Rufiji Environment Management Project[1]

Environmental Management and Biodiversity Conservation of Forests, Woodlands, and Wetlands of the Rufiji Delta and Floodplain

Strategy for the Assessment of the Woody Vegetation of the Rufiji Environment Management Area

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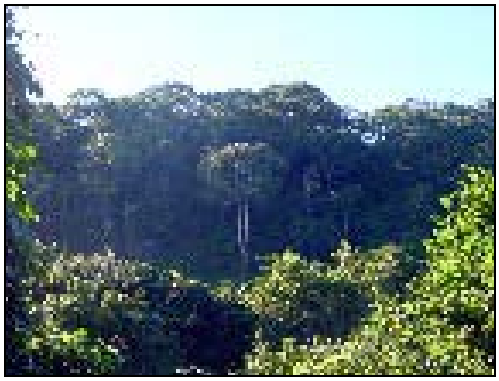

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[1] The Rufiji District Council implements Rufiji Environment Management Project with technical assistance from IUCN – The World Conservation Union, and funding from the Royal Netherlands Embassy.

Rufiji Environment Management Project – REMP

Project Goal: To promote the long-term conservation through 'wise use' of the lower Rufiji forests, woodlands and wetlands, such that biodiversity is conserved, critical ecological functions are maintained, renewable natural resources are used sustainably and the livelihoods of the area's inhabitants are secured and enhanced**.**

Objectives

- To promote the integration of environmental conservation and sustainable development through environmental planning within the Rufiji Delta and Floodplain.

- To promote the sustainable use of natural resources and enhance the livelihoods of local communities by implementing sustainable pilot development activities based on wise use principles.

- To promote awareness of the values of forests, woodlands and wetlands and the importance of wise use at village, district, regional and central government levels, and to influence national policies on natural resource management.

Project Area

The project area is within Rufiji District in the ecosystems affected by the flooding of the river (floodplain and delta), downstream of the Selous Game Reserve and also including several upland forests of special importance.

Project Implementation

The project is run from the district Headquarters in Utete by the Rufiji District Administration through a district Environmental Management Team coordinated by the District Executive Director. The Project Manager is employed by the project and two Technical Advisers are employed by IUCN.

Project partners, particularly NEMC, the Coast Region, RUBADA, The Royal Netherlands Embassy and the Ministry of Natural Resources and Tourism, collaborate formally through their participation in the Project Steering Committee and also informally.

Project Outputs

At the end of the first five –year phase (1998-2003) of the project the expected outputs are:

An Environmental Management Plan: an integrated plan for the management of the ecosystems (forests, woodlands and wetlands) and natural resources of the project area that has been tested and revised so that it can be assured of success - especially through development hand-in-hand with the District council and the people of Rufiji.

Village (or community) Natural Resource Management Plans: These will be produced in pilot villages to facilitate village planning for natural resource management. The project will support the implementation of these plans by researching the legislation, providing training and some support for zoning, mapping and gazettement of reserves.

Established Wise Use Activities: These will consist of the successful sustainable development activities that are being tried and tested with pilot village and communities and are shown to be sustainable

Key forests will be conserved: Forests in Rufiji District that have shown high levels of plant biodiversity, endemism or other valuable biodiversity characteristics will be conserved by gazettement, forest management for conservation, and /or awareness-raising with their traditional owners.

Summary

General Approach
The project is faced with a situation in which it has limited funds with which to assess an apparently quite diverse and extensive vegetation. The most cost – effective approach is to treat the proposed survey as a "first approximation" characterization of the project area's vegetation. As so little is known about the vegetation at present, even a simple characterization will provide an order to magnitude increase in knowledge. If required, a more intensive assessment can be made over a larger area once there are adequate funds to do so.

Preliminary base map and use of aerial photography
Black and white aerial photography at the scale of 1:40,000, with selected photos blown up to 1:10,000, is to be flown of the project area (which should include at least 10 km of land north and south of the floodplain on wither side of the river). An uncontrolled aerial photo mosaic is also to be produced and the detail (roads, rivers, villages etc.) on it traced onto an overlay. This will be the initial base map of the project area.

A preliminary base map of potential woody vegetation types can be prepared from examination of the vegetation patterns seen on the 1:40,000 aerial photo mosaic. Mapping units are apt to range in size from as small as a few square km to as large as several hundred square km or more. The 1:250,000 Hunting Technical Services map of land cover and land use should be used as a guide in delineating mapping units on the photo mosaic. It is probably better at this stage to error in the favour of large – rather than small – mapping units. (A mapping unit is the basic unit on a preliminary base map of vegetation. Each unit is assumed to represent a specific vegetation type usually consists of more than one mapping unit. However, ground truthing may also discover that a mapping unit actually consists of more than one vegetation type. In the latter case it must be divided into two mapping units, one for each vegetation type).

