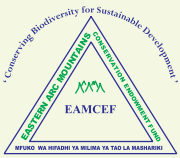

THE EASTERN ARC MOUNTAINS CONSERVATION ENDOWMENT FUND (EAMCEF)

MFUKO WA HIFADHI YA MILIMA YA TAO LA MASHARIKI

BASELINE SURVEY REPORT FOR 8 NATURE RESERVES AND 1 NATIONAL PARK IN THE EASTERN ARC MOUNTAINS OF TANZANIA

EXECUTIVE SUMMARY

Eastern Arc Mountains Conservation Endowment Fund,
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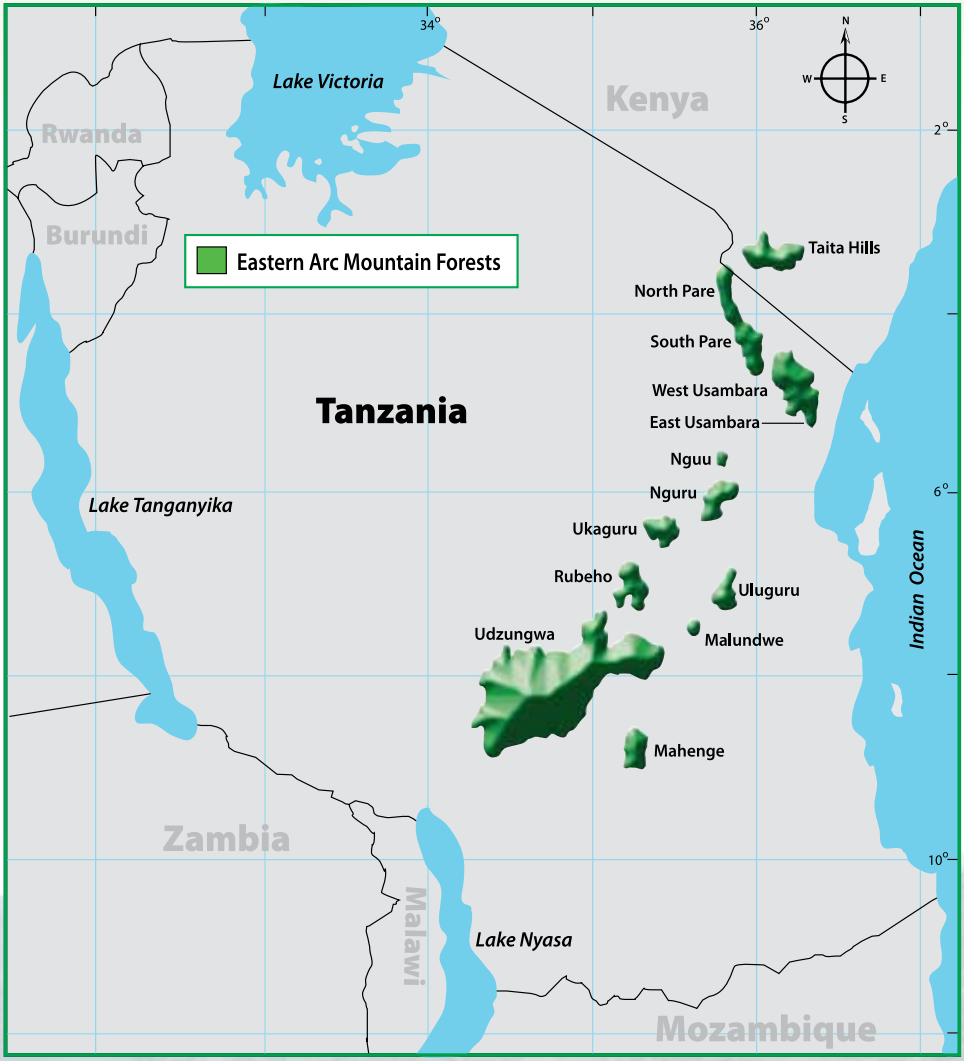
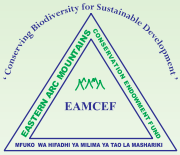
April, 2013

LOCATION OF THE EASTERN ARC MOUNTAINS





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April, 2013

TABLE OF CONTENTS

LIST OF ACRONYMS AND ABBREVIATIONS

ANR	Amani Nature Reserve
CBOs	Community Based Organizations
CEPF	Critical Ecosystem Partnership Fund
CNR	Chome Nature Reserve
dbh	diameter at breast height
EAMCEF	Eastern Arc Mountains Conservation Endowment Fund
EAMs	Eastern Arc Mountains
FBD	Forestry and Beekeeping Division
FR	Forest Reserve
GIS	Global Positioning System
KNR	Kilombero Nature Reserve
MkNR	Mkingu Nature Reserve
MNR	Magamba Nature Reserve
NAFORMA	National Forestry Resources Monitoring and Assessment
NGOs	Non-Governmental Organizations
NNR	Nilo Nature Reserve
NP	National Park
NR	Nature Reserve
UMNP	Udzungwa Mountains National Park
UNR	Uluguru Nature Reserve
USNR	Uzungwa Scarp Nature Reserve
VICOBA	Village Community Bank
WCPA	World Commission on Protected Areas

