viable populations of species. The viability of populations depends on the genetic diversity within the population, and the availability of sufficient food, water, and resting places in the management unit. Horizontal relationships in the landscape are important in this respect.

The LUR **Accessibility** of the land is an important management requirement. It is determined by the possibilities for linkage with the present road network. Also the distance to (potential) markets is included.
The LUR accessibility is relevant for the LUTs protection of biodiversity, NTFP collection by local population, shifting cultivation and small scale plantation agriculture. For the LUTs production of timber in natural forest and most forms of large-scale plantation agriculture, the distance to existing roads and markets is only of limited importance as roads can be constructed by the timber or agricultural enterprise and more heavy means of transport are available.

7.2.3. Requirements related to conservation

Conservation requirements considered relevant in the land evaluation study are tolerance to soil erosion, and diversity and uniqueness of flora and fauna.

The LUR **Tolerance to soil erosion** refers to the texture, slope, susceptibility to surface sealing and crusting, and land cover.
The land use requirement tolerance to erosion is relevant for the land utilisation types production of timber in natural forest, shifting cultivation and plantation agriculture.

The LUR **Diversity and uniqueness of flora and fauna** defines the need for conservation. The actual species composition reflects the relative importance of an area with respect to conservation of biodiversity. For endangered species, animal species with large home range and flora species with a small 'home' range, the potential of land as a suitable habitat is also evaluated.

This LUR is especially important for the LUT protection of biodiversity. In addition the LUTs production of timber in natural forest and NTFP extraction by local population can contribute to conservation of biodiversity.

7.3. LAND QUALITIES

Land Quality (LQ) is defined as ″complex attribute of land, which acts in a manner distinct from the actions of other land qualities in its influence on the suitability of land for a specific kind of use″ (FAO, 1976). For a more detailed description of the LQs than the one given below, one can refer to Hazeu *et al*. (2000).

The same three categories as the ones used for LURs are determined:

- Land qualities related to growth;
- Land qualities related to management;
- Land qualities related to conservation.

The classification of the land qualities per LMU is summarised in Table 7.2.

Table 7.2. Classification of land qualities related to growth, management and conservation for the various land mapping units (LMU). Source: Hazeu *et al*. (2000).

LMU	Land Qualities																			
	DR	SD	CF (a)	CF (b)	pH	CE	BS	OC	TI (a)	TI (b)	NT (a)	NT (b)	DI	RP	FP	LD	DS	RS	TX	SL	SW
Am (u)	1	1-2	1	1-2	3-4	1-2	4	1-3	4	3	3	2	1	1	3	4	1	2	4	4	1
Ah1 (u)	1	1-2	1	1-2	3-4	1-2	4	1-3	4	3	3	2	1	1	3	4	1	2	4	4	1
Bh1 (u)	1	1-2	1	1-2	3-4	1-2	4	1-3	1	1	1	1	1	1	1	4	1	2	4	4	1
Bh1 (l)	1	1-2	1	1-2	3-4	1-2	4	1-3	2	2	1	1	1	2	2	2	2	2	4	4	1
Bh2 (u)	1	1-2	1	1-2	3-4	1-2	4	1-3	1	1	1	1	1	1	1	4	1	2	4	3-4	1
Bh2 (l)	1	1-2	1	1-2	3-4	1-2	4	1-3	2	2	1	1	1	2	2	2	2	2	4	3-4	1
Bh2 (h)	1	1-2	1	1-2	3-4	1-2	4	1-3	4	4	1	2	2	3	3	2	3	2	4	3-4	1
Bu2 (u)	1	1-2	1	1-2	2-4	1-2	2-4	1-3	1	1	1	1	1	1	1	4	1	4	2-4	2-3	2
Bu2 (l)	1	1-2	1	1-2	2-4	1-2	2-4	1-3	2	2	1	1	1	2	2	2	2	4	2-4	2-3	2
Bu2 (h)	1	1-2	1	1-2	2-4	1-2	2-4	1-3	4	4	1	2	2	3	3	2	3	4	2-4	2-3	2
Bu1 (u)	2	1-3	1	1-5	1-4	1-2	2-4	1-4	2	1	1	1	1	1	1	3	1	4	2-4	2-3	3
Bu1 (l)	2	1-3	1	1-5	1-4	1-2	2-4	1-4	3	2	1	2	2	2	2	1	2	4	2-4	2-3	3
Bu1 (h)	2	1-3	1	1-5	1-4	1-2	2-4	1-4	3	3	1	2	2	3	3	1	3	4	2-4	2-3	3
Ch1 (u)	1	1-2	1	2	2-4	1	2-4	2-3	1	1	3	1	1	1	1	4	1	1	2-3	4	1
Ch1 (l)	1	1-2	1	2	2-4	1	2-4	2-3	2	2	2	1	1	2	2	2	2	1	2-3	4	1
Cu2 (u)	1	1-2	1	2	2-4	1	2-4	2-3	1	1	3	1	1	1	1	4	1	3	2-3	2-3	2
Cu2 (l)	1	1-2	1	2	2-4	1	2-4	2-3	2	2	2	1	1	2	2	2	2	3	2-3	2-3	2
Cu2 (h)	1	1-2	1	2	2-4	1	2-4	2-3	4	4	1	2	2	3	3	2	3	3	2-3	2-3	2
Cu1 (u)	2	1-3	1	2-5	1-4	1-2	2-4	2-4	2	1	3	1	1	1	1	3	1	3	2-3	2-3	3
Cu1 (l)	2	1-3	1	2-5	1-4	1-2	2-4	2-4	3	2	2	2	2	2	2	1	2	3	2-3	2-3	3
Cu1 (h)	2	1-3	1	2-5	1-4	1-2	2-4	2-4	4	3	1	2	2	3	3	1	3	3	2-3	2-3	3
Dh1 (u)	3	1-3	1-2	2-4	1-4	1-3	1-4	2-4	3	1	2	1	1	1	2	4	2	1	1-3	4	1
Dh1 (l)	3	1-3	1-2	2-4	1-4	1-3	1-4	2-4	3	2	2	1	1	2	2	2	3	1	1-3	4	1
Du2 (u)	3	1-3	2	3-4	1	2-3	1	4	3	1	2	1	1	1	2	4	2	3	1-2	2-3	2
Du2 (l)	3	1-3	2	3-4	1	2-3	1	4	3	2	2	1	1	2	2	2	3	3	1-2	2-3	2
Du2 (h)	3	1-3	2	3-4	1	2-3	1	4	4	4	1	2	2	3	3	2	3	3	1-2	2-3	2
Du1 (u)	4	1-3	1-2	2-5	1	1-3	1-4	3-4	3	1	2	1	1	1	2	3	2	3	1-3	2-3	3
Du1 (l)	4	1-3	1-2	2-5	1	1-3	1-4	3-4	4	2	2	2	2	2	2	1	3	3	1-3	2-3	3
Du1 (h)	4	1-3	1-2	2-5	1	1-3	1-4	3-4	4	3	1	2	2	3	3	1	3	3	1-3	2-3	3
Dpd (u)	4	1-3	1-2	2-5	1	1-3	1-4	3-4	3	1	2	1	1	1	2	3	2	3	1-3	1-2	3
Dpd (l)	4	1-3	1-2	2-5	1	1-3	1-4	3-4	4	2	2	2	2	2	2	1	3	3	1-3	1-2	3
Dpd (h)	4	1-3	1-2	2-5	1	1-3	1-4	3-4	4	3	1	2	2	3	3	1	3	3	1-3	1-2	3
Ev (u)	5	1-3	1	2-5	1	1-2	2-4	3-4	4	1	2	2	2	1	2	4	2	3	2-3	1	4
Ev (l)	5	1-3	1	2-5	1	1-2	2-4	3-4	4	2	2	2	2	2	2	2	3	3	2-3	1	4

DR: Drainage condition. 1: well; 2: well, incl. 10-20% (very) poorly; 3: moderately well; 4: moderately well, incl. 10-20% (very) poorly; 5: poorly to very poorly.

SD: Effective soil depth. 1: very deep (> 150 cm); 2: deep (100–150 cm); 3: moderately deep (50–100 cm); 4: shallow (25-50 cm); 5: very shallow (0 – 25 cm).

CF: Coarse fragment content (a) 0-25 cm; (b) 25: 100 cm. 1: very low (0-3%); 2: low (3–15%); 3: moderately high (15-35%); 4: high (35-55%); 5: very high (> 55%).

pH: Soil pH . 1: high (5-6.5); moderately high (4.5-5.5); 3: low (4-4.5); 4: very low (< 4).

CE: Cation exchange capacity (0-25 cm). 1: high (>12 meq/100g clay); moderately high (8-12 meq/100g clay); 3: low (4-8 meq/100g clay); 4: very low (< 4 meq/100g clay).

BS: Base saturation (0-25 cm). 1: high (50-100%); moderately high (35-50%); 3: low (20-35%);4: very low (<20%).

OC: Organic carbon content (0-25 cm). 1: high (> 8% C); moderately high (6-8% C); 3: low (4-6% C); 4: very low (2-4% C).

TI: Availability of timber species (a) superior grade only, (b) superior to low grade. 1: high; 2: moderately high; 3: low; 4: very low (relative scaling).

NT: Availability of non-timber forest products. (a) most important species only; (b) all species; 1: high; 2: moderately high; 3: low; 4: very low (relative scaling).
DI: Average species diversity of vegetation types. 1: high; 2: moderately high; 3: low; 4: very low (relative scaling).
RP: Occurrence of rare plant species. 1: high; 2: moderately high; 3: low; 4: very low (relative scaling).
FP: Availability of food plants for wildlife (based on data for gorilla, mandrill, chimpanzee and collared mangabey). 1: high; 2: moderately high; 3: low; 4: very low (relative scaling).
LD: Landscape diversity (based on the number of vegetation types per LMU). 1: high (N = 4); 2: moderately high (N = 3); 3: low (N = 2); 4: very low (N = 1).
DS: Disturbance (based on ecological spectra of vegetation types). 1: low; 2: moderately low; 3: high; 4: very high (relative scaling).
RS: Availability of resting-places (based on data for gorilla, mandrill, chimpanzee and collared mangabey). 1: high; 2: moderately high; 3: low; 4: very low (relative scaling).
TX: Texture (0-25 cm): 1: sand; 2: loamy sand, sandy loam, loam; 3: sandy clay loam, sandy clay; 4: clay loam, clay and heavy clay.
SL: Slope: 1: < 8%; 2: 8-16%; 3: 16-30%; 4: >30%.
SW: Swamps: 1: < 5%; 2: 5-10%; 3: 10–20%; 4: > 20%.

7.3.1. Land qualities related to growth

The soil **drainage condition** reflects the combined effects of climate, landscape and soil. Drainage class is determined by internal and external drainage, rainfall, seepage, and soil permeability and surface infiltration rate. The drainage condition, which is in fact a composite land characteristic, determines the oxygen and moisture availability. Concerning the TCP research area, Nyangong and Ebom soils are well drained, Ebimimbang soils well to moderately well drained soils and Valley bottoms are poorly to very poorly drained soils.

The LQ **Rooting conditions** is influenced by two land characteristics: effective soil depth and the percentage of coarse fragments at the surface or in the soil profile. These two characteristics vary according to the LMUs present in the TCP research area.

The LQ **Nutrient availability** is determined by four land characteristics: pH, Cation Exchange Capacity (CEC), base saturation and organic content.

The LQ **Timber species** is determined by the number of valuable timber species in an area, the frequency of occurrence and the diameters of these species, and the predicted growth rates and yields. Availability of superior grade timber is high in primary and old secondary forest of ecological zones B and C, and very low in the mountain forests, swamp forests and the primary and old secondary forest of ecological zone D.

The LQ **Non-timber forest products** refers to all products, which are gathered in the forest except timber and hunted animals. Availability of NTFPs is high in the primary and secondary forests of ecological zone B and in the young secondary forests and moderately high in the swamp forests.

For the LQ **Biodiversity (flora)** two aspects are taken into consideration: species diversity and occurrence of rare species. Species numbers are highest in the primary and old secondary forests of ecological zones B and C, and in the younger secondary forests of vegetation type IV. Rareness reflects the geographical distribution of the species encountered.

Various species of **food plants for wildlife** (gorilla, mandrill, chimpanzee and collared mangabey) per vegetation type were weighed according to their frequency class.

The LQ **Habitat quality** implies the degree of disturbance estimated per vegetation type. The land characteristics related to habitat quality are relevant for the LUTs non-timber forest products, conservation of flora and conservation of wildlife. Habitat quality for fauna implies three land qualities (species specific): availability of drinking water, availability of resting places and acceptable distance from human activities.

7.3.2. Land qualities related to management

The **workability** land quality expresses the ease of tillage, which is influenced only by the land characteristic texture in the TCP research area.

The LQ **Terrain conditions,** indicating the accessibility and the potential of an area for mechanised operations, is determined by the characteristics: slope percentage, percentages of areas covered with swamp or rock outcrops.

7.3.3. Land qualities related to conservation

The LQ **Resistance to erosion** is determined by a relatively large number of land characteristics, such as topsoil texture and structure, slope percentage (the most important one for the TCP area), slope length, land cover, and susceptibility to surface sealing and crusting.

7.4. LAND SUITABILITY

The suitability of a given area (LMU) for a given LUT is determined by matching the LUR of that LMU with the LQ of the LUT. Ad-hoc classifications systems have been defined, for the main LUTs of the TCP research area, giving a suitability value per LMU. For a more detailed description of suitability classifications than the one given below, one can refer to Hazeu *et al.* (2000). For each of the following LUTs, the classification ratings per LMU are presented in Annex IV and the suitability maps illustrating their distribution are presented in the cartographic annex:

- Conservation of biodiversity:
  - Flora conservation (Map 8);
  - Fauna conservation (Map 9);
- NTFP (Map 10);
- Timber production in natural forests (Map 11);
- Shifting cultivation (Map 12);
- Plantation agriculture:
  - Cacao (Map 13);
  - Pineapple (Map 14);
  - Oil palm (Map 15);
  - Hevea (Map 16).

