TECHNICAL PAPER 21

Baseline biological surveys in selected East Usambara forest reserves and forests, 1995-96

Project Evaluation Report

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East Usambara Catchment Forest Project

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Project Evaluation Report

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Table of Contents: **Page**

1.0   Summary

1.1   This report presents the findings of an evaluation of the project entitled 'baseline biological surveys in selected East Usambara forest reserves and forests', carried out between 18 and 28 August, 1996.

1.2   The project was initiated in July 1995 and is executed by Frontier Tanzania, under contract to the East Usambara Catchment Forest Project. The aims of the project are to provide baseline information on the biological values of different forests as a basis for management planning and long-term monitoring, as well as training Tanzanian personnel and overseas students in the use of biological inventory techniques.

1.3   An ambitious and wide-ranging programme of work has been carried out over three ten-week phases, and a fourth phase is currently underway. Altogether this will provide systematic inventory information an the flora and fauna of seven forests in the East Usambaras, namely Bamba, Mlungui, Marimba, Longuza North, Kambai, Semdoe and Mtai. Earlier work (during 1994/95) by Frontier provides additional information on the biodiversity values of Magoroto, Manga and Kwamgumi forests.

1.4   The work has become progressively more systematic and quantitative, and a strong team of "permanent" Frontier staff is now in place to provide the management, technical input and continuity necessary for a successful outcome to the project. The project has already resulted in the discovery of several taxa previously unknown to science, and this will undoubtedly raise awareness of the unique biodiversity values of the East Usambaras, and thereby contribute to the achievement of conservation objectives.

1.5   The field work programme makes excellent use of Frontier's experience and organisational strengths, and is generating an enormous amount of potentially useful data in a highly cost-effective manner. The immediate challenge is to transform this substantial resource into a final output that is relevant and useful to management. This will require a concerted effort to develop data management capacity and write up the results of each survey in a systematic manner.

1.6   The systematic field sampling methods now employed are generating data that are generally reliable and relevant to management. However, at present rates of progress, it would take about eight years to complete the survey of all the protected forests of East Usambara, and a reduced sampling intensity is recommended to speed up the work and ensure adequate coverage. Furthermore, a tighter focus to the animal survey work is necessary, concentrating on relatively few taxa, where adequate samples and reliable identifications can be obtained, in the expectation of establishing clear priorities for conservation management of particular areas/sites.

1.7   The following recommendations are provided:

Recommendation 1. The botanical inventory work should continue to use a systematic approach, but with a reduced sampling intensity, spacing transects 900 metres apart on the N-S axis, and 450m apart on the E-W axis.

Recommendation 2. A strategic approach should be adopted in the selection of forests, so as to ensure that representative examples of the full range of biodiversity values are sampled as early as possible.

Recommendation 3. Efforts should be made to compile a complete list of trees and shrubs for each forest block, by carrying out opportunistic sampling in addition to the systematic botanical work.

Recommendation 4. Special attention should be given to endemic species, which should be the primary focus of all the biodiversity work.

Recommendation 5. Two specimens, and a comprehensive field description of each tree species encountered in each forest block should be collected and maintained in a small herbarium.

Recommendation 6. To ensure consistency in taxonomic nomenclature, a standard checklist (including a list of synonyms) should be compiled as soon as possible, and used throughout the life of the project.

Recommendation 7. The animal inventory work should be focused on a limited number of 'core' groups of fauna.

Recommendation 8. Inventory work on 'non-core' groups of fauna should be discontinued, in the interests of saving time, that can be more profitably used by increasing sampling intensity for the 'core' taxa.

Recommendation 9. The collection of animal tissue samples should be continued, subject to confirmation from the University of Copenhagen that they are still required.

Recommendation 10. The soil assessment work should be scaled down substantially, or even discontinued.

Recommendation 11. The forest profile work should be discontinued.

Recommendation 12. The disturbance transects should be accorded priority status in the assessment work, and be modified to increase precision, and focus on use of building poles and timber.

Recommendation 13. The socio-economic survey work should be discontinued, and alternative approaches to community participation in forest protection and management should be explored by the Forestry and Beekeeping Division and/or the EUCFP.

Recommendation 14. In order to clarify thinking on data requirements a 'model' report should be developed for one of the sites that has already been surveyed.

Recommendation 15. Despite the obvious attractions of developing a comprehensive

computerised biodiversity database to store and process data generated by the surveys, simple manual methods of data management should be used initially to ensure that key results are written up in a timely manner.

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Recommendation 17. All biodiversity data should be entered onto a relational database.

Recommendation 18. A standard format for the (tabulated) presentation of data in the Biodiversity survey reports should be established and the necessary routines (`macros') written to extract the data from the database.

Recommendation 19. Consideration should be given to the need for more sophisticated analysis and/or graphic presentation of biodiversity inventory results.

2.0   Introduction

This report presents the findings of an evaluation of the project of `baseline biological surveys of selected forests and forest reserves in East Usambara'. The project is executed by Frontier - Tanzania, under contract to the East Usambara's Catchment Forest Project (EUCFP), and is aimed at providing information on the fauna and flora of different forests in the area, as a basis for management planning and long-term monitoring.

The project was started in July 1995, although Frontier has carried out biological inventory work in the East Usambaras since 1994, and other Tanzanian forests since 1989. The field work involves short-term expatriate volunteer Research Assistants (RAs), as well as permanent Frontier staff, EUCFP personnel and an international network of taxonomists and other experts. The fieldwork is carried out in ten-week phases, each involving a new group of RAs, and three phases were completed between July 1995 and March 1996 under the initial contract with the EUCFP. An evaluation of this work was planned for early 1996, but was delayed until August for a number of reasons. Consequently, the Frontier contract was extended to include one additional ten-week phase, and the evaluation exercise organised to coincide with this. The aim of the evaluation is to provide the basis for a decision on whether to continue the work, and if so, how to improve the field surveys, data collection and analysis and reporting procedures. A full terms of reference for the evaluation is provided in Appendix 1.

3.0   Evaluation procedure and itinerary

The evaluation was carried out over a period of 11 days between 18 and 28 August 1996 by one consultant with extensive experience of biological inventory work in Ugandan forests. The exercise was based at the EUCFP Office in Tanga, and involved three full days of fieldwork in the Usambara forests, assessing field methods and procedures with Frontier project staff, RAs and taxonomists. The remainder of the time was spent discussing aspects of the programme, reviewing project documents and other literature (see list, Appendix 4), and writing this report. A detailed itinerary is included in Appendix 3.