FOREWORD

The Eastern Arc Mountains forests occupy about 535,000 hectares, representing about 40% of Tanzania's remaining tropical high forests. The forests also represent one of the oldest and stable terrestrial ecosystem in Africa. The Eastern Arc Mountains are a global centre of biological diversity, recognized at international and national levels as priorities for nature conservation. In the national context they are also of critical importance for watershed services, tourism, erosion control on steep mountain slopes, carbon sequestration and mitigation of the impacts of rural poverty. Due to development activities and other human needs the Eastern Arc Mountains are presently under continuous threat of losing their original vegetation.

Apart from the more than 150 Forest Reserves, there are currently 8 Nature Reserves and 1 National Park that make up the Eastern Arc Mountains portion that contains about 50% of the remaining forest cover. Amani, Nilo, Chome, Magamba, Mkingu, Uluguru, Uzungwa Scarp and Kilombero Nature Reserves, and, Udzungwa Mountains National Park, constitutes the network that contains around 100 endemic species of animals and around 270 endemic species of plants.

The Eastern Arc Mountains Conservation Endowment Fund (EAMCEF) is a Trust Fund that was established in 2001 as a permanent and reliable funding mechanism for conservation interventions that promote the biological diversity, ecological functions and sustainable use of natural resources in the Eastern Arc Mountains of Tanzania. In mid 2011 EAMCEF secured a project grant from the Royal Government of Norway for strengthening its conservation financing mandate and for improved management of the 8 Nature Reserves and 1 National Park.

In order to demonstrate the impact of the Norwegian funded project, the FORCONSULT firm of the Sokoine University of Agriculture (SUA) was commissioned with a consultancy assignment to undertake a series of linked baseline studies for each of the 8 Nature Reserves

and 1 National Park so as to generate baseline information that can be used to measure progress and impact by the project, and that can also contribute to the better management of the Nature Reserves and National Park over the 5 years of the Norwegian funding. The consultancy work by FORCONSULT was undertaken between March and December 2012 and culminated into the production of this report which summarizes the baseline information status on forest cover, carbon storage, biodiversity values, forest condition, management effectiveness, livelihood status and hydrological values for each of the 9 target sites.

We sincerely thank the FORCONSULT team for their dedication and unmatched efforts in generating the important information. We wish to encourage each and all stakeholders of the Eastern Arc Mountains to make use of the baseline information contained in this report and it is our hope that you will all find the information useful.

Francis B.N. Sabuni
EXECUTIVE DIRECTOR

April, 2013
MOROGORO, TANZANIA

1 INTRODUCTION

The Eastern Arc Mountains (EAMs) are a chain of mountains in Kenya and Tanzania that are influenced by the Indian Ocean. The chain is a series of isolated mountains, which are heavily covered by forests. The EAMs, encompassing an area of about 23,000 km^2, are part of the Eastern Afromontane biodiversity hotspot of Conservation International and, one of the 34 world's biodiversity hotspots that are under continuous extreme threat of lossing their original vegetation. Due to the importance of these mountains, the government of Tanzania through the Forestry and Beekeeping Division (FBD) of the Ministry of Natural Resources and Tourism has looked systematically at the reserve network across the EAMs during the past decade, and has targeted the upgrading of some of the reserves from National Forest Reserves to 'Nature Reserves'. At present four of the Nature Reserves, have been gazetted and four remain proposed. There is also one National Park in the EAM forest habitats – the Udzungwa Mountains National Park (UMNP).

In total, this network of Nature Reserves and national park contains about 100 endemic species of animals, about 270 endemic species of plants, and about 50% of the forest cover (451,948 ha), within the largest remaining patches in the Eastern Arc Mountains. In order to ensure sustainable conservation of these mountain forests the Eastern Arc Mountains Conservation Endowment Fund (EAMCEF) was established in 2001 as a Trust Fund to provide a sustainable financing mechanism in the EAMs through issuing project grants to Government Departments (Central and Local Governments), NGOs, CBOs, Local Communities, Research and Academic Institutions, Private Entities as well as interested individuals.

The EAMCEF is currently implementing a project to improve management of the eight Nature Reserves and one National Park within the Eastern Arc Mountains ecosystem as part of its activities. The Nature Reserves are; Amani, Nilo, Chome, Magamba, Mkingu, Uluguru, Uzungwa Scarp and Kilombero while the National Park is

Udzungwa Mountains. This survey was conducted to gather baseline information on biodiversity in these areas as a basis for demonstrating the impact of the project in the future and therefore contribute to the better management of these reserved areas.