7.4.1. Conservation of biodiversity

The LUT Conservation of biodiversity is subdivided into two subtypes: flora/vegetation and fauna. These two subtypes are presented separately because combining flora and fauna would imply a considerable loss of information. Moreover, the results of the land evaluation procedure for flora/vegetation and fauna are not simply comparable, since the faunistic data are, unlike the vegetation data, not based on an extensive field survey.

For both subtypes, the requirements are listed below. These requirements are in fact criteria, which are used to assess the conservation value of the mapping units discerned. In this context, conservation value means priority (suitability) of land to be set aside as protection forest. The value of conservation of both subtypes is considerably influenced by the disturbance of human activities (mainly shifting cultivation). High disturbance corresponds to low conservation value.

<u>Flora/vegetation</u>

Three criteria (requirements) are used:

1 Integrity/disturbance;
2 Occurrence of endemic species;
3 Species diversity.

Most map units consist of a mosaic of vegetation types. In order to assess the botanical value ('suitability') per map unit (which is an essential step in land evaluation) extrapolation from vegetation types to map units is necessary. A mere weighting of values according to area is however not desirable, since the presence of relative small remnant of high-value primary forest should be appreciated quite different from a low value area with no relicts at all. On the other hand, a small enclave of disturbed low-value vegetation in an area containing mainly high-value primary forest should not alter the overall value of the map unit dramatically. For a more detailed description, one can refer to Hazeu *et al*. (2000)
Most (70%) of the TCP research area is suitable for flora conservation. The zones disturbed by shifting cultivation are moderately and marginally suitable. No part of the TCP area is unsuitable for Flora conservation.

<u>Fauna</u>
The LUR **diversity and rareness** of fauna is estimated on the basis of surveys conducted in the TCP area (Bekhuis, 1997; van Gemerden and Hazeu, 1999; van Dijk, 1999). Non of these surveys entailed a systematic assessment of the faunistic diversity.
The suitability for fauna conservation is based on a combination of the suitability for Gorilla, Chimpanzee, Mandrill and Collared Mangabey. The **distance to human habitats**, in this case villages, is an additional factor. Based on Bekhuis (1997), it has been concluded that areas within 3 km from a village are not suitable for fauna conservation, as the human interference is high. The suitability along roads (main roads only) was downgraded with one class within a distance of three kilometres by Hazeu *et al*. (2000). In the P-MMP, however, all land within 3 km from main roads and villages is considered not suitable.

The **size of the management unit** is to be sufficient to support viable populations of both plant and animal species. The estimation of the required size of the management unit is based on large mammals. Literature gives sizes of 10 to 40 km^2 for the home range of gorilla. In this case, the range of 25 km^2 was used.

The **accessibility** of land units is strictly speaking not relevant in the biophysical land evaluation. Clear forest legislation and strict control should preserve protected areas from illegal incursions. The success of conservation of biodiversity is, however, much more likely if the land units are located at some distance from human settlements and shifting cultivation areas. Ranges of three kilometres have been used.

Only the hills far from roads are considered suitable for fauna conservation (about 5% of the TCP area). Most of the area (62%) is marginally suitable or not suitable.

7.4.2. NTFPs
The suitability of land units for extraction of NTFPs by the local population is based on the LURs:
- Non-timber forest products;
- Diversity in species;
- Terrain conditions;
- Size of the management unit and accessibility.

Most of the TCP area (75%) is suitable for collection of a broad selection of NTFP species, including less frequent and lesser-known ones. There are no unsuitable areas, and only the mountains are considered marginally suitable.

7.4.3. Timber production in natural forest
The suitability of timber exploitation is related to the abundance and growth of timber species.

The **terrain conditions** reflect the suitability of the land to support mechanised timber operations. It is valued by the absence of steep slopes and swampy areas.

The **size of management unit** depends on the growth, stock, and productivity of the forest. MINEF (1998a) suggests that a Forest Management Unit (FMU) should be between 15 000 and 200 000 ha. Related to sustainable forest management criteria and the supplying needs of an industrial plant, it is assumed that the management unit (or part of a multi forest complex) should have an area of at least 65 000 ha[6].

Tolerance to soil erosion depends on soil types, landform. The suitability value will increase on well drained soils and decrease with the steepness of the slope.

Ecological zone A, hills of ecological zones B, C and D and valley bottoms, representing 34% of the TCP area, are not suitable for timber exploitation due to unfavourable terrain conditions. The rest of the area is considered moderately to marginally suitable due to both the extent of agricultural activities and long logging history, which has resulted in a depletion of the resource.
This low actual potential for timber exploitation comes from the lack of good quality standing trees but the situation could improve under good management conditions.

7.4.4. Shifting cultivation

Land suitability depends on the LUT proposed. Furthermore in case of cultivation the land suitability will depend on the types of crops. Usually mixed cropping systems are used. In this case the land suitability for shifting cultivation using traditional technology comes from a combination of requirements of the crops: banana, maize, groundnuts, cassava and macabo.

The predominant requirements for shifting cultivation are related to soil and terrain conditions:

- Drainage;
- Soil depth;
- Soil texture;
- Nutrient availability;
- Slope steepness;
- Accessibility.

In the TCP area, rooting conditions have some limitations in Ebimimbang soils.
Land that is more remote than 5 km from a road is considered to be unsuitable for cultivation.

About two-third of the area is considered moderately to marginally suitable. The zones located further than five km from the roads and the top of hills and mountains, approximately one third of the area, are considered unsuitable.

7.4.5. Agriculture plantation

The requirements for shifting cultivation are also important for agriculture plantation. In addition, workability, terrain condition and size of management unit are important requirements. The four agriculture plantations considered here are cacao, oil palm, pineapple, and rubber (Hevea).

The most limiting condition is slope steepness particularly for pineapple because of erosion hazard.

The poor and very poor drainage conditions of the valley bottoms are a limiting factor and therefore unsuitable for the plantations. Soil depth and drainage conditions of Ebimimbang soil

[6] It is assumed that it is necessary to have a yearly logging area of at least 2 500 ha to make logging operation and industrial processing profitable. If a minimum rotation period of 25 year is adopted, the minimum management unit area is 62 500 ha.

are slightly limiting for cacao. Ebimimbang soils that are not deeper than 100 cm are also slightly limiting for oil palm. Nyangong soils are too acid for pineapple cultivation.

The suitability maps of Hevea, oil palm, and cocoa plantations show, that a large percentage (75%) is moderately suitable and marginally suitable for these crops. The distance from the cultivated area to the transformation unit for Hevea and palm oil might be a limiting factor.

8. MESO-ZONING LAND ALLOCATION

8.1. ZONING PLAN OF SOUTH CAMEROON

In 1993, MINEF and CIDA elaborated a land allocation plan (*Plan de zonage,* Côté, 1993) for the southern part of Cameroon, which is covered by tropical humid forest. This plan resulted in the delimitation of the rural land and the permanent forest estate, illustrated by maps at 1:200 000 scale. It is manifest that this Zoning Plan is a framework, proposing optimum options of land use that have to be converted in definite proposals such as the classification of permanent forest. It also means that it is indicative and can be modified or improved according to the scale or level of information used for a given area. The boundaries of various permanent forest types shall be defined after consultation with the population (Decree 95-678-PM of 18 December; Republic of Cameroon, 1995b).

The TCP research area is entirely included in the Zoning Plan[7] with the following allocations:

- Permanent forest estate (to be classified);
  - Production forests 12 435 ha or 7% of the area;
  - Protection forests 37 650 ha or 23% of the area;
  - Council forests 16 943 ha or 10% of the area;
- Non-permanent forest estate
  - Human occupancy (habitation, shifting cultivation, industrial cultivation, agro-forestry, community forests, non permanent forests…) 100 325 ha or 60% of the area.

These allocations are shown on Map 17: Zoning Plan, of the cartographic annex.

8.2. MESO ZONING

The five LUTs exposed in Section 7.1 are the main ones encountered in the TCP area. In addition to those five main ones, nine actual or potential LUTs have also been considered, leading to a total of fourteen land-use types:

1 Biodiversity conservation;
2 Fauna conservation;
3 Timber exploitation;
4a NTFP exploitation;
4b Hunting[8];
5 Shifting cultivation;
6 Agriculture plantation;
7 Tree plantation;
8 Community forest;
9 Tourism, recreation;
10 Research and teaching;
11 Sacred places;
12 Human habitation;
13 Industrial plant;
14 Mining.

In practice, several kinds of land use occur often together on the same tract of land. For instance, land allocated to shifting cultivation is partially, and at the same time, used for hunting and gathering. This is especially true for the fallow land where the vegetation is regenerating. On the other hand, land allocated to plantation agriculture, timber production forest and

[7] Throughout this publication, the term Zoning Plan refers to the *Plan de zonage* (Côté, 1993).
[8] Even though hunting is considered as part of NTFP exploitation, it is preferred to make a distinction since hunting might require different management recommendations.

protection forest cannot be used for shifting cultivation. Van Berkum (1996) has made a study on the possible combinations of actual or potential LUTs and developed the designation of combined land use type (CLUT). The concept of land allocation type (LAT) seems more appropriate to designate the "multiple use areas" and facilitates their delineation, on maps or in the field. For the purpose of the P-MMP, a meso-zoning of the TCP area is proposed characterised by six land allocations types designed as following:

1 Ecological fragile sites (EFS);
2 Integral ecological reserve (IER);
3 Teaching and research forest (TRF);
4 Agro-forestry (AGF);
5 Production forest (PDF);
6 Protection forest (PTF).

These LATs can be delineated (meso-zoning) on maps. Each LAT has a prevalent management objective; conservation, protection, timber production etc. The six LATs will be described in the following sections. Inside the different meso-zones, a combination of LUTs is possible. Table 8.1 gives the possibilities of practising or implementing a given LUT inside a LAT. Three levels are considered:

1 Permitted; no special restriction;
2 Allowed under special conditions; this means that the intensity of exploitation has to be controlled or that a particular product or species should not be exploited;
3 Prohibited; the LUT cannot be implemented in the LAT.

Table 8.1 Allowability of Land Utilisation Types inside Land Allocation Types.

Land Utilisation Type	**Land Allocation Type**					
	Ecological fragile site	**Integral Ecological reserve**	**Teaching and research forest**	**Agro-forestry**	**Production forest**	**Protection forest**
Biodiversity conservation	1	1	1	1	1	1
Fauna conservation	1	1	1	1	1	1
Timber exploitation	3	3	3	1	1	3
NTFP exploitation	2	3	2	1	1[a]	2
Hunting	2	3	2	1	1[a]	2[b]
Shifting cultivation	3	3	3	1	3	3
Agriculture plantation	3	3	3	1	3	3
Tree plantation	3	3	2	1	1	3
Tourism recreation	2	3	2	1	1[a]	2
Community forest	3	3	3	1	3	3
Research and teaching	1	1	1	1	1	1
Sacred places	2	2	1	1	1[c]	1
Human habitation	3	3	3	1	3	3
Industrial plantations	3	3	3	1	3	3
Mining	3	3	3	1	2	3

1: permitted; 2: allowed under special conditions; 3: prohibited

a: prohibited during logging period for security reasons; b: prohibited where fauna conservation is the priority; c: sacred places should be localised and identified inside production forests so that they can be isolated from exploitation

Meso-zoning aims at identifying the most appropriate future use for each part of the TCP area by dividing the area in LATs. It takes account of the land suitability, for given LUTs, the propositions of the Zoning Plan and also the needs and requests of the stakeholders. During the meso-zoning process, priority is given to the sites or LMUs where only one unique LUT is possible, such as ecological fragile sites, and to the need to secure sufficient agriculture lands for the inhabitants. The remaining areas can support in most cases several LUTs or different LATs. This means that different options of management of the TCP area can be proposed. Instead of choosing unilaterally only one "scientifically based" land allocation plan, this P-MMP proposes different scenarios, which are presented in Chapter 9. The stakeholders will have the possibility to discuss the relative importance given to each one of them.

8.3. LAND ALLOCATION TYPES

Allocations 2 (IER), 3 (TRF), 5 (PDF) and 6 (PTF) are to be classified in the permanent forest estate and require management plans. Allocation 4 (AGF) is part of the non-permanent estate. Village management plans (*plan de gestion de terroir*) could be elaborated for every village.

It is considered that the level of information available does not permit to delineate recreational forests in specific sectors. The kind of tourism or recreation to promote in the area still has to be defined with the stakeholders. Tourism can then be proposed in favourable LATs with the objective of defining subsequently what can be done where.

There is no mining envisaged in TCP area at this stage, but it could take place in the future. Mining should take place outside the protected zones and should respect strict environmental protection rules.

Community forest should in fact be considered as a LAT but once again the level of detail at this moment is not sufficient to indicate where they could be located inside the non-permanent forest estate.

The purpose of considering industry or human habitations as LUTs is to stress that they should be located only in the agro-forestry zone.

8.3.1. LAT Ecological fragile sites

The mountains (Ah1), isolated hills (Am, Bh1, Ch1, Dh1) and also the valley bottoms (Ev) are critical zones susceptible to degradation if the soil or vegetation cover is disturbed. They should be protected against all intensive type of exploitation such as timber exploitation, shifting cultivation or agriculture plantation, which disturb the soil or vegetation. It is often difficult to classify them as ecological reserve or protection forest because they are often small in size and dispersed throughout the TCP area. They should be highlighted on the maps as ecological fragile sites where all intensive resource exploitation should be forbidden. Research is permitted and NTFP exploitation, hunting and sacred forest are acceptable as long as these do not disturb the natural habitat.

8.3.2. LAT Integral ecological reserve

An integral ecological reserve is "*an area where all types of resources enjoy complete protection with a view to preserving it wholly in its climatic condition. Any activity by man therein shall be strictly prohibited. However, the services in charge of forestry may authorise the execution of scientific research projects therein insofar as such projects do not perturb the ecosystem equilibrium*". Decree N° 95-531-PM of 23 August 1995; 3.(1) (Republic of Cameroon, 1995a)

There is a tendency to regard all and only the areas that are inaccessible or inappropriate for any other uses, as integral ecological reserve. It is important to protect all fragile and particular ecosystems, even if they are not always the best representatives of the biodiversity. Other ecological units, primarily contemplated for other uses, but that have a high biodiversity value, should be included in the integral ecological reserve.