4.0   Evaluation results

4.1   Appropriateness of project objectives

As stated under paragraph 2 of the project's terms of reference, the aims and objectives of the surveys are:

1.   To conduct biological baseline surveys in selected gazetted forests and forests which are proposed for gazettement;

2.   To provide information on the biological value and importance of these forests to assist in the development of management plans and practices for these forests;

3.   To develop a system for monitoring aspects of biodiversity, both on a general as well as a forest-specific level;

4.   To provide training to Tanzanian personnel from EUCFP, and other institutions suck as Tanzania Forestry Research Institute (TAFORI), the Forestry and Beekeeping Division (FBD), and the UDSM to improve their capacity to collect baseline forest survey data and conduct future long-term monitoring of the East Usambara forests; and

5.   To train overseas students in conducting baseline biological surveys, and provide an opportunity for individual research.

These are further elaborated under paragraph 3 (methods) of the project's terms of reference. In general, the objectives are clear and comprise an important component of the broader objectives of the EUCFP. Since the central mission of the EUCFP is the conservation of the unique biodiversity of the East Usambaras, a knowledge of that biodiversity, and an ability to monitor the effect of the project (and other interventions) on it, should clearly be an important element of the EUCFP. In sub-contracting this work to Frontier, the EUCFP management is making good use of available expertise which it does not have within the project.

Whilst the biological survey project objectives (as stated above) are fairly clear, they could perhaps be re-stated and elaborated to make more explicit their management implications and purpose. From discussions with EUCFP and Frontier project staff, it seems clear that the biological surveys relate directly management in two important respects:

(a)   The surveys are intended as a means of determining the relative importance of different areas for biodiversity conservation, so that forest management zones can be designated for different uses according to their suitability for each use. Areas of high biodiversity value ("hotspots"), as determined by the surveys, would thus be selected for biodiversity preservation and afforded the highest level of protection. At the same time, areas of low biodiversity value, which are heavily used by forest-adjacent communities, may be designated for the development of collaborative management/community-use zones; and

(b)   The surveys are intended as a means of assessing the impact of the project (and other factors) on the biological resources of East Usambaras, by providing baseline information against which to monitor change over time. Successful management interventions, which result in an improvement in the biodiversity status of the area (including, hopefully, the EUCFP!) can consequently be justified and enhanced, whilst new management efforts are directed at areas where biodiversity loss becomes apparent as a result of monitoring.

A revised statement of objectives, which explicitly recognises these management goals is proposed as follows:

The aims of the surveys are:

1.   To conduct biological surveys in selected forests as a baseline against which to monitor future changes in biodiversity status resulting from interventions supported by the EUCFP and/or other factors;

2.   To provide information on the biological value of different areas within each forest, at the finest possible level of resolution, and assist in the identification of areas most suitable for biodiversity conservation within a multiple-use forest management system;

3.   To provide information on human disturbance and levels of resource use in different areas of each forest, at the finest possible level of resolution, and assist in the identification of areas most suitable for community-use within a multiple-use forest management system;

4.   To develop specific, quantitative methods of monitoring key biodiversity indicators, and assist in establishing long-term monitoring procedures to address specific aspects of forest ecology and management such as regeneration and hunting;

5.   To raise awareness of the biodiversity values of the East Usambaras nationally and internationally through the discovery and description of unique taxa, never previously described;

6.   To train Tanzania personnel (from EUCFP; UDSM, the Tanzania Forestry Research Institute (TAFORI) and the Forest and Beekeeping Division) in forest survey work;

7.   To train overseas students in forest survey work, and provide an opportunity for individual research; and

8.   To contribute to global biodiversity assessment and conservation efforts through collaboration with specialists elsewhere, and the sharing of information, data and material collected during the surveys.

4.2   Overview of progress in relation to survey terms of reference

The programme of work outlined in the terms of reference has been followed, with three ten-week phases completed between July 1995 and March 1996. Each of the five forests listed in the terms of reference was visited (as well as one extra, Longuza North), and surveyed according to the agreed systematic survey methods. This has been a major achievement, not least because of the extremely difficult terrain.

The systematic sampling of vegetation on a 450 x 450m grid provides the framework for work on all other taxa. As described in the terms of reference, quadrats of 0.1ha (20 x 50m) are established at each grid intersection, providing a sampling intensity of 0.5%. In practise, this level of sampling intensity was achieved at Mlungui, Marimba and Kambai, but not at Bamba Ridge and Semdoe (of the forests specified for survey work in the terms of reference), nor at Longuza North (Table 1). This was partly because of the very steep and inaccessible terrain (at Bamba Ridge), and partly because of over-ambitious targets (completion of Kambai and Semdoe in the same phase). Sampling of all animal taxa was accomplished according to plan, although quantitative targets were generally less specific for these groups. Overall, the field work targets specified in the terms of reference were largely achieved, and even exceeded in some respects.

Table 1. Forests surveyed by Frontier using systematic methods.

Forest	Area (ha)	Work phase	No. of 0.1ha plots required at 0.5% intensity	No. of 0.1ha plots actually surveyed
Bamba Ridge	1,131	1	57	32
Mlungui	200	1	10	10
Marimba	887	2	44	50
Longuza North	360	2	?	20
Kambai	1,046	3	52	60
Semdoe	901	3	45	15
TOTAL				**187**

Progress in respect of data analysis and reporting has been slower, with only one of the planned biodiversity reports completed by August, 1996. The delays in reporting are partly due to the fact that systems of data management are not in place; partly the result of delays in specimen identification, and perhaps more importantly, the result of inadequate provision of staff time to this work.

4.3   Review of botanical inventory work

4.3.1   Relevance

        Clearly the botanical inventory work represents the "core" of the biodiversity assessment, since data are collected at a high level of "resolution"; and there is already a good basic knowledge of the species present in the area, their distributions and biogeographical significance. The aim is to build on the existing knowledge and provide more detailed information to assist in identifying biodiversity "hotspots" for priority attention in conservation management. Trees and shrubs are probably the best group for this since they exhibit a high degree of endemism in the East Usambaras, and they do not move about like animals! Because of the many earlier studies on trees and shrubs it is possible to interpret the results of the surveys, and "value" species according to their endemic status, and economic uses.