The specific objectives of the assignment were to:

1. Undertake an update of the area of forest cover and status (visibility) of the forest boundaries within the eight Nature Reserves and one National Park and to map forest cover and changes over time;
2. Quantify and update the carbon stored within each of the eight Nature Reserves and one National Park and the losses that have occurred due to forest loss over the past decade;
3. Update the status of the plant and animal biodiversity values of the eight Nature Reserves and one National Park;
4. Update the existing information on forest condition (disturbance) in the eight Nature Reserves and one National Park and assess changes in disturbance since 2009;
5. Update the existing management effectiveness information for the eight Nature Reserves and one National Park;
6. Undertake targeted surveys of the livelihoods of selected surrounding communities around eight Nature Reserves and one National Park; and
7. Document the available knowledge on hydrological values of the eight Nature Reserves and one National Park.

2 DATA COLLECTION METHODS

Different methods were used for data collection on specific areas of this assignment as follows;

2.1 Update of the Area of Forest Cover and Status

Proper image selection and acquisition was done to allow for image processing from a long list of possible images that were evaluated. The target was images acquired during the dry season (July-November) with minimum cloud cover. To ensure accurate identification of temporal changes and geometric compatibility with other sources of information, the images were geo-coded to the co-ordinate and mapping system of the national topographic maps, i.e. UTM coordinate (Projection-UTM Zone 37 and 36 South, Spheroid 1880, Datum Arc 1960). Most of the images were already rectified and available as geo-cover datasets from the previous CEPF work in the Eastern Arc Mountains. In order to reinforce the visual interpretability of images, a colour composite (Landsat TM bands 4 5 3) was prepared and its contrast was stretched using a Gaussian distribution function. Using of SPOT 4 images from Google Earth, the Nature Reserves and National Park shapefiles were re-projected to Geographic Coordinates System (GCS). These were then converted to Keyhole Markup Language (kml) format which is recognizable by Google Earth using ArcGIS software.

Field work was conducted to establish ground truthing data and to verify and modify land covers described in the preliminary image interpretation. GPS was used to locate sampled land cover observations and digital photos were also taken at the sampled land cover in four directions (North, East, South and West) clockwise. To gain more insights on changes in land cover, local communities were involved in a participatory manner. With respect to estimating rate of change, the change detection was done between datasets of 1980s and 2000s (CEPF data); and between 1999/2003 and 2010/11 periods (NAFORMA data). The various feature themes were overlaid in ArcGIS and intersected so that the boundaries and attributes of themes were combined to form the derivative output theme.

2.2 Quantification of Carbon Stored in Forests and Losses

Forest inventory data from the forests which were well covered under National Forest Resources Monitoring and Assessment (NAFORMA) were obtained from FBD. For forests which were not well covered or not covered at all new data were collected using NAFORMA Protocol. Existing tree family wood basic densities of trees were used to compute biomass for each tree and hence the carbon. Carbon content was computed as 50% of the biomass for each tree/plot. Other forest parameters determined included number of stems per hectare and basal area (m^2 ha^{-1}). The data on carbon density was further combined with the area change to determine how much carbon has been lost through deforestation over time. Only deforestation was considered in determination of carbon loss as analysis of cover change using Landsat images of 30m resolution is incapable of detecting forest degradation.

2.3 Status of the Plant and Animal Biodiversity Values

Field surveys were conducted in the target forests to determine the current plant and animal composition.

2.3.1 Floral Survey Methods

In the flora biodiversity survey, at least 30 permanent vegetation plots were systematically established and investigated within each target forest in order to determine the current plant composition. The National Forestry Resources Monitoring and Assessment (NAFORMA) plot design was adopted. In each plot laid, names of all plants encountered were recorded using both scientific and local names aided by a botanist and local ethno-botanists. From these techniques, such information as identity of plant species and status could be gathered for further analyses. Also intensive desk studies were executed for collection of secondary data.

Species composition was established for each reserve and national park. Shannon-Wiener Index and Index of Dominance for tree diversity were also computed based on the established standards.

2.3.2 Faunal Survey Methods

Inventories of mammals, reptiles, amphibians and bird species were compiled at different surveyed sites. The fauna was surveyed using a combination of repeatable methods, which lasted for four days per site. Four direct field survey methods were employed for sampling, depending on the species, animal size and behavior. These included opportunistic direct and indirect observation, snap trap lines, bucket pitfalls traps and mist netting. In addition to this, depending on topography of the study site, several transects were walked through specifically examining presence of animal signs that included dung, tracks and paths, as well as signs such as burrows, diggings, hairs among others. Where necessary night searches were aided using vocalizations.

2.4 Update on Forest Condition

Forest condition assessments completed in 2004 and 2009 were used as a baseline for updating information on forest condition. Disturbance was assessed within the same circular plots with radius of 15m as were established for carbon storage quantification. The level of disturbance was assessed as the proportion of the number of standing, dead or cut trees and poles in the plot. Threat assessment went hand in hand with forest condition assessment to give a sense on how far management has gone towards reducing threats to the nature reserves. In this assessment, threats were assessed in the same plots as for the disturbance assessment. From the plots direct threats to the biodiversity were identified and ranked.