No other LUT than biodiversity conservation and research should be permitted. Sacred places could be maintained as long as it does not disturb the natural habitat.

The south-western part of the TCP area composed of hills and mountains should be classified as an integral ecological reserve. Some of the complex hills and rolling uplands will then be included in this reserve contributing to the conservation of biodiversity.

The proposed integral ecological reserve covers an area of about 12 675 ha. The rest of the spots to be considered as ecological fragile sites represents approximately 24 000 ha and should appear in every scenario as protected zones even though they are not classified as protection forests. Their area will be included in the area of the LAT they fall in.

8.3.3. LAT Teaching and research forest

A teaching and research forest is " *a forest where students specialising in forestry sciences carry out practical work and where recognised bodies also carry out scientific research projects. Any forest exploitation activity, hunting and fishing therein other than for teaching and research purposes shall be forbidden*". Decree N° 95-531-PM of 23 August 1995; 3.(5) (Republic of Cameroon, 1995a)

Research and studies have been undertaken by TCP in many parts of the area. Some sites were temporarily used for specific data collection but on some other sites data are still and will be collected regularly over a long period of time. These sites are to be removed from all types of resource exploitation and should be included in the classified teaching and research forest. Exploitation of timber or other products is allowed only for research purposes. The non-permanent sample plots cover an area of 15 300 ha while the permanent plots cover an area of 2 693 ha. The permanent plots will appear as teaching and research forest in every scenario.

The activities accepted in this type of forest depend on what type of research is done. Normally timber exploitation, shifting cultivation or agriculture plantation should be prohibited except if the effects of those LUTs are being studied. Collection of NTFPs, hunting or recreation could be accepted if it does not interfere with the type of research carried out.

These research forests have to be well identified in the field to prevent any undesired exploitation or disturbance. They should then be included inside a more expanded classified forest or otherwise secured by a buffer zone around them.

8.3.4. LAT Agroforestry

Agroforestry as LAT is understood in this P-MMP as the zone dedicated to the local inhabitants for the different LUTs they might undertake: agriculture, tree plantations, agro-forestry systems, community forests or others. It belongs to the non-permanent forest estate. All LUTs can be accepted on a sustainable management basis. The further step will be to elaborate separate management plans at village level that will indicate more precisely the display of LUTs potential areas.

The main LUT encountered in the TCP area is shifting cultivation. It is important to make sure that the inhabitants will have sufficient land to continue this practice in a near future (20 years). It is difficult to know exactly what will be the orientation of land use in the future but one can make an estimation of the needs of land for shifting cultivation if the actual tendency persists. The socio-economic survey (Lescuyer *et al.*, 1999) gives a mean area used for cultivation per family (including the fallow period and cacao plantations) of 10 to 15 ha, depending on the type of village. A comparison between the 1999 census and earlier ones (1965, 1976 and 1987) shows the demographic tendencies of the villages. These two parameters indicate the minimum area of cultivable land that a given village will need during a projection period of 20 years[9]. This minimum cultivable area was purposely overestimated (doubled) and then actualised by respecting a maximum distance from the road varying between 1 and 5 kilometres, depending on the size of the village. According to these assumptions, the area to be dedicated to agricultural systems covers 88 000 ha, representing more than 50% of the TCP area, and will appear as a minimum in every scenario.

8.3.5. LAT Production forest

A production forest is "*an area intended for sustained and lasting production of constructional or service timber or any other forest product. The customary rights relating to hunting, fishing,*

[9] See Annex V for the details of demographic changes, and areas per village projections.

grazing and harvesting therein shall be controlled". Decree N° 95-531-PM of 23 August 1995; 3.(6) (Republic of Cameroon, 1995a)

A production forest is beforehand oriented towards timber production; other uses can be integrated into it in a sustainable way as a "multi-purpose use forest". Gathering of NTFPs, hunting, tourism and recreation are compatible activities as long as they are not interfering with logging activities. For reasons of safety these other activities should be completely prohibited in the logging areas (*assiette de coupe*) when logging is in progress.

8.3.6. LAT Protection forest

A protection forest is "*an area intended for the protection of fragile ecosystems or which is of scientific importance. Any activity entailing the tapping of resources in that area for non-scientific purposes shall be forbidden*". Decree N° 95-531-PM of 23 August 1995; 3.(3) (Republic of Cameroon, 1995a).

Proposed protection forests are to preserve fragile ecosystems against degradation or depredation of all resources (soil, vegetation and fauna). Exploitation of NTFP and tourism-recreation may be acceptable if control to prevent over-exploitation and ecological degradation is secured. Hunting will be forbidden if the protection of fauna is a priority.

9. PROPOSED SCENARIOS

An innovative aspect of this management plan is that it presents different options of management instead of only one pre-defined possibility fixed by "experts". These management options incorporated in different scenarios are to be presented to the different stakeholders of the as a base for discussion. The scenarios are accompanied by maps, on which the proposed LATs are delineated. The four proposed scenarios are:

- "Business as usual". This scenario is used as a comparative basis, assuming that no interventions will be done. This scenario (Map 18, cartographic annex) is the one from which all other scenarios are derived;
- Agro-forestry scenario (Map 19, cartographic annex);
- Timber production scenario (Map 20, cartographic annex);
- Conservation scenario (Map 21, cartographic annex).

The scenarios were established on the basis of four main sources of inspiration/information:

- The Cameroonian laws (Republic of Cameroon, 1994; 1996) regarding nature propose three main global objectives: conservation of nature (law 96/12, art. 62), sustained production (law 94/01, art 23), development of village communities (law 94/01, art. 68 and 71);
- The Zoning Plan (Côté, 1993): The TCP research area is entirely included in the Zoning Plan[10];
- Biophysical data (landform, vegetation, land use,…) collected mainly by the Lu1 project (van Gemerden and Hazeu, 1999; Hazeu *et al.*, 2000);
- Socio-economic data lastly updated and completed by the Econ2 project (see Lescuyer *et al.*, 1999).

The last three scenarios representing management options were chosen in conformity with the national land management objectives and also according to the principles of sustainability; ecologically sound (priority conservation scenario), economically viable (priority timber production scenario) and socially responsible (priority agro-forestry scenario). Other scenarios representing other management options could have been envisaged (e.g. NTFP production scenario) but too many scenarios would increase the complexity of the mediation which is still a novelty in this kind of decision making.

The zoning proposed in each scenario is mainly derived by overlapping of the suitability maps (see Chapter 7.4), which highlights which land uses are the most appropriate for a given area or LMU. Each individual scenario ensures maximal fulfilment of its own priority management option. This means that each scenario is designated in such a way, that an optimal distribution of that LAT (as developed in Chapter 8) is reached to satisfy the needs of the relevant stakeholders within that management option in a maximal way. The purpose is not to choose one scenario over another but to evaluate and compare the economic, ecological and social impacts of the different management options. The ideal would be to reach during the negotiation a suitable balance between the three options. The discussion concerning the scenarios is to be integrated in an impact evaluation process and should lead to one final land allocation map of the area. The final map will illustrate the land allocation types, and their locations, upon which all stakeholders have agreed. During this stage of land allocation planning process the stakeholders must examine the management options for the whole (TCP) area and not only for fragmented parts, such as an individual village. Interrelations between proximate LATs should be taken into account as well as the minimum acceptable area per LAT. It can be anticipated that stakeholders will not always agree fully on land allocation selection. Therefore it is necessary to guide the stakeholders throughout a mediation process and to assist them in reaching a consensual land

[10] See Chapter 8.1 and Map 17 of the cartographic annex for details of the Zoning Plan corresponding to the TCP area.

allocation plan that will satisfy them and be accepted by all. The mediation process is explicitly explained in Chapter 10.

The land mapping units defined by the Lu1 research project were used as the basic biophysical data enabling to define which LAT could be proposed for which LMU according to the land suitability rankings. The socio-economic data provided by the Econ2 survey were used to determine the areas that should be dedicated to agricultural/agro-forestry practices to meet the basic needs of the local people. Some specific LMUs or zones will be exclusively dedicated to a specific or unique LAT (Fragile ecological sites or Agro-forestry zones) because of particular ecological, economical or social characteristics. Their location will appear unchanged on all scenario maps and their limits should not be modified although some adjustments of the agro-forestry limits may be possible.

- *Fragile ecological sites*
  Mountains, isolated hills and valley bottoms are considered unsuitable for all intensive exploitation because of the ecological degradation that would result from it. They cover 24 425 ha and are scattered all over the area. It seems difficult if not impossible to propose a classification of these spots as protected forests but it should be clear that all type of intensive exploitation should then be proscribed from these ecological fragile sites.
- *Agro-forestry zones*
  The zones allocated to agro-forestry are bands of land on each side of the main roads and around villages. They have been traced to guarantee sufficient cultivable land to the inhabitants for at least the 20 next years[11], assuming that agricultural systems remain the same. This assessment results from a calculation using mainly demographic data, population growth since 1965, and average agricultural area by household (Lescuyer *et al.*, 1999). The width of the agro-forestry zones varies from 1 to 5 km depending on the population density. The agro-forestry zone has a surface of 80 850 ha.
- *Research and teaching*
  The location of the permanent and non-permanent research plots of the TCP area will also be indicated on every scenario map. Ideally the permanent plots should be preserved from any type of exploitation and be included inside a classified (ecological reserve, protection or production) forest or classified as research and teaching forests surrounded by a buffer zone of at least 0.5 km. The permanent research plots cover an area of 2 786 ha.
- *Multiple allocation zones*
  The zones, offering the possibilities of more than one LAT, cover 62 000 ha and will be called "multiple allocation zones". These will be modified according to the main management options. The unique allocation and the multiple allocation zones are clearly distinguished on the Business as usual scenario map (Map 18 of the cartographic annex).

Each scenario puts emphasis on one management option and the final land allocation plan (LAP) should emerge from the mediation between the stakeholders. Each scenario will also give indicative allocation proposals to assist the stakeholders in their decisions. These proposals are mainly inspired from the suitability maps and the Zoning Plan. The minimum acceptable dimension of a LAT has also been considered.

These proposals are meant to facilitate the understanding of the scenario maps and are indicated on the maps in light shade colours to show that they are only suggestions. It is important that the comparative analysis of the scenarios is conducted through an evaluation impact method enabled to evaluate the ecological, economical and social benefits and disadvantages of each management option. Table 9.1 gives for each scenario the possible advantages, disadvantages, and also the stakeholders who are more likely to be interested.
The surfaces covered by each LAT inside each scenario are presented in Table 9.2. Once again these surfaces should be considered indicative and not as the final solution.

[11] See Annex V, Minimum cultivable area; projection year 2019.

Table 9.1 Advantages and disadvantages per scenario.

Scenario	Advantages	Disadvantages	Interested stakeholders
Agro-forestry	- Increase of revenues from agricultural activities	- Loss of biodiversity - Decline of soil and water quality	- Local inhabitants - Forest dwellers - Decentralised authorities - MINAGRI
Timber production	- Cutting rights paid to population - Employment - Maintenance of the roads - Revenues for the state	- Soil erosion - Disturbance of wildlife habitat - Damage to NTFP goods - Restriction of availability of land for agricultural activities	- Local inhabitants - Forest dwellers - Decentralised authorities - MINEF - ONADEF - Logging companies - TCP (research)
Conservation	- Conservation of biodiversity - Preservation of water and soil quality - Preservation of wildlife habitat	- Restriction of availability of land for agricultural activities or timber exploitation	- Local inhabitants - Forest dwellers - Decentralised authorities - MINEF - NGOs - TCP (research)

9.1. BUSINESS AS USUAL SCENARIO

This scenario is not a management proposal. It is presented here as a reference base, representing the actual or unchanged situation. It will be useful to compare the actual situation during the examination of the other scenarios. The map of this scenario should then show only one land allocation type, the actual non-permanent forest estate. For the benefit of the P-MMP and the mediation process, the map outlines the ecological fragile sites (covering 24 425 ha or 14.5% of the area), the agro-forestry zone (covering 80 848 ha or 48.5% of the area) and the multiple allocation zone (covering 62 079 ha or 37% of the area).

9.2. AGRO-FORESTRY SCENARIO

This scenario puts emphasis on land uses favoured by local inhabitants. The agro-forestry zone is extended to its maximum allowing the expansion of shifting cultivation, agriculture plantations, NTFP collection, and community forests or tree plantations. The walking distance from the road is a constraint for shifting cultivation and agriculture plantation if no new roads are constructed. The studies[12] of Lu1 assume that beyond 5 km from the roads, the suitability of the land for agriculture activities declines. The forest at larger distance could be used for community forests or for NTFP collection. Village management plans considering the agro-forestry zone should be drawn up for every village. The village management plans should be done in conjunction with the elaboration of permanent forest management plans (production or protection forests).

The LAT agro-forestry covers 111 800 ha or 67% of the TCP area. Three production forests are located along a southwest - northeast line. Three protection forests, protecting mountain tops, are proposed. The Nyangong catchment is incorporated in the southern protection forest (ecological reserve). A teaching and research forest is proposed north of Ebom preserving the permanent plots located there.

Socially it seems to be the scenario that responds the most to the local population's expectations. The intensification of agriculture would probably improve the economic situation of the inhabitants.

[12] Section 7.3.4.

An intensified extension of shifting cultivation and agriculture plantations will diminish the biodiversity of the TCP area. It would probably also reduce the hunting and gathering areas of the forest dwellers. Negative ecological impacts like lost of soils or decline of the quality of water may be substantial if no protective measures are taken. Mountain tops or specific catchments for drinking water should be protected. Economic benefits from logging (taxes and employment) will decrease.

9.3. TIMBER PRODUCTION SCENARIO

The emphasis in this scenario is on timber production. Production forests are meant to produce timber in quantity and quality on a sustainable basis. Generally, the exploitation is done on the basis of a management plan by logging companies, controlled by the state. Other activities such as NTFP collection/production or hunting may be undertaken in production forests as long as they do not interfere with logging or silvicultural operations. Specific tree species important for the inhabitants might be excluded from the list of species the logger is allowed to harvest (see van Dijk and Wiersum, 2001).