There have been problems with earlier inventories of East Usambara trees, as a basis for conservation planning. The AFIMP inventory of 1986-87 provides the best available general assessment, but its purpose was primarily an assessment of timber values, and insufficient attention was given to distinguishing non-commercial endemic taxa, which should be the focus of biodiversity interest. A later rapid assessment was carried out by IUCN (Hamilton, 1989) based on variable-area tree plots established along gradient-oriented transects in three widely separated areas of the East Usambaras. This was a well-planned strategic assessment which overcame the taxonomic difficulties of the AFIMP survey, but was very limited in geographical scope. It is expected that the Frontier programme can combine the best of these

two earlier assessments (i.e. the systematic and wide-ranging approach of AFIMP, and the taxonomic precision of IUCN), and thus provide a firm basis for decisions on management zoning, and the identification of priority sites for biodiversity conservation.

4.3.2   Progress

As reported above (Table 1), approximately 18.7ha (187 plots) were assessed during the first year of the Frontier programme. This compares with a total "target" of 167ha (1670 plots) if all areas presently designated as forest reserves (or destined to become so) are to be sampled at 0.5% using the systematic sampling methods currently employed (see EUCFP Working Paper 19, Table 19 for area breakdown). Most of the work accomplished to date has been carried out in areas that were not sampled, or poorly sampled ("inaccessible areas") by the AFIMP survey.

4.3.3   Options

Clearly, completion of the systematic botanical work using existing methods and sampling intensity will take more than 8 years, and that is just the field work! For management zoning, the results are required much sooner that this, so alternative approaches have to be considered. The options discussed during the evaluation were:

(a)   Continue as now, targeting different forest blocks is a strategic manner to provide information which could, if necessary, be extrapolated to areas not surveyed.   In essence, this was Hamilton's approach, recognising and sampling "gradients" of biodiversity value from north to south; and in respect of aspect and altitude;

(b)   Continue with the systematic grid, but reduce the sampling intensity to increase the area covered each phase;

(c)   Adopt an alternative sampling strategy, based on stratification of the forest into different forest types from aerial photo-interpretation. Sample a limited number of plots within each stratum, and thereby make an assessment of the biodiversity value of each stratum. The forest type map can then be used as the basic tool for management zone planning; and

(d)   Based on existing knowledge of species distributions, adopt a more strategic sampling strategy similar to the Hamilton approach, and based on the use of 'gradsects' (transects established between the highest and lowest points of a forest block). Plots would be established at pre-determined intervals (probably based on altitude), and different gradsects established to sample slopes of different aspect, and different forest blocks throughout the range.

Of these options, the systematic approach is preferred because the field work depends on non-professional volunteer labour which may encounter difficulties in the placing of non-systematic transects and/or sample plots, and because the interpretation and presentation of results is relatively straightforward with a systematic plot layout.

4.3.4   Recommendations

The following recommendations on the botanical survey work are based on the above considerations, and more specific requirements identified through discussion with the field botanists, project staff and observations in the field:

Recommendation 1. The botanical inventory work should continue to use a systematic approach, but with a reduced sampling intensity, spacing transects 900 metres apart on the N-S axis, and 450m apart on the E-W axis. The basic grid, covering the entire project area, should be established at the beginning so that plots in different forest blocks are aligned along the same N-S or E-W transect lines. Prospective plots should be planned and numbered throughout the range at this initial stage so as to facilitate later analysis and presentation of data.

Recommendation 2. A strategic approach should be adopted in the selection of forests, so as to ensure that representative examples of the full range of biodiversity values are sampled as early as possible. Initial priority should be given to sampling intact forest at highest and lowest altitude, and examining forests representative of the wettest and driest conditions represented in the East Usambaras. For the next three phases, work in Mtai should be completed (so that data analysis can be undertaken; phase I), before moving to the high altitude areas of Lutindi (phase 2) and the low-lying, wet areas of Amani South (phase 3).

Recommendation 3. Efforts should be made to compile a complete list of trees and shrubs for each forest block, by carrying out opportunistic sampling in addition to the systematic botanical work. The botanists should make special efforts to visit unusual habitats which may not fall within the plots: hill and mountain tops, rocky outcrops, gallery forests, wetland patches, and so on. It is likely that many species will not be encountered in plots representing 0.25% of the vegetation, as now proposed for systematic sampling.

Recommendation 4. Special attention should be given to endemic species, which should be the primary focus of all the biodiversity work. The botanists, in particular, should make particular efforts to ensure that they are thoroughly familiar with the distinguishing features of the endemics. To assist in this, a loose leaf file containing photocopies of the ' Flora of Tropical East Africa' descriptions of each endemic should be maintained in camp, and herbarium specimens and field notes on each should be collected by the project botanists and kept in the project office for constant reference. It is all too easy for the botanists to lump, for example, all *Cola* species into one category - as was done in the AFIMP inventory, and by local people who distinguish only 'Muungu'.   To do so, undermines the central purpose of the work.

Recommendation 5. Two specimens, and a comprehensive field description of each tree species encountered in each forest block should be collected and maintained in a small herbarium. This provides an opportunity for subsequent checking of botanical identifications and reliability, and encourages the botanists to take care with difficult identifications (rather than making a wild guess, in the knowledge that nobody will ever be any the wiser). The field descriptions should be made on a standard form, and include notes on tree size, form, buttressing, bark, slash and leaves.

Recommendation 6. To ensure consistency in taxonomic nomenclature, a standard checklist (including a list of synonyms) should be compiled as soon as possible, and used throughout the life of the project. It may be necessary to commission this work as a small sub-contract.

4.4   Review of faunal inventory work

4.4.1   Relevance

There are several reasons for undertaking work on fauna as well as flora in any biodiversity assessment programme. The bulk of the world's species are animals, so they are numerically more important than plants. They are also more interesting to most people, and may consequently be better at generating popular support for biodiversity conservation programmes. Perhaps more importantly, from a scientific point of view, every group of plants and animals differs in its habitat requirements, dispersal abilities and ecology, such that no two groups are likely to require exactly the same areas for their continued survival. In order to provide for the survival of East Usambara's biodiversity, it is therefore necessary to know as much as possible about a variety of different animal and plant taxa, which can hopefully be taken as broadly representative of all taxa, including those we know little or nothing about. It is therefore entirely appropriate that the baseline biological inventories should include consideration of a variety of animal taxa.

4.4.2   Progress

A wide-ranging programme of animal inventory work has been undertaken, as described in the EUCFP Technical Report No. 31 "Methodology report, old and new". Generally a range of trapping methods is employed in a systematic manner in five of the grid blocks laid out for the botanical inventory work. The blocks are selected to cover the range of altitude and habitat types represented in the forest as a whole. In addition, opportunistic observations and collections are made, covering a wide range of taxa.