2.5 Management Effectiveness Assessment

For assessing any improvements in the effectiveness of managing the targeted forests, Management Effectiveness Assessment (MEA) was carried out based on the 2004 and 2009 assessments. This was conducted using the World Commission on Protected Areas (WCPA) Management Effectiveness Tracking Tool – METT.

2.6 Livelihood Survey

Questionnaire surveys to households and interview of key informants was conducted to collect socio-economic information from communities adjacent to these reserves. Purposive sampling design was used where by at least three villages close to the study sites were selected for survey depending on the size of the study site.

2.7 Assessment and Documentation of Hydrological Values

Assessment of hydrological values was carried out with reference to a number of previous studies on hydrology in the Eastern Arc Mountain Forests. Water sources identification and hydrological analysis was done to understand the flow regimes. Historical climatic (rainfall, temperature) and hydrometric (water levels, discharges) data in the study sites were collected from responsible authorities such as Rufiji Basin, Wami-Ruvu Basin and Pangani Basin Water Offices and Tanzania Metrological Agency. Existing hydrological models such as rainfall-runoff models were applied to understand the hydrology of the sites within their water catchments. Where sufficient historical temperature, rainfall and gauged river flow data exists, analysis using Mann-Kendal statistical test was used to investigate the trend in daily, monthly, seasonal and annual values.

3 FINDINGS

3.1 Forest Cover and Status (Visibility) of the Forest Boundaries

Results showed that across all the reserves, forests occupy 144,204 ha and woodlands 143,525 ha. Assessment of the forest loss showed that on average, between 1980s and 2000s, a total of 500.11ha and 9320.38 ha of natural forest and woodland respectively were lost, while between 1999/2003 and 2010/11 periods 216.09ha of forest and 50.16 ha of woodland were lost. The average rate of forest change is estimated at 62.51ha per year for the 1980s and 2000s period and 8.36 ha per year for the 1999/2003 and 2010/11 period, while for woodland it has been estimated to be 1165.05 and 8.36 ha per year between the two time windows.

Comparison on rates of deforestation and degradation reveals that the rates are not uniform in all the reserves and between the periods under investigation; some were more degraded than the others. For example, in terms of forest cover change, Udzungwa Mountains National Park experienced highest forest loss (1199.6 ha) between 1980s and 2000s followed by Amani Nature Reserve (1128.6 ha) in the same time window, while in the second window, Mkingu Nature Reserve experienced more forest loss (965.41 ha) followed by Amani Nature Reserve (556.73 ha). For woodland area change, Udzungwa Mountains National Park experienced highest loss (60,767.6 ha) between 1980s and 2000s followed by Uzungwa Scarp Nature Reserve (1822.57 ha) in the same time window, while in the second window, Mkingu Nature Reserve experienced more woodland loss (346.21 ha) followed by Nilo Nature Reserve (33.55 ha).

3.2 Carbon Stock and Losses

3.2.1 Carbon Stock

The stand parameters in terms of number of stems, basal area, volume, biomass and carbon per hectare were computed for all the studied reserves and the Park. It was found out that the stocking observed in

this study are relatively higher compared to previous studies. This study also estimated the above ground tree carbon based on the observed tree volume per hectare. For the woodlands carbon stock per hectare range from 27 to 40 t/ha while that of montane forest range from 45 to 337 t/ha.

3.2.2 Carbon Losses

Carbon loss was determined based on two periods between 1980s and 2000s and between 1999/2003 and 2010/11 and only carbon loss due to deforestation was considered in this study. Given the area loss due to deforestation, carbon loss has differed between the reserves and between the periods under study. Amani Nature Reserve experienced highest carbon loss of 47,508.69 tones/year and 31,247.03 tones/year between 1980s and 2000s and between 1999/2003 and 2010/11 respectively for montane forests. This could be due to the highest carbon stock observed in this forest but also the bigger area which had been deforested over the years. The carbon loss in montane forest for the different reserves in a decreasing order of magnitude for the last decade is Amani Nature Reserve(31,247.03t/year), Mkingu Nature Reserve (13,161.62 t/year), Nilo Nature Reserve (7,906.37 t/year), Chome Nature Reserve (1,692.88 t/year), Magamba Nature Reserve (527.96 t/year), Kilombero Nature Reserve (176.58 t/year) and Uzungwa Scarp Nature Reserve (158.19 t/year) while for Uluguru Nature Reserve and Udzungwa Mountains National Park there was

no carbon loss. Udzungwa MNP experienced highest carbon loss (206,913.68 tones/year) in the first period window for woodlands which could be due to its highest annual rate of change (deforestation) and followed by Kilombero NR (91,840.31 t/year).

3.3 Status of Plant and Animal Biodiversity Values

3.3.1 Plant Biodiversity

The survey indicated relatively a large composition of trees (47%) in these reserves, followed by herbs (37%) and shrubs (16%). Climbers and lianas were also numerous, in most of the forests.