Three blocks of forest are located in the centre of the site along a southwest - northeast transverse. Another one is located south of the Mvié - Ebom road. The production forests cover 43 193 ha or 26% of the TCP area. A minimum surface of 2 500 ha should be respected for a forest production block.

Some protection forests are suggested, mainly located in the southeastern part of the site as recommended by the Zoning Plan. Another one is proposed in the northern part.

The multiple allocation zone located northwest of Akom II seems more adequate for agro-forestry as well as the remaining part north of the Ebimimbang - Ebom road.

The centrally located production forest incorporates the permanent plots of the F6 research project as well as the Mvié catchment. The Nyangong catchment is incorporated in the southern protection forest (ecological reserve). A teaching and research forest (TRF) is proposed north of Ebom preserving the permanent plots located there. The TRF could be incorporated in the suggested production forest nearby.

Exploitation of other products such as NTFPs will contribute to the sustainability of the management. The state as well as the local population will obtain economic benefits, through taxes and employment, from timber exploitation. Regular road maintenance by logging companies should be considered as a considerable benefit for the inhabitants.

Selective cutting may have negative consequences on diversity of biological resources but well managed production forest will contribute in maintaining the biodiversity if appropriate measures are taken (such as incorporating inside these forests some integral ecological reserves or protected areas). Timber harvesting may cause damage to the soils creating erosion as well as soil compaction. It may also cause damage to non-timber goods. Logging activities may cause disturbances to wildlife habitat. A full extension of classified production forests could restrain the availability of land for other local uses.

9.4. CONSERVATION SCENARIO

The emphasis in this scenario is on the conservation of the natural habitat. It results in a patchwork of protection forests and integral ecological reserves. It responds to the wish of having integral ecological reserves located also on good terrain and not only on hill tops or inaccessible places that are not suitable for timber exploitation or agriculture anyway. All types of exploitation are forbidden inside the integral ecological reserves. NTFP collection might be restricted in protection forests and overexploitation control measures should be taken.

The LATs integral ecological reserve and protection forest as well as the fragile sites cover an area of 57 350 ha or 34% of the TCP area.

Three patches of production forest are proposed in this scenario, located in the central and western part of the site. The multiple allocation zone located northwest of Akom II seems better suited for agro-forestry and so are the remaining part north of the Ebimimbang - Ebom road and the multiple allocation zones surrounding the protection forest north of Ebom.

The central production forest incorporates the permanent plots of the F6 research project as well as the Mvié catchment. The Nyangong catchment is incorporated in the southern protection forest (ecological reserve). A teaching and research forest is proposed north of Ebom preserving the permanent plots located there. The TRF could be incorporated in the possible nearby protection forest.

This scenario would be the one offering the most positive impact regarding ecological aspects. Conserving forests (particularly in strategic places, for example the top of mountains) will play an important role in water regulation or preserving soil qualities, which will be to the advantage of agriculture in the long term. Protected forests will preserve wildlife habitat.

Socially and economically, it seems the most constraining scenario for agriculture and timber exploitation. The full extension of classified integral ecological reserves and protection forests may restrain the availability of land for other local uses.

9.5. AMENDMENTS TO THE SOUTH CAMEROON ZONING PLAN

The scale of maps reflects the degree of precision of the data used. The 1:100 000 scale of the basic Lu1 maps has thus permitted to define the management possibilities of the TCP research site with more precision than the 1:200 000 maps that were used for the Zoning Plan by Côté (1993). The socio-economic and biophysical information used for the P-MMP was indeed much more detailed. The Zoning Plan was done as a framework for classifying all forests of the southwestern part of the country and was made with very little or no local consultation. It is therefore logical, that the P-MMP scenarios do not fully correspond with the Zoning Plan proposals.

The production forest proposed by the Zoning Plan in the northern part of the TCP area proved to be less suitable due to high demographic pressure and demand in cultivable land in that area. It is considered more appropriate to manage part of this forest as a protection forest and to locate the production forests in the centre of the TCP area where there are fewer villages..
The protection forests proposed in the Zoning Plan for the southwestern part are justified because of mountains and the risks of erosion if exploited for timber or agriculture. The protected forests have been amplified to all small hills encountered in the area. The southeastern part of the TCP site, which is proposed as protection forest in the Zoning Plan, may also be used for timber production. It could be exploited if special measures are taken to protect the slopes.

A communal forest was proposed in the Zoning Plan but it was not specified to whom or which town it was allocated. The P-MMP has not identified communal forests in the TCP area.

Table 9.2 Areas of various LATs in the four scenarios

Scenario	Land allocation types														
	Permanent research plots[1]	**Ecological Fragile Zone**[2]		**Integral Ecological Reserve**		**Protection forest**		**Teaching and Research forest**		**Agro-forestry**		**Production forest**		**Communal Forest**[5]		**Total**
	ha	**ha**	**%**	**ha**	**%**	**ha**	**%**	**ha**	**%**	**ha**	**%**	**ha**	**%**	**ha**	**%**	**ha**
Business as usual[3]	2 709	24 425	14.59	0	0.00	*62 079*	*37.09*	0	0.00	*142 927*	*85.41*	*62 079*	*37.09*	0	0.00	167 352
Agro-forestry	2 709	13 273	7.93	15 030	8.98	9 480	5.66	3 870	2.31	111 739	66.77	13 959	8.34	0	0.00	167 351
Timber Production	2 709	12 262	7.33	14 374	8.59	9 602	5.74	3 870	2.31	84 050	50.22	43 193	25.81	0	0.00	167 351
Conservation	2 709	10 425	6.23	19 830	11.85	27 096	16.19	3 870	2.31	85 525	51.11	20 604	12.31	0	0.00	167 350
Zoning plan[4]	0	0	0.00	0	0.00	37 650	22.50	0	0.00	100 325	59.95	12 435	7.43	16 943	10.12	167 353

[1] The area of the research plots is included in the other LATs.
[2] The area of the ecological fragile zones located inside protection forests or ecological reserves are integrated in the area of the protection forests or reserves.
[3] In the Business as usual scenario the multi allocation zone of 62079 ha is divided equally to the Production forest and Protection forest and added to the Agroforestry zone (80 848 + 62 079 ha).
[4] The figures of the Zoning plan (Côté, 1993) are given as reference.
[5] Not included in the scenario.

10. MEDIATION PROCESS

Mediation is the decision phase during which the scenarios and management proposals are presented to stakeholders. One of the main purposes of the Econ2 subproject is to carry out an Impact Assessment (IA) of the different options of managing forest resources in the TCP area. This methodology has rarely been applied in Central Africa and never in relation to tropical forest management, although integrating this set of assessment techniques in the standard approach of forest management may well be to the benefit of sustainable development. The Impact Assessment (IA) methodology is introduced in the following sections and so is the mediation process to be carried out.

10.1. IMPACT ASSESSMENT AS A TOOL IN PARTICIPATORY MANAGEMENT

10.1.1. Introduction to IA methodology

Impact Assessment methodology is a mechanism to collect, structure and analyse the likely effects of alternative scenarios, which in this case are directed at forest development. The methodology attempts to complete the economic analysis of projects. As a matter of fact, it is common nowadays that many plans are analysed according to monetary criteria, as the usual variable in the decision-making process is financial profitability. This approach is highly problematic when projects have major consequences for the environment; in such case, most costs cannot be assessed with economic valuation techniques, providing decision-makers with biased information. The purpose of IA is to provide a formal framework to estimate all non-monetary effects (hence ecological, social and economic) of development projects and give decision-makers clear information on the environmental impacts of potential forest developments.

A standard Impact Assessment approach includes the following main steps:

- **Screening:** narrows the application of IA to the projects that may have significant environmental impacts.
- **Scoping:** seeks to identify, from the project's potential impacts and from the conceivable alternatives, those that are the key issues.
- **Description of the project:** includes an understanding of the project's various characteristics, its temporal, physical and socio-economic boundaries.
- **Description of the environment baseline:** displays the establishment of both present and future states of the environment in the absence of the project.
- **Consideration of alternatives:** when a project is believed to have potentially significant impacts on the environment, several feasible alternatives to this project should be investigated and submitted to IA as well.
- **Prediction of impacts:** aims to identify the magnitude of changes in the environment by a project in comparison with the situation without that project.
- **Evaluation and assessment of significance of these impacts:** to know more about environmental impact assessment techniques, it is advisable to consult the following references: Glasson *et al*. (1994), Smith (1993) and André *et al*. (1999).
- **Mitigation:** involves the introduction of measures to avoid, reduce, remedy, or to compensate for any significant adverse impacts.
- Publication of the **Environmental Impact Statement** (EIS)**:** i.e. a simple and understandable abstract of the main impacts of the project and of its alternatives.
- **Decision-making on the project:** involves a consideration of the EIS by the relevant authorities together with other material considerations. The objective of IA is not to force decision-makers to adopt the least environmentally damaging alternative but to make them aware of the environmental consequences of their decision.

- **Auditing:** involves comparing actual outcomes with predicted outcomes of the project. It can be used to assess the quality of predictions and the effectiveness of mitigation.

The active participation of involved stakeholders is expected throughout the IA process.
In Cameroon, two laws (the forest law 94/01 art. 16 and the environmental law 96/12 art. 17; Republic of Cameroon, 1994; 1996) mention the duty to carry out IA prior to the implementation of a project that may have significant effects on the environment. These legal prescriptions are however still not put in practise in Cameroon due to the lack of an application decree that precisely defines the implementation clauses of IA. This chapter may clarify the potential implementation and utility of IA in Cameroon, especially when applied to forest resources management.

10.1.2. Relevance for strategic-level forest management

Because of the need of numerous and complex data as well as the required commitment of stakeholders, IA is usually defined as a project-size tool. Nevertheless, this local level of environmental impact assessment has been considered insufficient when several projects are implemented at the same time within common environmental boundaries or when decision-makers want to assess the impacts of a regional or a national programme on the ecological, social and economic environment.

Contrary to Environmental Impact Assessment (EIA), which focuses at the project and operational level, Strategic Environmental Assessment (SEA) is dedicated to a higher, earlier and strategic tier of decision-making. Rather than multiply single and independent EIAs, the purpose of SEA is to realise a comprehensive analysis and to cope better with cumulative impacts, alternatives, and mitigation measures than project assessment. The SEA proved to be a relevant approach in designing a Master Management Plan for the TCP research area. Two arguments support this fact.

First, the TCP area is more than 160 000 ha and, as previously noticed, displays very diverse ecological and social situations. Because of this heterogeneity, a single management plan, defining the forest use practices in detail, is not conceivable for the whole forest zone: it should deal with too much complexity and therefore has little chance to design a forest planning that would actually be implemented. Rather, one should think of development planning as a bundle of individual forest management plans that fully take into account the local data because of their small scale of application. For instance, one plan should focus on a specific production forest in some part of the area, another on a protection forest, and another one on agro-forestry systems in other parts of the TCP area. Each small-size forest area could then be managed on the basis of precise knowledge and according to adapted criteria. It is also better appreciated by local stakeholders whose participation is integrated in the management of forest resources.

However, these local management plans are interconnected due to the interactive and cumulative effects between the several modes of using resources. For example, excessive timber exploitation in one production forest may have consequence for the wildlife in the neighbouring protection forest. In the same way, the establishment of too many nature conservation areas may lead to a substantial growth of predators and an increase of damage to food crops. Thus, such interactive and cumulative effects urge to design a higher-level management plan that, without precisely detailing all the forest practices in the area, guarantees a co-ordination of the resources uses and provides a synthetic overview of the potential development of the region.

The second advantage of applying SEA methodology to design the MMP is that it allows taking into consideration broader concerns than what is conceivable when working out local management plans. This strategic level analysis gives the opportunity to directly apply and compare at a sub-regional scale the governmental choices regarding economic policy, environment conservation, social evolution or sustainable development. SEA must not be only considered as an aggregation of co-ordinated local management plans but also as a means of implementing and testing the national prescriptions on forest utilisation. In the TCP case, for instance, the strategic alternatives to be compared come from both the national forest zoning map (which embody the public authorities' concerns about southern forests) and the local data on ecological suitability.

10.2. STRATEGIC ENVIRONMENTAL ASSESSMENT IMPLEMENTATION

This SEA approach to improve the quality of the MMP is described below for all the IA steps presented in Section 10.1.1.

10.2.1. Screening and Scooping

The first step of screening is not relevant in our case as the forest law 94/01 compels logging companies to apply IA. This obligation may be extended to agricultural practices in forest areas. On the opposite, nature conservation seems to have light impacts on environment, although social and financial consequences must not be underestimated.

The choice of the key impacts has been made on the basis of a literature study on the state of the art. For instance, the key impacts of logging operation are mentioned in the official guidelines of ONADEF and MINEF (MINEF, 1998a; 1998b). The other main impacts for using forest resources are described in numerous books on multiple-use of forest resources (Panayotou and Ashton, 1992; Cleaver *et al*., 1992) as well as by many TCP projects. For instance, agricultural impacts have been surveyed by the Lu2 project, numerous social impacts by S1, hydrological impacts by Lu1, impacts on biodiversity by Ecol1, etc.. This leads to the selection of a list of economic, environmental and social impacts, represented as lines in the impact matrix (see annex VI for details).

10.2.2. Description of the project and of the environmental baseline

The most effective means to design land use maps is to use the suitability maps of the Lu1 project (Hazeu *et al*., 2000) and the official Zoning Plan (Côté, 1993), that indicates the pre-supposed uses of forest lands in the area. The micro- and macro-data these publications provide constitute two main inputs to describe both the forest management project and its environmental context. Socio-economic surveys have been conducted to complement the available information, with the aim to include the needs and interests of the local population in the baseline description.

At this strategic level, specific and detailed knowledge on local land tenure and access rules to forest resources is not necessary.

10.2.3. Consideration of forest management alternatives

On the basis of the Zoning Plan and the Lu1 land use surveys, basic scenarios for using the forest can be designed: timber exploitation, conservation of natural resources, increase of local welfare, scenarios where different uses are mingled, a "Business As Usual" scenario, etc..