4.4.3   Options

The difficulty with this approach is that sampling effort is dissipated across a broad spectrum of sampling methods and taxa, resulting in vast quantities of data, but no clear focus, The risk is that a small amount of information will be generated on a large number of taxa, but this will be extremely difficult to interpret, providing little help to management decision-making and long-term monitoring. The present approach is oriented towards the discovery of new taxa, in true expeditionary tradition.

A more focused approach is clearly necessary, aimed at generating quantitative data that are amenable to interpretation and can be used to guide management decisions. As with the botanical inventory work, particular attention should be given to identifying areas of the forests that are important for endemic taxa, so that these 'hotspots' can be afforded adequate protection, and 'coldspots' might be considered for alternative uses such as sustainable production of forest products. As mentioned above, it is unlikely that 'hotspots' for different taxa will coincide, so several different animal groups should be represented in the survey programme.

The following criteria might be used to assess the suitability of different animal taxa for inclusion in the survey programme. An ideal group would:

-         be easily sampled, so that large numbers of individuals of a range of species can be recorded with minimal effort;

-         be readily and reliably identified;

-         be well known, with comparable data available from other sites;

-         be taxonomically diverse, with a high level of strict endemism in the East Usambaras;

-         include species with narrow habitat requirements which are sensitive to disturbance and other changes in habitat quality; and

-         include species that are already recognised as internationally threatened.

        In addition, it would be beneficial to sample a range of taxa which are as different as possible from one another including vertebrates as well as invertebrates, and groups that are good at dispersal as well as more sedentary ones.

4.4.4   Recommendations

        The following recommendations on the faunal survey work are based on the above considerations, and take into account the work already done, and observations made in the field during the evaluation exercise:

Recommendation 7. The animal inventory work should be focused on a limited number of 'core' groups of fauna. The most suitable groups to include are:

(a) Small terrestrial mammals (rats, mice and shrews). This group can be sampled relatively easily with a variety of trap types, and reasonable sample sizes obtained within the time available for each phase. Although the group exhibits relatively low levels of endemism in the Usambaras, and is not particularly diverse, it includes potentially useful ecological indicators, such as the domestic rat, *Rattus rattus* and several notable species listed as globally threatened, such as the endemic mouse, *Beamys hindei*, and the elephant shrew, *Rhyncocyon petersi*. Not much work on small terrestrial mammals has been carried out in the East Usambaras, so there is a reasonable chance of finding a new species, particularly amongst the shrews.

The present sampling regime involves use of 100 standard snap traps baited with fried coconut and peanut butter, together with three lines of 11 (20-litre) pitfall traps set nightly for 10 nights at each of 5 locations. This would be enhanced by use of a greater diversity of traps, including Museum specials, and Shermans and a greater diversity of baits including termites, rehydrated dried fish, mashed banana and crushed oats; and paying more attention to the placement of traps in the lower branches of shrubs and trees, and along stream beds.

(b) Bats: Very good capture rates have been obtained by mist-netting bats during the early phases of the work, and new records for the East Usambaras and Tanzania have been

obtained.   This is despite the fact that very little effort has been put into this work. A more systematic effort with increased sampling intensity will probably yield useful quantitative data.

(c) Ungulates: Although no work has been done on ungulates during the early part of this programme, experience elsewhere suggests that they offer potential as a means of monitoring the effect of improved protection and a reduction in hunting pressure. Duikers, particularly, are likely to increase quite rapidly once hunting pressure is decreased, and this should be reflected in increased numbers of dung piles on the forest floor. It is recommended that a 5 km section of the vegetation sampling grid is used as a transect to count dung piles in a 4m wide strip (2m on other side of the line). To control for observer bias, several teams of Frontier research assistants (RAs) should assess the same transect, recording the exact location of each dung pile encountered.   It should be possible to distinguish the dung of different species (or groups) of ungulate. This work would be of particular value as an indicator of hunting pressure on (and possibly the status of) the vulnerable Abbott's duiker, *Cephalophus spadix.*

(d) Reptiles and amphibians: These groups exhibit particularly high levels of endemism in the Usambaras, and have been the subject of earlier studies which now provide a very sound basis for further work. Frontier has already achieved notable success in working with these groups, obtaining good samples at most study sites. It is therefore recommended that this work be enhanced with greater sampling effort, including increased searching of the animal quadrats, and increased opportunistic collecting along streams and other water bodies at night.

(e) Butterflies: These have not been a major focus of earlier Frontier work, although many species are readily identified, and they are widely recognised as being sensitive ecological indicators. In the Uganda biodiversity inventory programme, butterflies have proved to be one of the best indicator groups with quite distinct suites of species characterising different forest habitats. Furthermore, it seems that relatively modest effort is required to produce useful results. It is therefore recommended that this aspect of the baseline surveys is enhanced, with more Blendon butterfly traps employed in each of the animal quadrats (20 is a recommended minimum), using a variety of baits (especially carnivore/dog dung) and increasing the amount of sweep netting. All butterfly work should be undertaken within the quadrats to ensure that suites of species characteristic of particular altitudinal zones and/or habitats can be distinguished. Identification work should be done 'in-house' as far as possible, perhaps by engaging a Tanzanian research assistant at the UDSM.

(f) Millipedes and molluscs: Unlike butterflies, there groups are very poor at dispersal and it seems probable that the Usambaras represent a major centre of endemism for both groups. Frontier has collected millipedes and molluscs over a number of years during its earlier coastal forests programme, and developed good working relationships with international experts, so that reliable identifications can be obtained. Early results from this work are most encouraging: 3 new millipede genera and one new species were collected in Magoroto alone. Both groups are easy to collect and the work is worth continuing, with effort concentrated on systematic searching of the quadrats.

Recommendation 8. Inventory work on 'non-core' groups of fauna should be discontinued, in the interests of saving time, that can be more profitably used by

increasing sampling intensity for the 'core' taxa. In particular work on the following taxa should be discontinued.

(a) Birds: Despite there being a wealth of existing baseline data on the birds of Usambaras, from which we know of several endemic or near-endemic taxa recognised as globally threatened, it seems inappropriate to include birds for the Frontier work programme. There are two reasons for this: first, reliable field identification of forest birds is notoriously difficult, and whatever the skills of Frontier staff and research assistants, there will inevitably be a strong element of uncertainty over the birds recorded. Second, there are already a reasonable number of specialist ornithologists in Tanzania who can (and will) carry out the necessary work in East Usambara more reliably.