The numbers of plant species, including herbs, shrubs and almost in trees are the highest in Nilo Nature Reserve followed by Mkingu and Magamba, Uzungwa Scarp, Amani, Kilombero and Chome. Udzungwa Mountains National Park and Uluguru Mountains Nature Reserve have the lowest biodiversity as far as plants are concerned. However, when only tree species are considered, Nilo Nature Reserve becomes the richest again, followed by Amani, Uzungwa Scarp, Mkingu, Magamba, Udzungwa Mountains National Park, Chome and Uluguru. In this case, Kilombero Nature Reserve is the poorest.

Udzungwa Mountains National Park and Amani Nature Reserve have the lowest composition of herbs and also about the same for shrub species. This could have been attributed to the introduced species some of which are also invasive, colonizing the forest area. They include *Maesopsis eminnii, Cedrella odorata, Clidemia hirta, Psidium cattleianum, Landolphia* spp., *Elaeis guineense, Arenga pinnata* and *Bamboo vulgaris.*

The Index of Dominance ranged from 0.03 in Uluguru, Nilo, Mkingu and Kilombero, 0.04 in Magamba and Uzungwa Scarp, 0.05 in Amani and Chome to 0.18 in Udzungwa Mountains National Park. These all can be treated as low values and they indicate that each species contributes to the community relatively evenly. The Shannon-Wiener index of diversity (H') for Udzungwa and Amani Mountains National Park are relatively low (2.78 and 2.93 respectively) indicating relatively low tree species diversity as compared to the rest of the forests which

scored above 3.0. Meanwhile, most of the endemic species found in this study are either strict endemics to individual mountain ranges, or shared endemics between the different mountain massifs, thus referred to as near endemic. *Psychotria peteri* and *Annickia kummeriae* for instance, are endemic with a very restricted range in Amani and Nilo nature reserves only (East Usambara Mountains). On the other hand, *Mammea usambarensis* is also endemic to Tanzania, but occurring in Magamba Nature Reserve (West Usambara) and Chome Nature Reserve (South Pare Mountains).

3.3.2 Animal Biodiversity

The diversity of animals in the EAMs was found to be extremely varied as has been observed in other studies. This study observed that the occurrence of various species such as small mammals, birds and amphibians was fairly high with small variations throughout the Arc while large mammals were mostly restricted to the southern end where Udzungwa Mountains National Park, Kilombero Nature Reserve and Uzungwa Scarp are located. The location of these areas relative to other conservation areas of the Selous GR and Mikumi NP could be one of the reasons for this observation. We report here for the first time, the occurrence of some small mammals' species, i.e., a shrew; *Crocidura* spp and a rodent; *Aethomys* spp., in Mkingu Nature reserve. Similarly, other small mammals *Rabdomys pumilio* and *Lophuromys kilonzoi* that have not been previously documented were observed in Chome and Magamba Nature Reserves respectively. The majority of the observed, amphibians, reptiles, birds and large mammals' species were also reported by previous studies.

On the other hand, most studies in the Eastern Arc Mountains have so far been concentrated on organisms other than aquatic life that is also potentially likely to show endemism. As such the numerous mountain streams and rivers of the EAMs are less well known in terms of faunal species. Besides the extensive occurrence of the introduced rainbow trout (*Oncorhynchus mykiss)* and Nile tilapia (*Orechromis niloticus*) in high and low altitudes streams respectively, we document existence of mountain catfish (*Amphilius sp)* that is very abundant in areas where it occurs. Further to this finding, other fish species that are considered to exist in the regions and also confirmed by the local communities during the survey included members of Hapochromis, Eels, Cyprinids (*Labeo* sp), and Mochokinids (*Synodontis* sp). However, this study could not verify their presence and therefore calls for more studies designed specifically for fishes of Eastern Arc Mountains.

The aquatic mammals that were observed to occur in survey areas include marsh mongoose (*Atilax paludinosus*), African clawless otter (*Aonyx capensis*), and Hippopotamus (*Hippopotamus amphibius*). There is a need to obtain further information on distribution and ecological requirements based on seasonal variability. Additionally, while this study managed to document animals mainly during day time only, the use of monitoring camera as used in UMNP could significantly improve our knowledge on the animal biodiversity of the eastern Arc. This is because; several mammals are known to be nocturnal and active only during a certain times of the night.

Generally, the findings in this study when compared to the previous ones indicate a sharp decline in the observed medium to large sized mammals in the northerly direction. Similarly, in some reserves, e.g., USNR the observed numbers of reptiles were too far low when compared to those documented in the previous studies. The effective conservation measures in the Udzungwa Mountain National Park have significantly contributed in the high fauna diversity resilience within and neighbouring Uzungwa Scarp and Kilombero Nature Rerseves. On the other hand, rapid human population growth coupled with increasing encroachment of Eastern Arc Mountains especially within

the Uluguru and Pare Mountains reas is responsible for the decline of fauna diversity.

3.4 Forest Condition and Disturbances

The observations with respect to forest condition and disturbances for the studied forests are summarized as follows:

All the forests were disturbed, threatened and had some management problems that varied in magnitude. Presence of new cut trees and poles in most forests indicated that tree/pole cutting is still prevalent in the EAM forests in spite of continued efforts by the Government, donors and NGOs to reduce the problems.