These forest management alternatives have been defined on the basis of three main objectives of the Cameroonian forest policy: conservation of nature (law 96/12, art 62), sustained production (law 94/01, art 23) and development of village communities (law 94/01, art 68 and 71). At least two other scenarios can be added:

- a "business as usual" situation, that considers the evolution of the TCP area without forest management; and
- a "mixed uses" scenario, where the land use types are determined on the basis of ecological suitability and local aspirations contrary to the preceding scenarios where one particular resources utilisation type is favoured in *priori*.

Several "mixed uses" scenarios may be designed with the collaboration of involved stakeholders.

10.2.4. Prediction and assessment of impacts

The strategic forest management alternatives are static and as forest management is long-term planning, it is necessary to assess how these scenarios may evolve over the long run. Several assumptions have been formulated to know how the forest uses may change. Most of these projections come from specialised literature (trends of timber prices, evolution of the international demand for NTFPs, etc.) and from other available data (demographic growth, evolution of agricultural techniques, etc.).

The next step is the comparison of the long-term forest management alternatives by resorting to SEA methods. Two methods are used to this purpose: Impact Matrix (see Annex VI) and Overlay Maps. These SEA techniques show two interesting characteristics:

1) They do not require precise data but rather general data that are usually available at the regional level;
2) Their outcome must be useful to decision-makers and therefore must be and can be expressed in an easily understandable form.

As a consequence, they constitute both an easy-understanding means to compare alternatives and a stimulating tool for the stakeholders' negotiation.

10.2.5. Stakeholders participation and involvement

The consultation of the stakeholders is required in several steps of the SEA application:

- Definition of basic forest strategic management alternatives;
- Outline evolution assumptions regarding forest uses;
- Choice of the preferred strategic forest management alternative.

At this strategic level, the involved stakeholders could be representatives of forest administration, elected people from local populations, NGOs, representatives of private interests, etc.. (see Section 10.4.1 for an introduction to the stakeholders of the TCP area). These heterogeneous agents have to be gathered several times and the objective of those meetings is to arrive at a common view about forest management issues. In these circumstances, SEA is a tool to stimulate debate between stakeholders and, at the same time, uses the resulting conclusions.

10.2.6. Publication of the Environmental Impact Statement

The Environmental Impact Statement (EIS) is presented in Annex VII. It recapitulates all SEA steps and elicits the most satisfying alternative for the Master Management Plan. This forest management alternative must include a meso-zoning map of the TCP area, where one priority land-use type is allocated to each forest, and propose mitigation policies to reduce the most negative impacts.

Still, the outcome of the SEA is not to design the optimal alternative of TCP forest management but to show to what extent the different alternatives are satisfactory according to different criteria. SEA results are only one input in the decision-making process and do not necessarily compel the final political choice.

10.3. ACTIVE NEGOTIATION RATHER THAN PASSIVE PARTICIPATION

In managing national forest resources, the participation or, at least, the consultation of concerned stakeholders is a duty prescribed by the Cameroonian legislation. The law 96/12 (art. 9) refers to a participation principle that implies that "*every citizen must have access to information related to the environment […]; decisions on the environment must be taken after consulting the concerned sectors or groups, or after public discussion when they have a general scope*". More specifically for the forests, the application decree 95/531 (art. 18) stipulates that the official establishment of a permanent forest must be presented to local communities, who can formulate claims to the responsible authorities.

Beyond the legal obligation, stakeholders' involvement in decision-making process is also an empirical requirement. From a practical point of view, forest management cannot be defined without integrating conceptions and interests of local stakeholders, who are the *de facto* users of the resources. Examples are plenty to illustrate the impossibility of an external development project to succeed without the active support of local stakeholders (Drijver, 1991; Kiss, 1990).

Local stakeholder participation is a fashionable topic in literature dedicated to natural resources management and conservation (Cernea, 1986; FAO, 1989; IIED, 1994). People's participation may take on a variety of forms but they commonly share the objective of mobilising populations around the implementation of a project, which objectives have already been defined by political or economic decision-makers. Such a process may also occur when elaborating a Master Plan. "Participatory management" then implies that the Master Plan be worked out by "experts" with the support of authorities and, once achieved, it is finally presented to villagers for acceptance or marginal local change of the classified forest's boundaries.

Another participatory approach is proposed for implementation in the TCP area. Its main steps are presented below and compared to the ones of the "participation" approach described above (Figure 10.1):

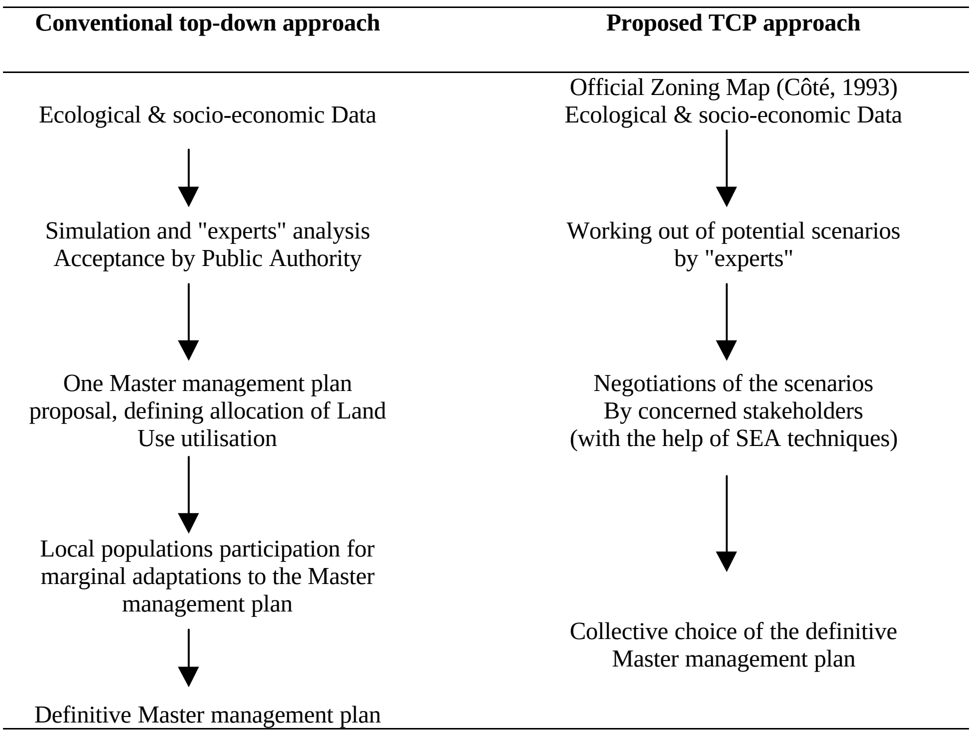

Figure 10.1: Two alternative decision-making processes to the realisation of a Master Management Plan.

The main difference between these two approaches is the role of the stakeholders and experts in the design of the MMP. In the proposed approach, the task of planning specialists is to clarify the conceivable options in order to initiate and support stakeholders' negotiations on the actual formulation of a sustainable management regime. These discussions also have the advantage That they allow these actors to express their claims and views and to adjust the MMP to their needs, notably through SEA techniques.

As a consequence of such a decision-making process, the legitimacy of the Master Management Plan does not originate solely from its administrative "officialisation" but also from a covenant negotiated and agreed by all stakeholders. The advantage of this MMP designing process is not just to adapt the MMP to local conditions but to make stakeholders define and appropriate an effective and actual set of sustainable forest management actions.

In this new approach, the link between management scenario design and SEA implementation should not be linear but interactive; it is a permanent exchange of information and feedback.

Quantified results aim at supporting stakeholders' negotiation and strengthen the consensus they reach. Therefore, the SEA methodology contributes to solve disputes and to facilitate their coming to an agreement on one sustainable and efficient MMP.

Thus, this concept of participatory approach breaks with conventional top-down processes since forest management possibilities are now discussed and worked out by local stakeholders. But this is not a typical bottom-up approach either: the first drafts of the MMP to be submitted for stakeholder negotiation are conceived according to the forest policy prescriptions. Thus, this kind of co-management of forest seems to be a balanced approach, which integrates national considerations about forest strategy while taking into account local (professional and village) interests and opportunities of managing forest resources.

10.4. ORGANISATION OF A MEDIATION

10.4.1. Main TCP stakeholders

- *The local Bantu population*: because of the large number of villages and inhabitants in the TCP area, the participation of Bantu population can only be ensured through the appointment in every village of representatives who shall express the population claims during meetings with other stakeholders. The issue of empowering local actors is complex. As mentioned by von Benda-Beckmann *et al*. (1997, p. 9), "it is hard to identify leaders who can take decisions on behalf of the villagers and who have enough authority to impose execution of such decisions". This difficulty may be partly overcome when first discussions about potential forest management are organised with the whole population of the village. This initial form of consultation must be public, giving the moderator the opportunity to directly answer villagers' questions, to inform them about their rights on the forest and to emphasise that the MMP is a good opportunity to have these rights recognised. Providing this preliminary information may help villagers to appoint the most suitable person(s) to represent their interests in further higher-level negotiation. It is advisable that these village representatives both embody the official and "traditional" authorities in order to acknowledge these two decision-making processes in use at the village level. As a whole, each village should be able to delegate some people to negotiate with other stakeholders and eventually to commit the village regarding the management of the forest[13].

- *The Bagyéli groups*: due to historical predominance of Bantu people over Bagyéli/Bakola, it seems important to separate voices of these semi-nomad groups from the ones of Bantu. However, to identify representatives for the Bagyéli is a major problem as social hierarchy is almost non-existent in this ethnic group. To express the viewpoint of those groups, Biesbrouck (1997, p. 17) suggests, among others, to call for the co-operation of specialised associations which have been working with Bagyéli for many years and which "*could serve as a channel*" to motivate Bagyéli participation. It is likely that these associations would provide Bagyéli with convenient means to express their concerns on forest management. Associations of this kind are located in the TCP area (CODEBABIK, *Petites sœurs de Jésus*, Planet Survey, SAILD, etc.): they are usually appreciated by the Bagyéli and appear to be willing to co-operate (Booijink and Seh, 1999).

- *Decentralised authorities*: which include division and sub-division officers, mayors, "chefs de groupement", etc.. These individuals represent the public administration. Their place in the negotiation is crucial as they represent an intermediate level which function is both to organise the application of the national policy at the local level and to integrate villagers'

[13] cf. also the conclusion of the integration report of the TCP social science project (van den Berg and Biesbrouck, 2000) concerning the need to compose ad hoc platforms including the various forms of leadership within the village.

claims in this application. Moreover, they have a good knowledge of the area they administer.

- *Specialised authorities*: the following agencies are of importance:
  The Forest Direction of the Ministry of Environment and Forests (MINEF): is in charge of the forest policy and expresses the national interest about forest. The *Ministry of Agriculture (MINAGRI)*: also has a role to play in these negotiations. The principal activity in the TCP area is agriculture, which means that the MMP has to make sure sufficient and appropriate areas are dedicated to it. *ONADEF*: is a parastatal institution specialised, among others, in the technical management of timber resources. It has proficiency in working out standard forest management plans and their follow-up. Moreover, this organisation is involved in the management of the forest reserve of Kienke, which is partly located in the southwest part of the TCP area.
  These public services are present on the field through the division delegates and local agents who represent the actual and direct interface between local-level management and external policies. As such, these local agents should be included in the negotiation on forest management and should be trained on new forestry topics like multiple-use management, agro-forestry, technical support to communities, etc. (Wiersum and Lekanne dit Deprez, 1995).

- *Private economic actors* (logging companies, COTCO, etc.) who aim at a profitable exploitation of the resources and contribute to the economic development of isolated villages through many secondary benefits: road maintenance, employment, trade, etc. (Brown and Ekoko, 1999). They also provide communes with substantial amount of taxes. Their representation in forest management mediation does not seem problematic since they are used to such negotiation with authorities and local people.

- *National and international NGOs related to nature conservation or rural development*. The participation of NGOs in the MMP discussion is legitimate since they can act as representatives of international community's concerns about ecosystems and people of Central Africa. Local NGOs who carry out activities in the TCP area should be included in the mediation.

- *Tropenbos-Cameroon Programme.* Many studies are carried out in this forest area by the Tropenbos-Cameroon Programme, in connection with local people and public authorities. As a research programme, it may have a voice in the negotiation, not only as a mediator but also as an actual stakeholder with concerns and interest of its own.

- *Other projects*. It may also be useful to involve the forest management projects in adjacent areas (GEF-Campo Ma'an project, Lokoundjé-Nyong project, etc.) in the negotiation. They have accumulated an interesting experience in dealing with local population and they work on the same ecosystems as TCP. Moreover, as their study area is close to the TCP site, one joint intervention may be considered.

10.4.2. Process of negotiation

The negotiation on the MMP for the TCP research site may be schemed in four steps, from local to sub-regional levels.

1 Presentation of the draft Master Management Plan and P-MMP maps to the divisional and sub-divisional officers of Océan and Mvila divisions.
  This first step is a necessary requirement to get an explicit official authorisation to carry out the MMP surveys in the two administrative divisions. Actually, these officers are in charge of the national territory management and, as such, are the main officials to meet before further implementing the MMP in the TCP research area. Moreover, their supports and recommendations will facilitate contacts with local authorities and rural

population. A complete presentation of the MMP design process, the predicted schedule, the people involved, the methodology, the outcomes, etc. will be presented so that the divisional and sub-divisional officers are able to follow all the steps of the negotiation approach. The representatives of MINEF and MINAGRI should also be invited.

The meetings should take place in Kribi and Ebolowa and should preferably be conducted by Econ2 researchers.

Mediation tools: P-MMP draft maps.