(b) Primates: None of the primates known from the East Usambaras is of conservation concern, so there is little reason to make major efforts to monitor population changes. In addition, the transect census methods employed by Frontier to date are notoriously unreliable and a very large number of replications would be required to achieve statistically valid results. The two species of forest primate which occur in the area are both highly adaptable, and able to persist (even flourish) in logged and degraded forest, so they are unlikely to provide any useful indication of forest condition.

(c) Moths, dragonflies, spiders, crustacea, and other invertebrates: Work on these groups involves a considerable amount of staff and RA time collecting, sorting labelling, documenting and dispatching specimens to various taxonomists around the world. There has been very little return on this investment to date, and it is difficult to see how work on any of these taxa could be useful to management without greatly increased sampling effort. The time and resources spent operating the light trap, Malaise trap and invertebrate pitfalls would be better utilised supplementing efforts on the 'core' taxa.

(d) Fish: The same applies

(e) Bryophytes: The same applies

Recommendation 9. The collection of animal tissue samples should be continued, subject to confirmation from the University of Copenhagen that they are still required. Although this work is unlikely to contribute to the management of East Usambaras, the extra work involved in collecting tissue samples from specimens that have already been captured is negligible, and it makes sense to continue this collaborative work as a contribution to the development of taxonomic science.

4.5   Review of other field assessment work

4.5.1   Soil surveys

Detailed soil surveys are presently being undertaken under sub-contract to the National Soil Service, and involve analysis of physical and chemical characteristics of samples taken within each of the botanical sample plots (i.e. systematic sampling on a 450 x 450m grid). The work

is largely self-contained and a separate report on each survey is produced by the National Soil Service.

The objectives of the soil survey work do not appear to be clearly defined, except to provide 'baseline' data. There does not appear to be any direct link to management, such as a need to identify areas of high potential for agriculture, cardamom production or timber plantation development, thus obviating the need for detailed knowledge of the soils. Furthermore, the objectives of forest management are to protect water catchment qualities and biodiversity, both of which can be achieved without reference to soil quality, simply by providing effective protection of the vegetation cover and associated fauna. If the soil survey work was oriented towards these management objectives, there should be greater emphasis in the analysis on the erosivity characteristics of the soils sampled. Instead of this, the stated objective of the soil work is "to give general soils distribution and assess the fertility status" (Shaka and Mwanga, 1995), with emphasis on fertility rather than erosivity characteristics.

Experience to date has shown that the soils do not differ markedly between sites, the most significant differences occurring along catenary gradients.

Recommendation 10: The soil assessment work should be scaled down substantially, or even discontinued. At most, samples should be analysed from alternate E-W transects on the revised grid sampling system (i.e at 450m intervals along transects traversing the mountains, with transects spaced 1800m apart). This would provide a substantial cost saving to the project, and enable additional resources to be directed at biodiversity database development and reporting (which are presently under-resourced.)

4.5.2   Forest profiles

Forest profiles are presently being assessed along 50m x 5m transects within each recognised forest type. The purpose of this work is not clear, and it is doubtful whether the methods could be developed sufficiently to provide quantitative, repeatable data sufficient to monitor long-term changes in vegetation structure and composition.

Recommendation 11: The forest profile work should be discontinued

4.5.3   Disturbance transects

Human disturbance is presently assessed along each of the transects on the E-W axis of the standard sampling grid, by counting the number of stems (>1cm dbh) that have been cut, have naturally fallen, and remain intact, in a strip 5m either side of the transect line. This is one of the most useful assessments undertaken within the programme of baseline surveys, being of direct and immediate relevance to management. The results will help to identify areas of most importance to local communities as a source of forest products, which might be considered for designation as multiple-use zones and/or where there is clearly a need to assist local communities in becoming more self-sufficient in their use of forest products in order to protect the reserved forest. If the method is applied with sufficient rigour, it should be possible to monitor the impact of the project in reducing dependence on natural forest products.

Recommendation 12: The disturbance transects should be accorded priority status in the assessment work, and be modified to increase precision, and focus on use of building poles and timber.

All transects on the (modified) grid should be assessed and records maintained for each 50m section. Poles (defined as straight stems of all species, 5-15cm dbh and at least 2m length) should be assessed in terms of number cut/standing in a 10m strip, (5m either side of the transect line). Timber (defined as straight stems of all species, exceeding 16cm dbh and 3m length) should be assessed in terms of number cut/standing in a 50m strip (25m either side of the transect line). The point at which each transect intersects the surveyed boundary of each forest reserve should be carefully measured to the closest numbered boundary cairn, so that the assessment can be precisely repeated at a later stage.

4.5.4   Socio-economic survey work

Standard participatory rural appraisal (PRA) techniques are used to assess local community attitudes and needs in respect of forest resource use. It is clearly important to understand local community needs in order to devise appropriate management systems for the protected forests, but the social survey work could probably be carried at more effectively as part of a collaborative-management oriented process, with stronger linkages to the management authority and/or EUCFP.   Frontier-Tanzania has no particular experience or expertise in this work, and the results obtained many not be reliable. Furthermore, carrying out such work in the villages, without any follow-up, may make it more difficult for subsequent work of this type with a stronger management focus.

Recommendation 13: The socio-economic survey work should be discontinued, and alternative approaches to community participation in forest protection and management should be explored by the Forestry and Beekeeping Division and/or the EUCFP.

4.6   Recording procedures and data management

A very substantial quantity of data is being collected, and strict recording procedures have been instituted, with standard field record sheets used throughout. Indeed, there is a tendency to record too much, without any realistic prospect of using most of the data. This may have been an appropriate strategy at the beginning of the programme, when there was still doubt over the required outputs of the survey work, but it should now be possible to focus this aspect of the work and become more goal-oriented.

Recommendation 14: In order to clarify thinking on data requirements a 'model' report should be developed for one of the sites that has already been surveyed. This has been done to a limited extent in the production of Biodiversity Survey Report No. 4 on Bamba Ridge Forest Reserve, but in this case a very small proportion of the total data collected are synthesised and presented, and a more comprehensive model is now required.