Forest disturbance was more pronounced in Mkingu Nature Reserve followed by Uluguru Nature Reserve and least in the Amani Nature Reserve and Udzungwa Mountain National Park and it appeared that the later two (ANR and UMNP) which were gazetted in 1990s are less disturbed than recently gazetted Nature Reserves.

A total of five major threats were recorded in the study forests;fire and encroachment were the most dominant threats followed by illegal tree/pole harvesting and fire wood collection. Forest fire and encroachment occurred in all the study forests, logging in eight forests while pole cutting and firewood collection occurred in six and five forests respectively. Illegal tree harvesting was not recorded in UMNP. On average UMNP was the least threatened reserve followed by Amani and Kilombero Nature Reserves.

Although mining is a new threat in the EAMs and was recorded only in ANR, NNR, MNR and CNR its impact could be very detrimental to water catchments (water quality) and biodiversity if it is not contained henceforth. Similarly Invasive plant species was only mentioned as a threat in ANR but several ecological reports from the protected areas implicate Invasive plant species as one of the main threats to biodiversity.

Conservation interventions (particularly alleviating some Forest Reserves to nature Reserves) executed by different Institutions are key to reduced disturbance and threats in most the reserves. Experience from ANR however, shows that conservation initiatives are not sustainable without donor funding.

3.5 Management Effectiveness

Thirty main issues were considered to evaluate the Management effectiveness in the studied areas. The study found out that all the forests are legally gazetted and the boundaries are well demarcated and known to both the management and the local communities. In spite of this achievement, some biodiversity, ecological and cultural values are partially being degraded by anthropogenic activities although the most important values have not been significantly impacted.

Generally scores from the Management Effectiveness Tracking Tool (METT) indicated that most of the studied forests were well managed. Only Uzungwa Scarp, Mkingu and Chome Nature Reserves with METT of 52%, 53% and 60% respectively were averagely managed

while the rest of the reserves were properly managed (METT >60%). Udzungwa Mountains National Park with METT 82% was the most shimmering forest followed by ANR 79% and Kilombero Nature Reserve (76%).

The flourishing management reported here could be linked with several reasons, the most outstanding being: defined forest boundaries, management plan and regular work plan, management striving to meet agreed objectives, regular and adequate budget, adequate and well trained personnel, public education and monitoring and evaluation.

Upgrading of Forest reserves to Nature Reserves seems to be a successful conservation and management model in the EAM forests.

3.6 Livelihood Survey

This study observed variations in socio-economic status for communities around the surveyed eight Nature Reserves and one National Park. Most households around most of the NRs and the NP had 5-10 members except ANR where households had less than 5 members. In terms of assets, most households in the surveyed NRs kept livestock, owned a mobile phone and radio with exceptional of UMNP and KNR which in addition to those majority of households had a bicycle. In all the surveyed NRs except USNR, most of the households accessed and owned land of less than 5 ha. Firewood and kerosene have been found to be major sources of energy at household level in most of the NRs and NP. Furthermore, agriculture was found to be the main source of household food security and income.
The results showed that the majority of households in all NRs were happy with the formation of nature reserves to increase conservation of biological diversity. Conversely, majority of the households around UMNP were not happy with the conservation status of the park. In another development, eight of the surveyed NRs' and the NPs' communities agreed on the possibility of reducing forest products consumption from the conserved areas if alternatives are provided. With exception of USNR and UMNP, forest surrounding communities agreed to have harvested forest products for the past

12 months illegally. Alternatives to forest products use were noted in most of the NRs and NP despite being less practiced and or used. Several environmental, social and economic development projects are operating within or around most of the NRs and NP with exception of Mkingu and Maghamba NRs. Nevertheless, some of the projects have phased out and the need to reassess their impact to forest conservation and livelihood of surrounding communities is crucial.

3.7 Documentation of Hydrological Values

3.7.1 Hydrological Values and Trends

The analysis of the available river flow time series data have revealed seasonal patterns that reflect those in rainfall with periods of high flows during the rainy season and low flows during the transition and dry periods with minor exceptions in some areas. The results of trend analyses on annual flows generally indicate a predominance of declining flows in the dry season with minor exceptions. The declining flows during the long and short rain seasons in both catchments reflect on the impacts related to catchment degradation. It is more evident that the rain season flows have been more variable and erratic with some seasons experiencing floods while in other seasons experience abnormally low flows associating these with declines in forest cover within the catchments.