2a Introduction of the first drafts of the Master Plan to each separate group of stakeholders (Bantu villages, Bagyéli settlements, logging company, local public authorities, NGOs, etc.) to make them familiar with the P-MMP scenarios and to allow them to come with comments and improvements. This should be considered as a step to prepare for the following multi-stakeholders negotiation. It seems particularly important in each village to clarify the approach, to precise the objectives of the survey, and incite villagers to consider the MMP as a real opportunity to assert their claims in the forest resources. It should be stressed that the MMP constitutes an arrangement between local forms of forest management and application of the forest law. This discussion is to be dedicated to the management of the whole TCP forest area, although actually the debate may rather focus on areas near the village. To facilitate this large-scale perception, large-size MMP maps will be shown, which are supposed to be the main factor for stimulating discussion among villagers. Any quick response from the villagers is not to be expected. To deepen the debate among inhabitants, a set of maps (A3 format) should be left in each village so that villagers have time to reach a common position about their acceptance, claims, and recommendations.

The meetings should be held in the villages, the entire village population should be invited to assist.

A team composed of three persons should conduct the presentations; a TCP mediator associated with one person from MINEF and another from local authorities. The mediator should be a person well known in the TCP area who has a good understanding of the P-MMP and with whom villagers will feel confident. Because there are 67 villages of the TCP area, the work has to be divided between three field teams, one team by sub-divisions for Akom II and Ebolowa and one for Bipindi and Lolodorf.

2b Two or three weeks later, another short meeting is foreseen in each village to take notice of the final viewpoint of the villagers concerning the P-MMP proposals. This information will be used to improve the subsequent MMP. At the same time, in each village, few people must be appointed to participate to further negotiations at the sub-division level. These persons may be the village chief, well-accepted personalities coming from traditional structure like traditional court, Elders committee, etc. If possible, these people should represent the diversity of the village lineage structure.

Mediation tools: P-MMP draft maps.

3 A meeting at the sub-division (*arrondissement*) level, which aims at broadening the negotiation to new stakeholders and to a larger forest area. Whereas the first village discussions were conducted within relatively homogeneous groups, the district level mediation makes different stakeholders meet and confront their viewpoints on forest strategic management. The result should be the expression of a common agreement, or at least common concerns, on the most satisfying alternative.

The involved stakeholders are: Bantu village representatives (two persons per village[14]), Bagyéli people and/or specialised NGOs standing up for Bagyéli concerns, local official authorities (*chefs de groupement*, sub-division officer), local agents of MINEF and

[14] Further deliberation will be necessary with village representatives to what extent it will be desirable to include also the so-called "external elites" in these negotiations (see van den Berg and Biesbrouck, 2000).

MINAGRI, logging and/or other companies, conservation and development NGOs. The negotiation meetings will be held in the principal towns of the four subdivisions. Neutral mediators are needed to conduct this negotiation, most probably the mediators who had led the village meetings. Their role is to supervise the debate, to equally share the speaking time and make sure that all viewpoints have been presented and discussed before reaching an agreement.
Mediation tools: amended P-MMP draft maps, impact matrix

4 An overall meeting should gather all the stakeholders to discuss the feasibility of the P-MMP scenarios that have been improved to integrate the outcomes of sub-division level mediations. The objective is to establish, with the help of SEA techniques, a final proposal for the MMP that is accepted by all stakeholders mentioned above. This document is to be made official by regional authorities and send to the MINEF for ratification. The meeting should take place in Kribi, preferably under the leadership of the provincial governor. One of the previous mediators will conduct the negotiations.
Mediation tools: amended MMP draft maps, impact matrix

A recapitulative diagram, displaying the main steps of the mediation process for the TCP Master Management Plan is given in Figure 10.2.

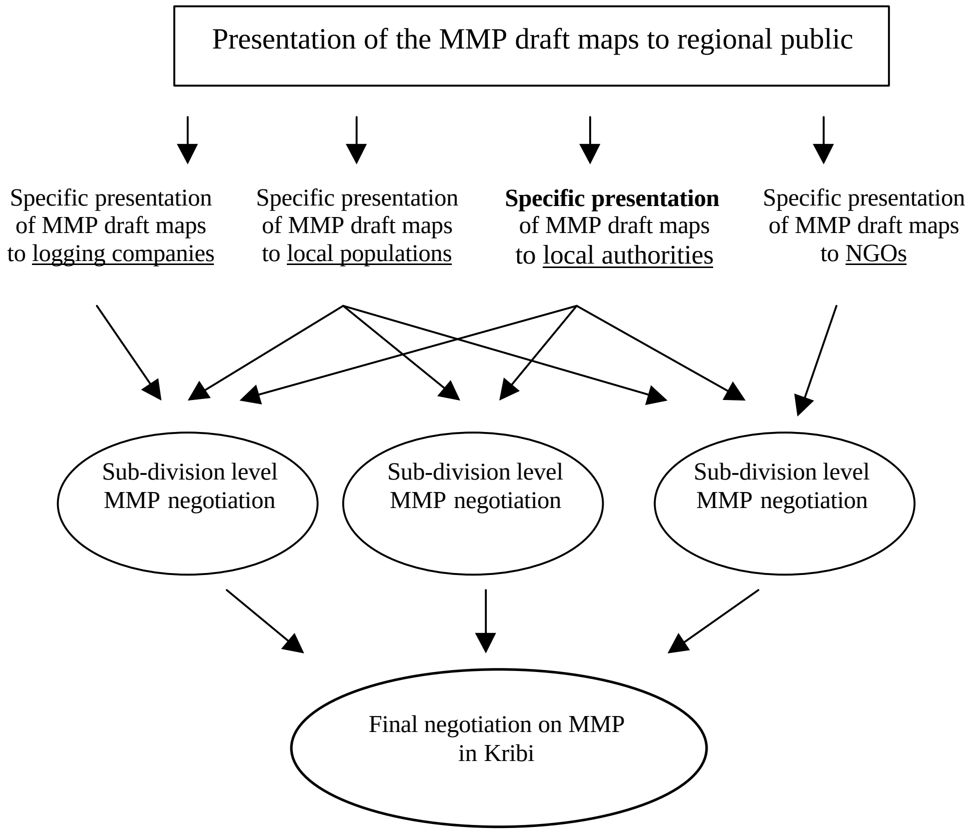

Figure 10.2: Recapitulative diagram of the mediation process.

11. CONCLUSION

This pre-mediation version of the Master Management Plan represents the result of what could be called the conception phase. This P-MMP is not a definitive MMP since the mediation with the stakeholders still has to be undertaken. This first version is meant to provide the responsible agency, which should conduct the mediation process, basic instruments such as management scenarios, EIA tools and the mediation procedure. This P-MMP stresses the importance of using a participatory approach that really takes the management conceptions of local stakeholders into consideration. This approach will improve the quality and representativeness of the final version that can be drawn up following the mediation process.

It was not possible to bring this P-MMP to its final version, among others because of time and funding constraints. Basic information, particularly on socio-economic aspects, was still missing when the elaboration of the P-MMP started. In fact it would have been preferable to wait until all projects had completed their research before starting on the (pre-mediation version of the) Master Management Plan. The data and information from research projects of the Tropenbos-Cameroon Programme was used when available. However, some of the TCP research projects are not yet completed, and have not published their final results. In other cases it was not possible to extrapolate the available results to the entire area because the research was too specific or at a level of detail inappropriate for a management plan of this type. Consulting and involving the local population and other stakeholders is time consuming and needs to be funded. The time and funds necessary to go through the mediation process were not available at the moment the elaboration on the P-MMP started.

This pre-mediation was realised by the Tropenbos-Cameroon Programme, mainly by researchers of Econ2 project. The mediation phase should now follow as soon as possible It should be conducted by a responsible national agency, such as MINEF or ONADEF in association or not with an external funding agency. Econ2 should develop its environmental impact assessment methodology and test the mediation process in a number of villages[15].

The final version of the MMP should contain the final land allocation plan and express recommendations on the management actions to be undertaken in the area. The translation of the MMP recommendations in tangible actions will take place in the implementation phase. The agency or government level of responsibility for the implementation of the MMP should be identified promptly to assure an effective follow-up of the MMP. The roles of relevant stakeholders who will contribute to it should be clearly defined. Some of the proposed zones will need to be classified as permanent forests. Forest management plans should be drawn up for the permanent forests. The surrounding non-permanent forest will need more detailed studies and prescriptions specially adapted to the inhabitants' needs. These subsequent actions should be done at a larger mapping scale, with more detailed studies, directed to more precise stakeholders. Local inhabitants will develop great expectations after being incorporated in a mediation process. The implementation becomes a very important aspect, if it is not rapidly conducted, people will be disappointed. They will feel cheated if promised benefits do not reach them. The implication of the inhabitants in sustainable management or conservation of the forests depends greatly on the economic development of their area.

The implementation of the MMP should always remain as flexible as possible and should function as an adaptive process. The management proposals of the area are formulated according to the presently available information and directed towards actions in the future. The problem is that nobody can predict what the future will exactly be. The objectives can change or some land uses that are not relevant now could become of great importance in the coming years.

[15] This was done in Kribi in August 2000. The procedure used will be described in the final report of Econ2. The result has no legal status.

Future studies and improved knowledge of the area will definitely lead to adjustments of the original management proposals. It is suggested that the revision of the MMP should be done every ten years. The mediation process and participatory approach will also be improved. Appropriate modifications should be undertaken when necessary.

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ANNEXES

Annex I	Description borders Tropenbos-Cameroon Programme research area
Annex II	Rainfall and temperature charts of Kribi, Ebolowa and Lolodorf meteorological stations
Annex III	Soil characteristics Tropenbos-Cameroon Programme research area
Annex IV	Suitability ratings (LUT/LMU)
Annex V	Minimum cultivable area; projection to the year 2019
Annex VI	Impact matrix
Annex VII	Comparative analysis of three forest management alternatives

ANNEX I DESCRIPTION BORDERS TCP RESEARCH AREA

Table I.1: Co-ordinates of the boundary marks, TCP research site. For boundary marks: see Figure I.1.

Coordinates		
Boundary Mark	**Latitude**	**Longitude**
1	10º25.59'	2º47.84'
2	10º25.59'	2º59.40'
3	10º24.04'	3º04.53'
4	10º32.84'	3º10.16'
5	10º35.13'	3º08.11'
6	10º42.76'	3º12.02'
7	10º48.91'	3º11.90'
8	10º48.91'	3º03.44'
9	10º51.13'	3º02.48'
10	10º51.13'	2º55.66'
11	10º49.22'	2º56.80'
12	10º49.22'	2º53.14'
13	10º43.70'	2º53.14'
14	10º43.70'	2º51.31'
15	10º41.93'	2º51.31'
16	10º41.93'	2º49.10'
17	10º30.86'	2º47.84'

Table I.2: Description of the borders of the TCP research area. For boundary marks see Figure I.1.

Boundary Mark		**Direction**	**Distance**	**Observations**	**Type**
From	To	º	m		
1				Southwest corner of site	
1	2	0	20,890.3	Straight line north	Li
2	3	North	11,257.1	Following Mvié-Bipindi road	Ro
3	4	North-east	20,325.0	Following Bipindi-Lolodorf road	Ro
4	5	45	5,702.4	Straight line south east	Li
5	6	North-east	22,078.5	Following upstream Lokoundjé river	Ri
6	7	East	16,384.9	Following upstream river	Ri
7	8	180	15,604.4	Straight line south	Li
8	9	South-east	4,263.9	Following river	Ri
9	10	180	12,804.1	Straight line south	Li
10	11	West	5,375.9	Following river	Ri
11	12	180	6,915.0	Straight line south	Li
12	13	270	10,348.5	Straight line west	Li
13	14	180	3,302.3	Straight line south	Li
14	15	270	3,498.6	Straight line west	Li
15	16	180	4,089.6	Straight line south	Li
16	17	West	22,160.5	Following Ebolowa-Kribi road	Ro
17	1	270	9,914.3	Straight line west	Li
		Total :	194,915.3		
		River sides (Ri) :	48,103.2		
		Road sides (Ro) :	53,742.6		
		Straight lines (Li) :	93,069.5		

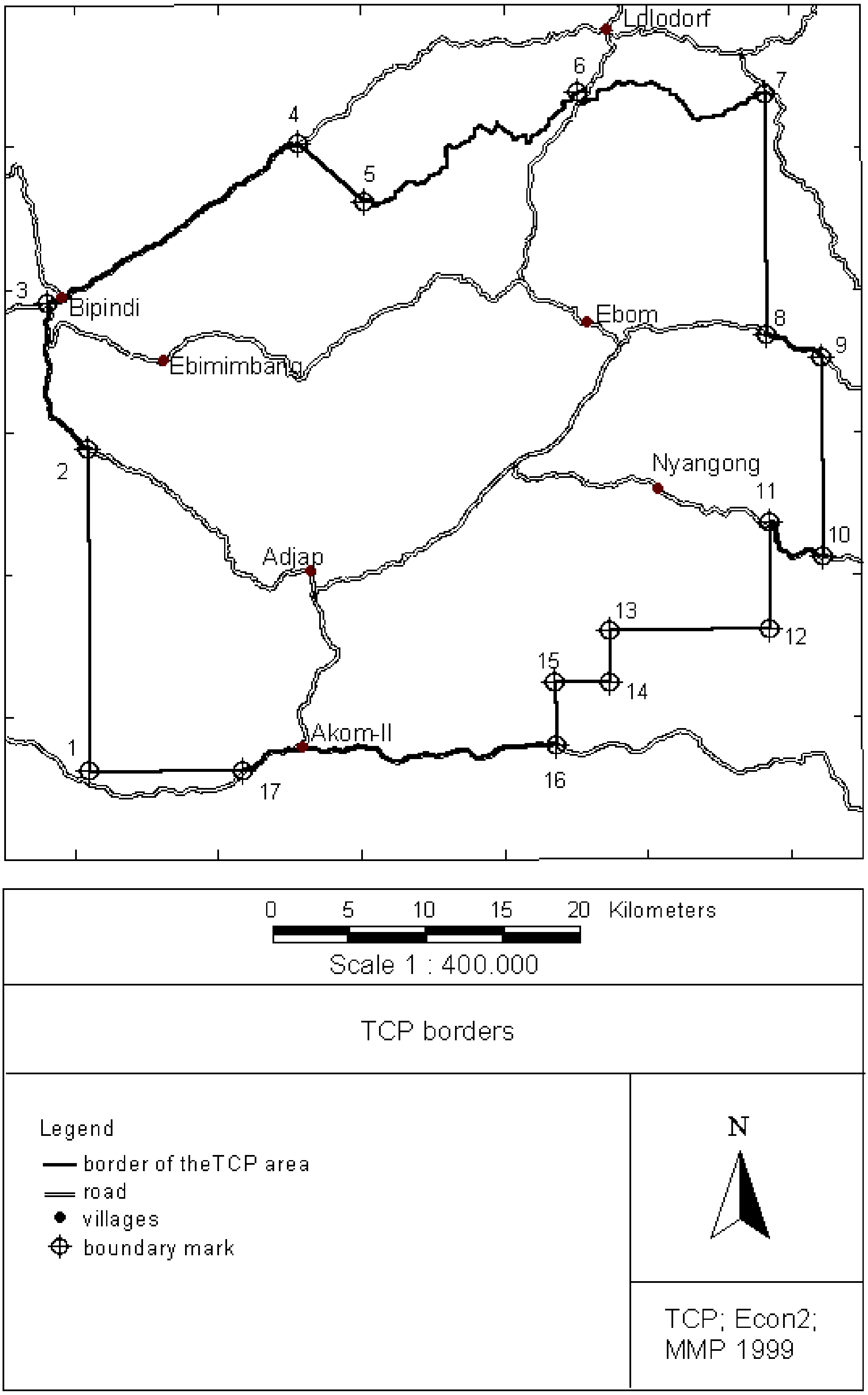

Figure I.1: Borders and boundary marks of the TCP research area.