The development of a computerized biodiversity database would transform the inventory programme, and greatly increase the opportunities for analysis and data presentation. Certainly it would be worthwhile storing all biodiversity data in standard relational database format, such as that provided by Microsoft's 'Access' software, which comes with MS Word and Excel in the 'Office Professional' software package. This would facilitate the production of standard tables of

data for presentation in each biodiversity survey report. Once the data are stored in this format it is relatively straight-forward to carry out multivariate statistical analyses and produce graphic outputs using additional software such as SPSS, Idrisi and MapInfo.

Clearly, Frontier's experience and expertise lies in the field of scientific exploration - biological sampling in remote areas. It would be unrealistic to expect them to manage a substantial database, producing high quality graphic outputs. If the EUCFP requires this kind of product, it would be more appropriate to sub-contract the work elsewhere.

Recommendation 15: Despite the obvious attractions of developing a comprehensive computerised biodiversity database to store and process data generated by the surveys, simple manual methods of data management should be used initially to ensure that key results are written up in a timely manner. This is particularly important given the nature of Frontier, as an organisation which tends to have a rapid staff turnover. It is important that those who are involved in the fieldwork also produce the reports, and this may not be possible if the organisation of data handling depends on too many people, institutions and too much equipment - all potentially weak links in the chain! As far as possible Frontier's biodiversity work should remain as self-contained as possible.

Based on the above considerations, and a review of recording procedures observed in the field and described in the Frontier `Methodology' report, the following additional recommendations are made in respect of recording procedures and data management.

Recommendation 16: All field data recording sheets should be revised in consultation with a database expert, to facilitate data entry onto a relational database. Careful thought should be given to the elimination of unnecessary data fields (e.g. mammal parasites, nipple location), and unnecessary duplication of data on more than one sheet (e.g. mammal biometrics, colour, sex etc). For any given taxon, there should normally be no more than two field record sheets and corresponding database files (linked by a common field): one of these would be a description of a (numbered) plot, and the other a description of the sampling effort and/or specimens taken.

Recommendation 17: All biodiversity data should be entered onto a relational database. This may be done at the EUCFP office, by Tanzanian data input personnel, and checked by Frontier staff. However, this should not be regarded as a necessary pre-requisite to the production of biodiversity survey reports, if delays and/or difficulties are encountered in developing the necessary database capacity. The development of database capacity should be regarded as an 'optional extra' not a necessity.

Recommendation 18: A standard format for the (tabulated) presentation of data in the biodiversity survey reports should be established and the necessary routines ('macros') written to extract the data from the database. Such tables of data will provide the substantive content of all reports, and the text will serve to highlight results of particular significance.

Recommendation 19: Consideration should be given to the need for more sophisticated analysis and/or graphic presentation of biodiversity inventory results. It may not be appropriate to develop in-house capacity in this respect, but rather sub-contract the work to the University of Dar es Salaam or a Finnish institution.

4.7   Technical reporting

Biodiversity survey reports have been produced for the Magoroto, Manga Kwamngumi/Segoma and Bamba Ridge reserves, of which the Magoroto and Bamba Ridge reports were reviewed as part of the evaluation exercise. Substantial changes are anticipated in the format of subsequent reports (P. Cunneyworth and L. Stubblefield, pers. comm.).

The reports produced so far have successfully highlighted a number of interesting records of fauna and flora that are new to science, new to Tanzania, or of interest because they are rare, endemic and/or threatened. Whilst these records are valuable, the data are not presented in a sufficiently rigorous manner to enable long-term monitoring, or facilitate management zone planning.

A series of 33 Biodiversity Reports covering 65 Ugandan forests is now (almost) complete, and for these a standard format was used. A sample copy of the report for the Rwenzori Mountains National Park is included as an attachment to this evaluation report, and could be used as a 'model'. In this case, each indicator group is treated as the subject of a largely independent chapter, which describes the rationale for the work, the methods used, localities sampled and daily record of captures and/or species encountered. The discussion section of each chapter draws attention to rare, endemic and threatened species that are of particular interest. In most of the Uganda biodiversity reports, the final chapter is devoted to management considerations, and reviews the condition of the forest, and reports on the incidence of illegal harvesting, hunting and other human activities (this was omitted from the Rwenzori report for political reasons).

Not all of the detailed data presented in the Uganda reports is necessary or even desirable in the East Usambara ones, but it is recommended that the following components be included in every case:

-        A map showing the precise locations of all vegetation sampling plots, animal sampling quadrats, 'ungulate dung count' and 'disturbance' transects.

-        From the results of the vegetation sampling, outline maps of the forests with symbols located at each plot location, scaled according to:

        (a)   Species richness, based on a count of the number of species represented in each 20 x 50m plot.

        (b)   Degree of endemism, expressed in term of the percentage of species represented in each 20 x 50m plot that are endemic to the Usambaras.

        (See timber volume distribution maps in AFIMP East Usambaras Map Volume, and Appendix 7)

-        From the animal sampling, the following information should be tabulated for each taxon and each of the five quadrats:

        (a)   Summary of habitat characteristics: altitude, vegetation type, slope, disturbance.

        (b)   Summary of sampling effort.

(c)   Species list and No. of individuals of each species sampled.

(d)   No. (and %) of species endemic to the Usambaras, to the Eastern Arc Mountains; to the Zanzibar - Inhambane regional centre of endemism.

A standard format for such a table of data is outlined in Appendix 5.

-      From the disturbance transect results, one map with scaled symbols to show the intensity of pole-cutting (No. of poles cut per 50 x 10m transect section), and one to show the intensity of timber cutting. It would be helpful to distinguish old cutting (say more than 1 year previously) and recent cutting; this could be represented as a 'bar graph' on each 50m section of transect, with solid (recent) and dotted (old) sections (see sketch, Appendix 6).

-      A complete list of trees and shrubs, combining the results of the systematic and opportunistic botanical sampling.

-      A matrix summarising the results of the systematic botanical work, showing the number of individuals of each species recorded in each (numbered) plot (cross-referenced to the map of plot locations). The bottom of each column would show the total number of individuals, total number of species, and total number of endemic species in each plot.

-      Results of the ungulate dung counts, expressed as a mean (+/- standard error) number of dung piles observed per `team' (5 `teams' of 2 people should search the same transect, independently as a check on observer bias), considered by species, for the whole length of the transect.

5.0   **Conclusion**

5.1   The first year of the project has been successfully implemented, and has proved to be a highly cost-effective means of collecting biodiversity information. The work should be continued, preferably with a 3-4 year time horizon.