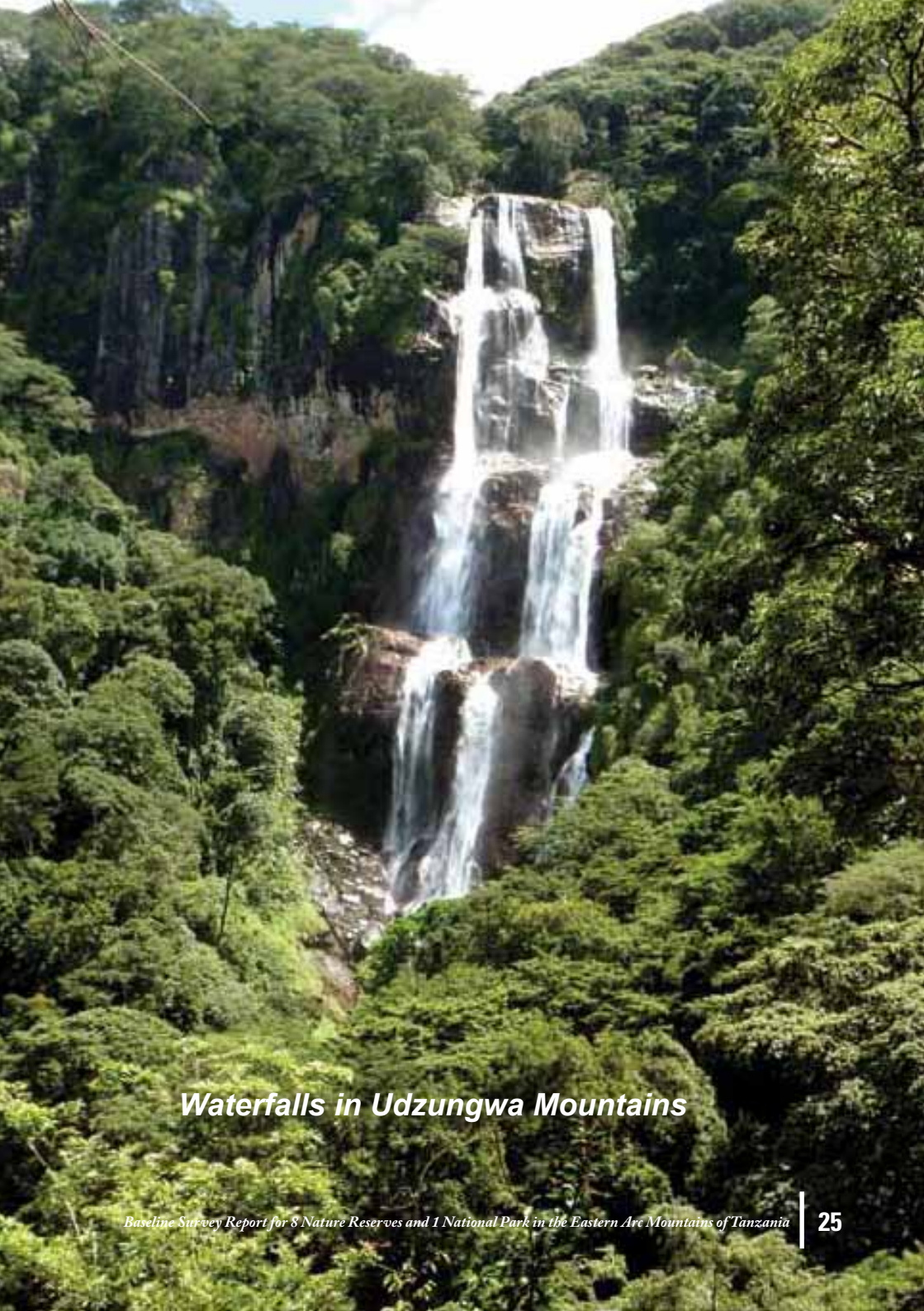
3.7.2 Spatio-temporal Trends in Water Quality

It has been difficult to describe changes in water quality conditions over time due to the lack of good time series data. Most water sources have been sampled only a few times, and there has not been consistency in the parameters selected for repeated measurements. Analysis of spatial trends in the basin, as in the case of temporal trends, was hampered by the uneven distribution of data points. Even for the areas with high data density, the lack of geo-position information and large variation in the measurement dates (different seasons and different years) make comparisons difficult. The scantiness of information has made it impossible to present a similar summary for other catchments. As water quality is one of the major parameter for improvement if water PES schemes would be implemented in the Nature Reserves and NP

it is important to consider initiating a long term monitoring of such parameter in major rivers/streams alongside water flow.