ANNEX II RAINFALL AND TEMPERATURE AT KRIBI, EBOLOWA AND LOLODORF METEOROLOGICAL STATIONS

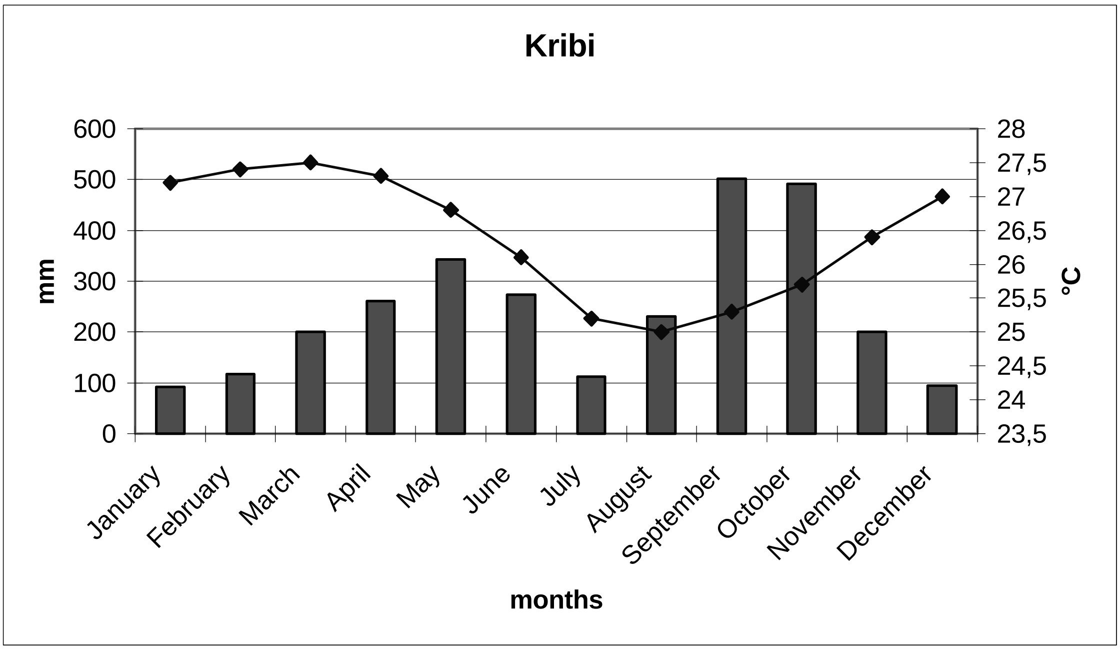

Figure II.1: Monthly mean rainfall (column) and temperature (line), Kribi meteorological station

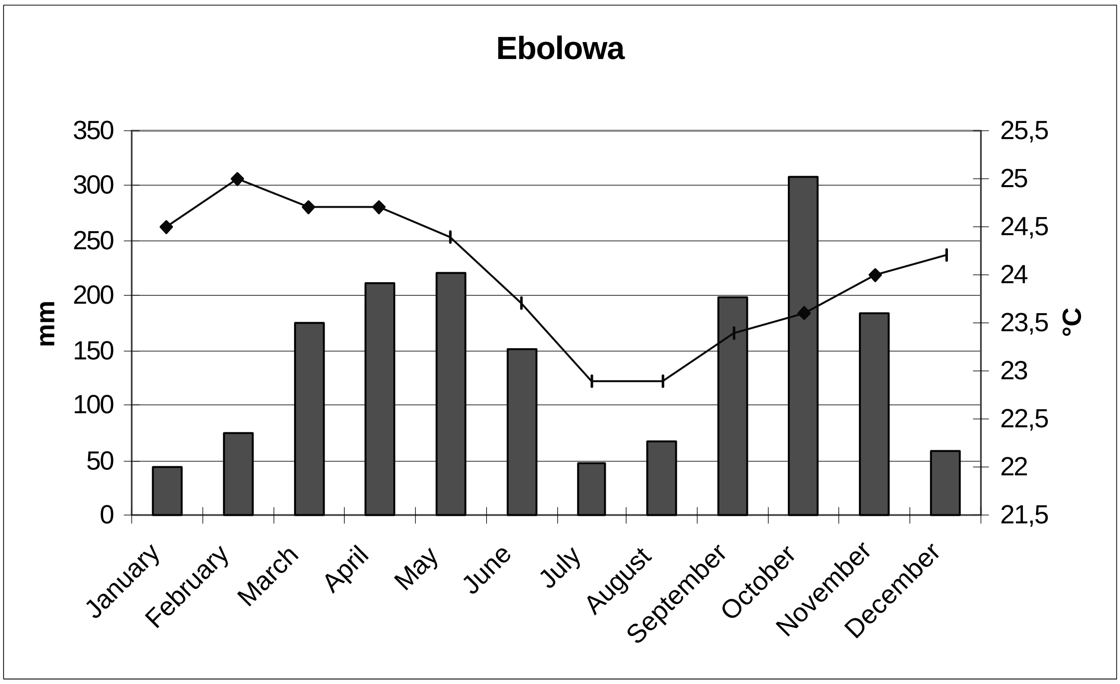

Figure II.2: Monthly mean rainfall (column) and temperature (line), Ebolowa meteorological station

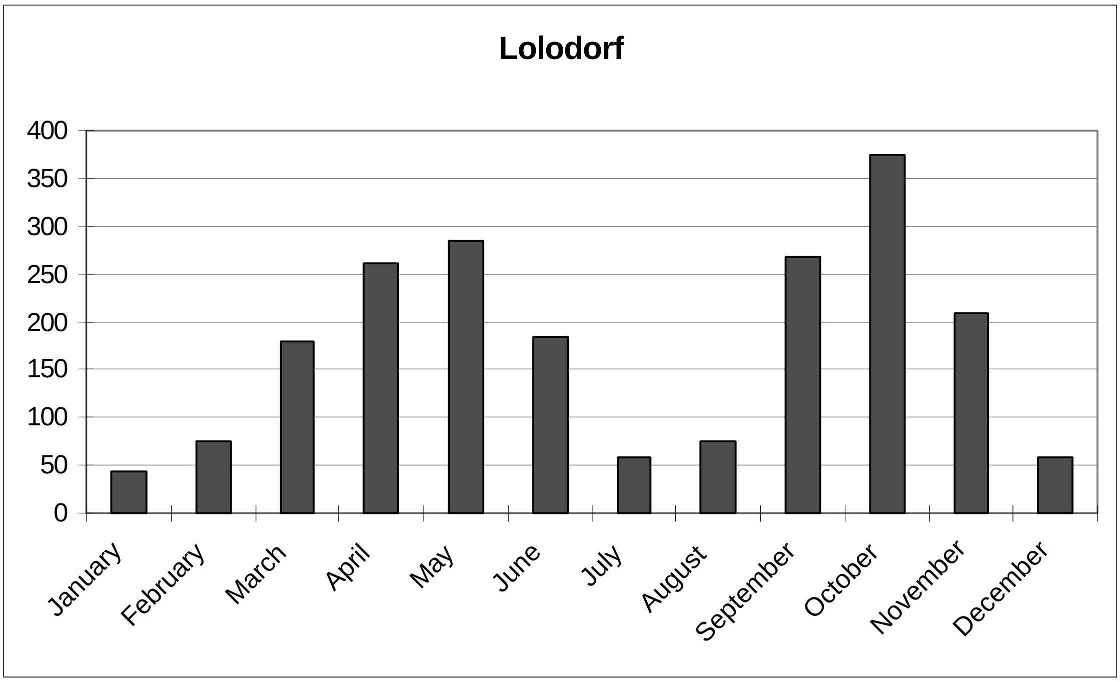

Figure II.3: Monthly mean rainfall (column) and temperature (line), Lolodorf meteorological station

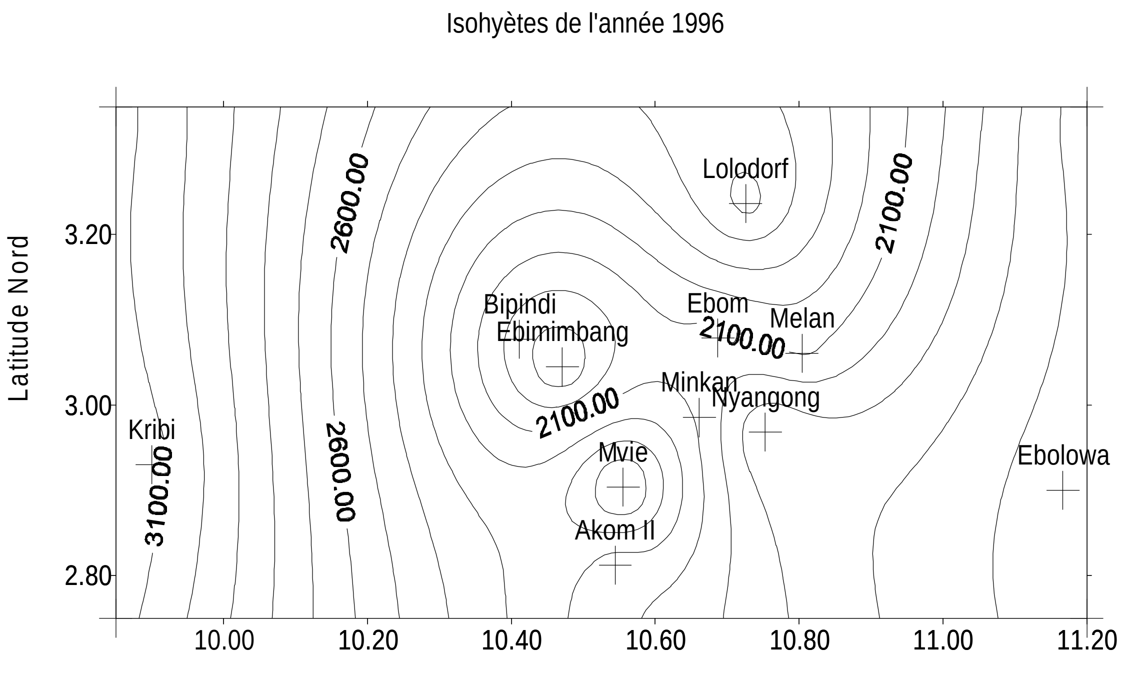

Figure II.4: Rainfall distribution (mm per year) between Kribi and Ebolowa (south Cameroon) in 1996.

ANNEX III SOIL CHARACTERISTICS TCP RESEARCH AREA

Table III.1: Soil physical characteristics of the Nyangong, Ebom and Ebimimbang soils (source: van Gemerden and Hazeu, 1999).

Soil type	Depth[1]	Texture			Bulk density[2]	AWC[3]
		Clay	Silt	Sand		
		%	%	%	g/cm^3	%
Nyangong	1	35-70	10-20	10-40	1.03	10
	2	50-80	5-15	10-40	1.21	12
	3	-	-	-	1.26	7
Ebom	1	20-50	5-20	40-60	1.22	17
	2	35-60	5-15	30-50	1.37	16
	3	-	-	-	1.4	12
Ebimimbang	1	0-25	5-15	60-90	1.3	11
	2	20-45	5-15	40-80	1.55	15
	3	-	-	-	1.63	n.a.

[1] Soil depth classes: 1 = 0-20 cm; 2 = 20-60 cm; 3= 60-90 cm.
[2] Bulk density values are the average of at least 4 observations.
[3] AWC = Available Water Content (one or two observations per soil depth class).

Table III.2: Ranges in some chemical characteristics of the four soil types in the TCP research area (source: van Gemerden and Hazeu, 1999).

Soil type	Depth[1]	$PH_{(H2O)}$	Total N	O.C.[2]	Available phosphorous
			%	%	Ppm
Nyangong	1	3.5-4.5	0.25-0.40	4.0-9.0	4-11
	2	4.0-5.0	0.10-0.15	1.0-3.0	0-3
Ebom	1	3.5-5.0	0.25-0.50	4.0-8.0	12-26
	2	4.0-5.0	0.05-0.15	0.5-1.5	1-4
Ebimimbang	1	5.0-6.0	0.15-0.35	2.0-3.5	10-24
	2	4.5-5.5	0.02-0.06	0.2-0.6	1-4
Valley Bottom	1	5.0-6.0	0.25-0.40	2.5-6.5	30-60
	2	4.5-5.5	0.05-0.20	0.1-0.7	2-10

[1] Soil depth: 1 = topsoil, generally 0-10 cm; 2 = Subsurface horizon of about 20-60 cm depth.
[2] O.C. = Organic carbon

Table III.3: Ranges in some nutrient characteristics of the four soil types in the TCP research area. All values, except BS, in Meq per 100g (source: van Gemerden and Hazeu, 1999).