5.2   The field programme has resulted in several notable discoveries of new genera, species and first records for Tanzania, and has generated vast numbers of specimens and data. The field methods have become progressively more rigorous and quantitative, but there is a need to do more, with a tighter focus to the work. As detailed above, much of the animal collecting activity should be discontinued, and the time re-allocated to increasing sampling effort for specific "core" taxa.

5.3   The most urgent need is to work out the details of the final output anticipated for the project, and to devise data recording and database management procedures to satisfy this need. Some suggestions are provided above, but the best way to clarify thinking on this is to develop a 'model' Biodiversity Survey Report, according to an agreed standard format.

<u>**Appendix 1.**</u>

Terms of Reference for the Evaluation of the
Baseline Biological Surveys in the East Usambara Forest Reserves

Background

During the planning of Phase II of the East Usambara Catchment Forest Project the need for baseline information on biological diversity contained in the forest reserves and other protected areas in the East Usambaras was highlighted.

In 1995, the EUCFP project contracted Frontier-Tanzania, which had been conducting biological inventories in the coastal forests, and in selected lowland forests in the East Usambara, for one year to survey a total of six existing or proposed forest reserves. The contract included the surveys already done in the four forest reserves or forest areas in 1994. The survey methods applied in 1994 and in 1995-96 differ in some aspects and there has been a constant attempt to change the methods to become more systematic and solid to allow a better use of the data and comparison with other similar surveys. The present methods, especially those applied in the vegetation sampling, are in many ways similar to those used in the survey of the Uganda Forest Reserves.

The data would eventually be compiled in a database which would be used together with the national biodiversity databases developed at the University of Dar es Salaam.

As a part of the contract an evaluation of the first year was included. This was to provide the basis for a decision on whether to continue the work, and if so how the surveys, the data collection and analysis, reporting etc. could be improved.

Objective of the Evaluation

The general aim of the evaluation is:

1.   To assess if the surveys are justified against the background of the overall aim of the surveys, the output, and the cost of the surveys; and
2.   To provide a basis for a decision on the future of the work.

There is a general impression that the work makes sense, and that it would be worthwhile to continue. The role of the evaluation is to verify if this impression is justified, and to view the exercise in a critical but constructive manner. If the exercise is considered useful the evaluation should provide practical and operational suggestions on how to improve the work.

Specific Tasks

The evaluation should specifically review and evaluate following aspects:

1. Are the aims of the surveys clearly expressed and sufficiently justified, and do they need revision and further elaboration;
2. Are the methods and outputs of the surveys compatible with the objectives, i.e. do they produce what is expected with the way they are conducted;
3. Are the outputs and the implementation according to the Term of Reference for the surveys;
4. Is the implementation and organisation of the field surveys appropriate and how could they be improved;
5. Are the survey methods (floral and faunal surveys methods) appropriate, and according to common standards;
6. Do the Frontier surveys make sufficient use of existing material, such as aerial photographs, topographic and land use maps, existing data (meteorological, population, existing studies etc.), and available expertise;
7. To provide an assessment of the relevance and reliability of the data collected;
8. Is the presently available hardware and software sufficient to handle the survey work;
9. How has Frontier-Tanzania addressed the training needs or staff involved in the work, and what type of training and capacity building would be required;
10. Based on the work Frontier-Tanzania was to propose a biodiversity monitoring system. Has this issue been sufficiently addressed, is it relevant, and if so what kind of ideas could be considered for a "permanent" biodiversity monitoring;
11. Review the structure and contents of the existing biodiversity survey reports and propose an appropriate structure for such reports.

Expected outputs

A general assessment of the usefulness of the surveys and if they should be continued;

1. Proposal on how the implementation of the field surveys could be improved with the aim of improving the quality and usefulness of the collected data;
2. Proposal on how the methods applied could be improved with the aim of improving the quality and usefulness of the collected data;
3. Proposal on how the data collection, handling, storage and analysis could be improved with the aim of improving the quality, usefulness, and availability of the collected data;
4. Proposal on the structure and contents of biodiversity reports.

The consultant should provide a report addressing the issues outlined in these Terms of Reference.

Appendix 2.

List of people consulted

1.   Stig Johansson, Chief Technical Advisor, EUCFP

2.   M.I.L. Katigula, Project Manager, EUCFP

3.   Leigh Stubblefield, Project Coordinator, Frontier

4.   Raymond Kilenga, Forest Catchment Officer seconded to Frontier

5.   Shedrack Mashauri, Amani Nature Reserve Officer.

6.   Pam Cunneyworth - Research Coordinator, Frontier

7.   Frank Mbago, Assistant Curator, Dept of Botany, University of Dar es Salaam

8.   Charles Mabula, TAFORI botanist

9.   Claire Patten, Research Assistant, Frontier

10.   Jack, Research Assistant, Frontier

11.   Mike Dilger, Zoologist, Frontier

12.   Nick Beale, Assistant Zoologist, Frontier

13.   Chris White, Camp Leader, Frontier

Appendix 3.

Itinerary

18 August 1996	Travel Entebbe - Dar es Salaam
19 August 1996	Travel Dar es Salaam - Tanga Meetings with S. Johansson, M.I.L. Katigula, L. Stubblefield Review project documents
20 August 1996	Visit Amani Nature Reserve and Botanical Garden, Kwamkoro Forest
21 August 1996	Visit Frontier field operations in Mtai Forest Reserve
22 August 1996	Visit Frontier field operations in Mtai Forest Reserve Review animal inventory work
23 August 1996	Meeting with P. Cunneyworth, L. Stubblefield to review all aspects of Frontier field operations (a.m.) Meeting with S. Johnsson, M.I.L. Katigula, P. Cunneyworth and L. Stubblefield to discuss provisional findings of evaluation exercise.
24-25 August 1996	Writing of draft report.
26 August 1996	Writing draft report (a.m.) Review of draft report with S. Johannson, M.I.L. Katigula, P. Cunneyworth and L. Stubblefield.
27 August 1996	Editing and completion of draft report (a.m.) Travel Tanga - Dar es Salaam
28 August 1996	Travel Dar es Salaam - Entebbe

Appendix 4.

List of documents consulted

1   Project document, East Usambara Catchment Forestry Project Phase II: 1995-98 Vols I
         and II. Jan 1995.

2   Baseline biological surveys of selected forest and forest reserves in East Usambara.
         Terms of Reference, EUCFP document, 26 pp. July 1995.