4 CONCLUSION AND RECOMMENDATIONS

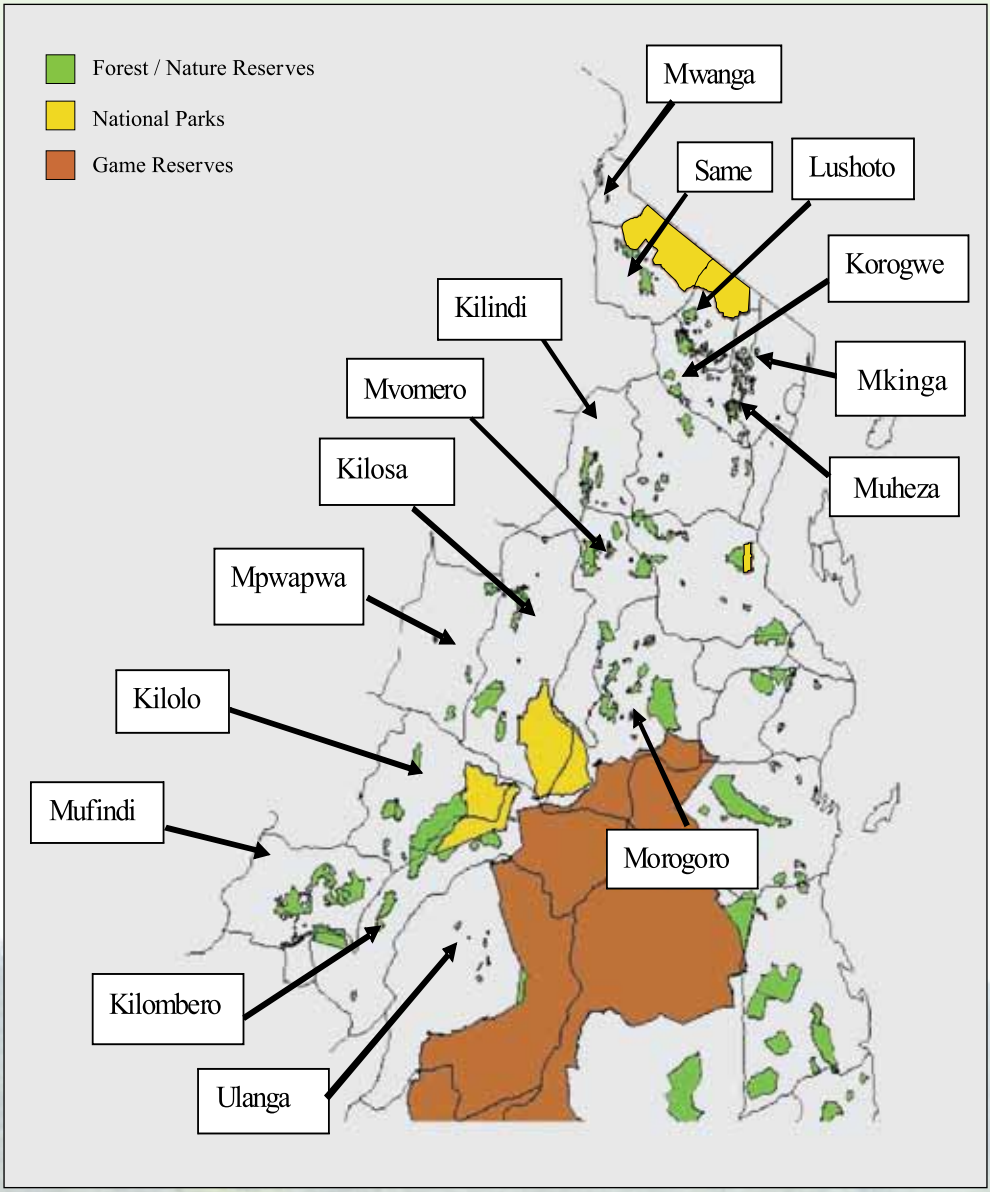
Given the present rates of forest loss, carbon loss, biodiversity threats, forest disturbances and increased dependence on forest products by surrounding communities, the sustainability of protected areas is questionable unless concerted efforts are taken to ameliorate the present situation, otherwise the biodiversity values, hydrological values, carbon sequestration potential of the nature reserves and the national park will be threatened. Therefore, effective conservation measures aiming at improving forest and woodland cover and the general situation in the nature reserves and national park as well as improvement of community welfare around these ecosystems are inevitable.

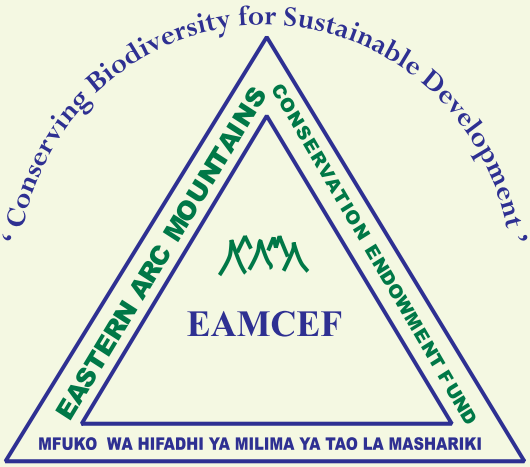


Waterfalls in Udzungwa Mountains

EAMCEF Administration Block in Morogoro Municipality

DISTRICTS OF THE EASTERN ARC MOUNTAINS IN TANZANIA





Motto

The EAMCEF's Motto is "Conserving Biodiversity for Sustainable Development"

Vision

A Conservation Fund sufficiently endowed to provide the financial resources necessary to ensure effective, long-term conservation and management of forest biodiversity in the Eastern Arc Mountains of Tanzania.

Mission

Catalyze resources to foster conservation of forest biodiversity in the Eastern Arc Mountains of Tanzania through investment in sustainable community development, sustained financing for protected areas management and financial support to applied research.