Soil type	Depth[1]	K^+	Mg^{++}	Ca^{++}	TEB[2]	Al^{+++}	ECEC[3]	CEC	BS[4]
		Meq per 100 g soil							%
Nyangong	1	0.1-0.5	0.2-0.8	1-2	1.5-3.5	4-9	6-10	10-20	10-20
	2	0-0.1	0-0.5	0.2-0.6	0.5-1.2	2-6	5-7	6-9	5-15
Ebom	1	0.1-0.9	0.4-1.6	0.5-4	2-5	0.5-0.6	4-9	12-25	10-50
	2	0-0.2	0-0.5	0-0.5	0.3-1	2-5	3-6	5-8	5-20
Ebimimbang	1	0.1-0.7	0-1.5	1-8	3-7	0-3	3-10	4-12	5-100
	2	0-0.2	0-0.5	0-2	0.2-1.5	1-2.5	1.5-1	2-6	10-70
Valley Bottom	1	0-0.5	0.3-1.5	0.5-4	4.5-6	0-3	5-7.5	7-17	15-50
	2	0-0.1	0-0.2	0-0.5	0.5-0.8	0-1.5	0.5-2	1-8	20-40

[1] Soil depth: 1 = topsoil, generally 0-10 cm; 2 = subsurface horizon of about 20-60 cm depth.
[2] TEB = Total Exchangeable Bases.
[3] ECEC = Effective Caution Exchangeable Capacity.
[4] BS = Base Saturation.

ANNEX IV SUITABILITY RATINGS (LUT/LMU)

Table IV.1: Suitability (1 = suitable; 2 = moderately suitable; 3 = marginally suitable; 4 = not suitable) of LMUs for Flora and Fauna Conservation and Production of NTFPs and Timber.

LMU	Flora	Fauna		NTFP production	Timber production
	Conservation/ Biodiversity	from road and village			
		> 3 km	< 3 km		
Ah1 u	1	3	4	3	4
Am u	1	3	4	3	4
Bh1 u	1	1	4	2	4
Bh1 l	2	2	4	2	4
Bh2 u	1	1	4	1-2[1]	3-4[2]
Bh2 l	2	2	4	1-2[1]	3-4[2]
Bh2 h	3	3	4	1-2[1]	4
Bu2 u	1	2	4	1	2-3[3]
Bu2 l	2	3	4	1	2-3[3]
Bu2 h	3	4	4	1	4
Bu1 u	1	2	4	1	2
Bu1 l	2	3	4	1	2
Bu1 h	3	4	4	1	3
Ch1 u	1	1	4	2	4
Ch1 l	2	2	4	2	4
Cu2 u	1	2	4	1	2-3[3]
Cu2 l	2	3	4	1	2-3[3]
Cu2 h	3	4	4	1	4
Cu1 u	1	2	4	1	2
Cu1 l	2	3	4	1	2
Cu1 h	3	4	4	1	3
Dh1 u	1	1	4	2	4
Dh1 l	2	2	4	2	4
Du2 u	1	2	4	1	2
Du2 l	2	3	4	1	2
Du2 h	3	4	4	1	4
Du1 u	1	2	4	1	2-3[3]
Du1 l	2	3	4	1	2-3[3]
Du1 h	3	4	4	1	3
Dpd u	1	2	4	1	1-2[4]
Dpd l	2	3	4	1	2
Dpd h	3	4	4	1	3
Ev u	2	3	4	2	4
Ev l	2	3	4	1	4

[1] Suitable if slope < 30%, moderately suitable elsewhere.
[2] Marginally suitable if slope < 30%, not suitable elsewhere.
[3] Moderately suitable if slope < 20%, marginally suitable elsewhere.
[4] Suitable if slope < 10%, moderately suitable elsewhere.

Table IV.2: Suitability of LMUs for various agricultural uses (1 = suitable; 2 = moderately suitable; 3 = marginally suitable; 4 = not suitable)

LMU	Shifting cultivation	Cacao	Pineapple	Oil palm	Hevea
Ah1 u	4	4	4	4	4
Am u	4	4	4	4	4
Bh1 u	4	4	4	4	4
Bh1 l	4	4	4	4	4
Bh2 u	3-4[1]	3-4[1]	4	3-4[1]	3-4[1]
Bh2 l	3-4[1]	3-4[1]	4	3-4[1]	3-4[1]
Bh2 h	3-4[1]	3-4[1]	4	3-4[1]	3-4[1]
Bu2 u	2-3[2]	2-3[2]	3-4[3]	2-3[2]	2-3[2]
Bu2 l	2-3[2]	2-3[2]	3-4[3]	2-3[2]	2-3[2]
Bu2 h	2-3[2]	2-3[2]	3-4[3]	2-3[2]	2-3[2]
Bu1 u	2-3[2]	2-3[2]	3-4[3]	2-3[2]	2-3[2]
Bu1 l	2-3[2]	2-3[2]	3-4[3]	2-3[2]	2-3[2]
Bu1 h	2-3[2]	2-3[2]	3-4[3]	2-3[2]	2-3[2]
Ch1 u	4	4	4	4	4
Ch1 l	4	4	4	4	4
Cu2 u	2-3[2]	2-3[2]	3-4[3]	2-3[2]	2-3[2]
Cu2 l	2-3[2]	2-3[2]	3-4[3]	2-3[2]	2-3[2]
Cu2 h	2-3[2]	2-3[2]	3-4[3]	2-3[2]	2-3[2]
Cu1 u	2-3[2]	2-3[2]	3-4[3]	2-3[2]	2-3[2]
Cu1 l	2-3[2]	2-3[2]	3-4[3]	2-3[2]	2-3[2]
Cu1 h	2-3[2]	2-3[2]	3-4[3]	2-3[2]	2-3[2]
Dh1 u	4	4	4	4	4
Dh1 l	4	4	4	4	4
Du2 u	2-3[2]	2-3[2]	3-4[3]	2-3[2]	2-3[2]
Du2 l	2-3[2]	2-3[2]	3-4[3]	2-3[2]	2-3[2]
Du2 h	2-3[2]	2-3[2]	3-4[3]	2-3[2]	2-3[2]
Du1 u	2-3[2]	2-3[2]	3-4[3]	2-3[2]	2-3[2]
Du1 l	2-3[2]	2-3[2]	3-4[3]	2-3[2]	2-3[2]
Du1 h	2-3[2]	2-3[2]	3-4[3]	2-3[2]	2-3[2]
Dpd u	2	2-3[2]	3	2-3[2]	2-3[2]
Dpd l	2	2-3[2]	3	2-3[2]	2-3[2]
Dpd h	2	2-3[2]	3	2-3[2]	2-3[2]
Ev u	4	4	4	4	4
Ev l	4	4	4	4	4

[1] Marginally suitable if slope < 30%, not suitable elsewhere.
[2] Moderately suitable if slope < 16%, marginally suitable elsewhere.
[3] Marginally suitable if slope < 16%, not suitable elsewhere.

ANNEX V MINIMUM CULTIVABLE AREA: PROJECTION YEAR 2019

Table V.1: Minimum cultivable area per village, projection year 2019

N° village	Village	Sub-division	Number of Families	Mean used area per family[1]	Demographic Projection[2]	Minimum cultivable area needed	Distance from the road[3]
				ha	%	ha	km
18	Abiete	Akom II	39	10	0.6	437	1
11	Akom II	Akom II	188	15	0.6	3,159	5
1	Assok I	Akom II	66	10	0.6	739	3
23	Bibindi	Akom II	26	10	0.6	291	2
22	Bibole	Akom II	20	15	0.6	336	2
14	Biboulemam	Akom II	42	15	0.6	706	3
8	Ebemvok	Akom II	91	10	0.6	1,020	3
10	Ekowong	Akom II	28	10	0.6	314	2
12	Enyi anko	Akom II	58	15	0.6	975	3
21	Malomba	Akom II	32	15	0.6	538	2
4	Mbanga	Akom II	47	10	0.6	527	2
17	Mefane	Akom II	11	10	0.6	123	1
7	Mingoh	Akom II	12	10	0.6	134	1
16	Mvié	Akom II	83	10	0.6	930	3
13	Nemeyong	Akom II	55	15	0.6	924	3
6	Nkomakak	Akom II	107	15	0.6	1,798	4
9	Nkoo Mvomba	Akom II	18	10	0.6	202	2
5	Nlomoto	Akom II	73	15	0.6	1,227	3
20	Nlonkeng	Akom II	27	15	0.6	454	2
2	Nyabitande	Akom II	78	10	0.6	874	3
3	Nyabitandé	Akom II	2	10	0.6	22	1
15	Tchengue	Akom II	27	15	0.6	454	2
19	Toko	Akom II	30	15	0.6	504	2
35	Assok II	Bipindi	50	15	0.0	750	3
27	Bidjouka	Bipindi	202	15	0.0	3,030	5
28	Binzambo	Bipindi	3	10	0.0	30	1
24	Bipindi	Bipindi	110	10	0.0	1,100	3
29	Bongwana	Bipindi	22	15	0.0	330	2
32	Ebimimbang	Bipindi	102	15	0.0	1,530	4
36	Edo'omang	Bipindi	14	15	0.0	210	2
26	Lambi	Bipindi	83	15	0.0	1,245	3
25	Log Ndiga[4]	Bipindi	61	15	0.0	915	3
67	Mimbiate	Bipindi	5	15	0.0	75	1
33	Melen	Bipindi	32	15	0.0	480	2
31	Mindjo	Bipindi	4	15	0.0	60	1
66	Minfombo	Bipindi	15	10	0.0	150	1
34	Nyaminkoum	Bipindi	33	15	0.0	495	2
30	Sa'a	Bipindi	7	10	0.0	70	1
40	Tyango	Bipindi	49	15	0.0	735	3
37	Abo'ontomba	Ebolowa	20	10	2.0	291	2
41	Adjap-Essawo	Ebolowa	69	15	2.0	1,508	4
65	Bikouba	Ebolowa	20	15	2.0	437	2
55	Bityili	Ebolowa	8	15	2.0	175	2
46	Ebom	Ebolowa	99	15	2.0	2,163	4
63	Elon	Ebolowa	32	15	2.0	699	3
48	Engomba	Ebolowa	37	10	2.0	539	2
38	Kalate-Aba'a	Ebolowa	54	10	2.0	787	3
44	Ma'amenyin	Ebolowa	46	15	2.0	1,005	3
56	Mefak	Ebolowa	48	15	2.0	1,049	3
51	Meka'a II	Ebolowa	39	15	2.0	852	3
47	Mekalat	Ebolowa	29	10	2.0	422	2
42	Melan	Ebolowa	19	15	2.0	415	2
64	Melangue Biyeng	Ebolowa	34	10	2.0	495	2
50	Messambe	Ebolowa	26	15	2.0	568	2

Table V.1: Minimum cultivable area per village, projection year 2019 (continued).

N° village	Village	Sub-division	Number of Families	Mean used area per family[1]	Demographic Projection[2]	Minimum cultivable area needed	Distance from the road[3]
				ha	%	ha	km
43	Mfala	Ebolowa	36	15	2.0	787	3
49	Minkan	Ebolowa	27	15	2.0	590	2
54	Nko Adjap	Ebolowa	5	15	2.0	109	1
45	Nkoekouk	Ebolowa	95	15	2.0	2,076	4
39	Nkoutou	Ebolowa	25	10	2.0	364	2
52	Nyangong	Ebolowa	54	15	2.0	1,180	3
53	Yem-Essakoe	Ebolowa	18	10	2.0	262	2
62	Mbango Kaba	Lolodorf	8	10	1.4	104	1
61	Mbango-Bitouer	Lolodorf	88	10	1.4	1,146	3
59	Mbango-Boulou	Lolodorf	34	15	1.4	664	3
60	Mbango-Ngoumba	Lolodorf	14	15	1.4	273	2
57	Melangue Mvog Esson	Lolodorf	17	15	1.4	332	2
58	Ngongo	Lolodorf	6	15	1.4	117	1

[1] Figures obtained with the socio-economic survey (Lescuyer *et al.*, 1999).
[2] Figures obtained with the census of 1965, 1976, 1987 and 1999
[3] Minimum distances from the road kept for agricultural uses.
[4] Bipindi rural.

ANNEX VI IMPACT MATRIX

Table VI.1: Example of an Environmental Impact Assessment table as used by the Tropenbos-Cameroon Programme.

Types of Impact	**Master Management Alternatives**			
	Production	*Protection*	*Agroforestry*	*Unchanged*
Economic Impacts				
Employment				
Net Local Incomes				
Net Public Incomes				
Net National Benefits				
Environmental Impacts				
Water Regulation and Supply				
Erosion Control				
Climate and Air Quality				
Food and Raw Materials Production				
Fauna & Flora Diversity				
Fauna & Flora Quality				
Social Impacts				
Village Basic Equipment				
Road/Transport System				
Traditional Tenure System				
Intra-village Relationships				
Valorisation of Local Human Resources				

ANNEX VII COMPARATIVE ANALYSIS OF THREE FOREST MANAGEMENT ALTERNATIVES

Table VII.1: A Comparative Analysis of three forest management alternatives (timber production, protection of the environment and agroforestry).

Step1	Step 2	Step 3			Step 4		
Environmental Impacts	**Relative Importance**	**Magnitude of impact in each alternative**			**Final Index**		
		Production	***Protection***	***Agroforestry***	***Production***	***Protection***	***Agroforestry***
Employment	6	9	2	8	54	12	48
Local Income	8	5	4	10	40	32	80
Public Revenue	7	8	4	4	56	28	28
Fauna Diversity	4	3	9	6	12	36	24
Flora Diversity	3	4	9	5	12	27	15
Water Quality	3	4	8	5	12	24	15
Soils	4	5	7	4	20	28	16
Climate	2	2	8	5	4	16	10
Land Use Conflict	7	2	2	5	14	14	35
Transport System	6	7	5	7	42	30	42
					266	**247**	**313**

ANNEX VIII MAPS