3   The Frontier-Tanzania East Usambara Forest Research Programme. An Introduction. 9
         pp. 1996.

4   EUCFP Biodiversity Survey Report No. 1 Magoroto Forest. Natural forest surrounding a
         disused oil palm estate. Edited by J. Bayliss, P. Cunneyworth and L. Stubblefield. 83 pp.
         1996.

5   EUCFP Biodiversity Survey Report No. 4 Bamba Ridge Forest Reserve. An outlying
         easterly forest reserve. Edited by J. Bayliss, P. Cunneyworth and L. Stubblefield, 66 pp.
         1996.

6   The Frontier-Tanzania East Usambara Forest Research Programme. Technical Report
         No. 31. Methodology Report `Old and New' compiled by P. Cunneyworth, C. Holliday
         and L. Stubblefield. The Society for Environmental Exploration and the University of
         Dar es Salaam. 104 pp. 1996.

7   Brief comments on the Biodiversity Survey Report No. 5: Methodology Report Old and
         New. Matti Maatta, Finnish Forest and Park Service, 5 pp. June 1996.

8   EUCFP Miscellaneous Reports 9.   Biodiversity database development in the East
         Usambara Catchment Forest Project. Report of a visit by the Uganda Forest Department
         database coordinator Paolo Viskanic. 5 pp plus attachments. Nov. 1995.

9   EUCFP Technical Report 17. Establishment of Forest Trails and Drive Routes in the
         Amani Nature Reserve. A. Ellman, A. Tye, S. Rwamugira, B. Mallya, F. Mahenge and
         A. Mndolwa. 91 pp. 1995.

10   EUCFP Working Paper 19.   Updated Forest Area Information in the Usambara
         Mountains (Draft). S. Johansson and R. Sandy. 29 pp. 1996.

11   EUCFP Working Paper.   Conservation in the East Usambara Mountains - a partly
         annotated bibliography of selected published and grey zone materials. S. Johannson. 20
         pp. 1996.

12   EUCFP Working Paper. Facts and Figures on the East Usambara Mountains. Draft in
         process. S. Johansson. 6 pp. 1996.

13   EUCFP Working Paper. Endemic and Near-endemic trees in the Usambara Mountains, 8
         pp. 1995.

14   Soils and vegetation of Mlungui Forest Reserve, Maramba Division, Muheza District, Tanga. J.M. Shaka and H. Mwanga. Mlingano Agricultural Research Institute, Tanga, Tanzania. 15 pp. October 1995.

15   Amani Forest Inventory and Management Plan Project. Final Report. Matti Maatta. Jan 1988.

16   East Usambara Map Atlas, July 1988.

17   AFIMP Inventory in Natural Forests. Field Instructions. 27 pp.

18   AFIMP Tree species lists.

19   Iversen, S.T. (1991a). The Usambara Mountains, NE Tanzania: Phytogeography of the vascular plant flora. Acta Univ. Ups. Symb. Bot. Ups. 29,3.

20   Iversen, S.T. (1991b). The Usambara Mountains, NE Tanzania: history, vegetation and conservation. Uppsala University.

21   Hamilton, A.C. and Benstead-Smith, R. (Eds.) (1989). Forest conservation in the East Usambara Mountains, Tanzania. IUCN, Gland, Switzerland and Cambridge, UK.

22   Lovett, J. C. and Wasser, S.K. (Eds) (1993). Biogeography and ecology of the rain forests of eastern Africa. 341 pp. Cambridge University Press.

23   Sheil, D. (1994). Naturalised and invasive plant species in the evergreen forests of the East Usambara Mountains, Tanzania.

Appendix 5.

Suggested format for tabulated results of work on each of the animal taxa (eg. small terrestrial mammals)

_____

Animal quadrat No.   1   2   3   4   5

Altitude
Vegetation type
Catenary position
Slope (%)
Disturbance

Trapping effort (example)
        Museum specials (trap-nights)
        Standard breakbacks (trap-nights)
        Shermans (trap-nights)

Species (number of individuals captured)

        Species A
        Species B
        Species C
        Species D
        Species E
               etc.
_____
TOTAL INDIVIDUALS
TOTAL SPECIES

Of which, endemic to U   No. (%)
           endemic to EA   No. (%)
           endemic to ZI   No. (%)

_____

East Usambara Catchment Forest Project Technical Paper Series

The East Usambara Catchment Forest Project Technical Papers Series consists of reports on forestry issues in the East Usambara Mountains. This series started in 199. These reports aim to make information more widely available to staff members of the East Usambara Catchment Forest Project, to the Forestry and Beekeeping Division, and to other institutions and individuals concerned and interested in the conservation of the East Usambara forests.

The reports are prepared by staff members of the East Usambara Catchment Forest Project or by other researchers, consultants and interested individuals. The views expressed in the reports are those of the author(s).

Current titles in the series are:

1. Mwihomeke, S.T. 1991. Some notes to identify and discuss coopeation in forestry research in the East Usambara mountains.
    Räsänen, P.K. 1991. Outline of a research planning programme for the East Usambara Catchment Forest Project.
2. Hyytiäinen, K. 1992. Forest management plan for Longuza teak plantations.
3. Seymour, M. 1992. Manual harvesting of *Maesopsis eminii* in the East Usamaba mountains, Tanzania.
4. Newmark, W.D. 1992. Recommendations for wildlife corridors and the extension and management of forest reserves in the East Usambara mountains, Tanzania.
5. Häkkinen, I. & Wambura, M. 1992. A Frame plan for the Amani Nature Reserve.
6. Masilingi, W.M.K. 1992. Consultancy report on the legal establishment of the Amani Nature Reserve.
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17. Ellman, A., Tye, A., Rwamugira, S., Mallya, B., Mahenge, F. and Mndolwa, A. 1995. Development of forest trails and drive routes in the Amani Nature Reserve.
18. Ellman, A.E. 1996. Handing over the stick? Report of a village forest management and farm forestry consultancy
19. Katigula, M.I.L., Mmasi, S.E., Matiko, W., Mshana, L., Kijazi, M.S., Rwamugira, S. 1995. Planning ourselves. Evaluation report on the participatory planning of the EUCFP Phase II project document.
20. Fowler, S. & Nyambo, B. 1996. Invasive species and biodiversity - Report of a short consultancy on the potential of biological control of invasive species in Amani Nature Reserve. International Institute for Biological Control & EUCFP.
21 Howard, P.C. 1996. Baseline biological surveys in selected East Usambara forest reserves and forests, 1995-96 - project evaluation report.