It will take additional time and expense to carry out a stereoscopic interpretation of the aerial photos. Therefore, this should be delayed until there are sufficient funds to warrant:

(a) A more intensive survey of the project area,
(b) Special vegetation studies and/or establishment of a monitoring programme.

Field check / ground truthing
Mapping units with similar features (density, tone, topographic site etc) on the aerial photo mosaic are initially grouped into the same potential vegetation type. Examples are visited on the ground and their composition, structure, use, and physical site conditions noted. Except for use data, which may vary according to accessibility, this information is assumed to hold true for other mapping units in the vegetation type. Occasionally, however, it may be found that some mapping units, originally thought to be similar, actually significantly differ in terms of species composition. These may represent a different vegetation type.

Updated base map
An updated base map is prepared from information obtained during the vegetation survey. Vegetation types will be named and, where this has been found to be necessary, type boundaries changed. When combined with infrastructural detail (roads, villages river etc) this comprises the map that will be used by project and district staff for management planning. It should be further updated as new information becomes available.

Important vegetation attributes to be recorded in the survey

The survey should identify and map individual vegetation types on the basis of their species composition (especially dominant species) and physiognomy (growth form, cover and height of the principal vertical layers/strata). It should also provide simple description of the type of side on which a vegetation type occurs and obtain some measure of biodiversity of the vegetation type in question. Biodiversity can be estimated with species lists, species / area curves and the calculation of biodiversity indices. Observations of the number, density, size and species of trees that have been utilized, compared with those that have not, will provide insight into both the type and degree of usage and the relative availability (population structure) of desirable trees and shrubs. Information on scientific and local plant names and their uses and values will add further to the picture of the values and uses of woody plant species and of the general health / condition of the vegetation as a whole.

Biodiversity "hot spots"

Biodiversity "hot spots" are areas of especially high diversity and / or which contain endemic and / or rare species. "Hot spots" may also occur where the spatial juxtaposition of significant differences in important environmental factors, such as topography, soils and drainage, result in a relatively dense mosaic or steep gradient of relatively diverse vegetation types. Any "hot spots" that are discovered during the survey should be given priority for conservation activities. Some potential biodiversity "hot spots" are listed in this report. These should be included in the proposed survey if resources allow.

Priority areas to survey

Limited funds require that the vegetation survey concentrate on priority areas. These are:

a) Woodland vegetation in and around the two pilot villages north of the river;

b) Natural Forest vegetation on the upper and lower flood plain and adjacent higher ground (including lake – side riparian forests);

c) Woodland vegetation along the Utete – Nyamwage – Mohoro road; and

d) Woodland and forest vegetation along the potential "hot spot" transect from near Utete South to the Kichi Hill.

Tyre, placement and numbers of sample plots

These will, ultimately, be the responsibility of the principal surveyor and will reflect his experience and the conditions, such as visibility and compositional variability, found within each vegetation type. However, some guidelines are provided in the report to assist him in his decision – making. These include the collection of data from at least ten fixed – area plots located so as to occur across the entire spectrum of variability within mapping unit / vegetation type.

Lists of plant species, scientific and local names and their values and uses, will be developed from plants found both inside and outside of the fixed area plots.

Survey output

- Base map of the project area
- Baseline data on the woody vegetation of the project area
- Important vegetation types and their composition and structure (ht. Cover)
- Species lists with scientific and local names, values and uses
- Biodiversity
- Present health/status/condition of the vegetation (especially some of the most important species).
- An increased understanding of the type and degree of use of the vegetation

- Possible discovery of biodiversity "hot spots"
- Possible recording of some species known to be endemic and/or rare
- Identification of stands of vegetation usable for study of secondary succession
- Identification of potential monitoring 'sites"

Data recording and analysis
These consists of the following:

a) Qualified vegetation ecologist and/or forest inventory specialist

b) An expert in identifying (and collecting) tree and shrubs species of the coastal region

c) A local fund in plant names, uses and values (and in past and present use of the area) and

d) Two people to help mark put plot boundaries, take measurements and assist in data analysis

These latter might profitably be graduate forest officers provided by the district. Addition information on plant names, uses etc. may be obtainable from local villagers within the context of the project's community development activities. Some local labour may occasionally be needed to help in clearing plot boundaries in dense thicket vegetation.

Monitoring
Three alternative approaches to monitoring are given. The most practical and cost effective approach is proposed to be the monitoring of specific areas which are especially important for some reason.

They may, for instance be:

a) Subject to particularly heavy use,

b) Ecologically sensitive, or

c) Have especially high biodiversity.

Some indicator attributes to monitor are mentioned. These depend upon the reason for monitoring. However, the attr5ibutes most likely to be used are:

a) Physical evidence of use (cut and damaged trees and shrubs)

b) The local peoples' perceptions about the type and degree of use and the relative abundance of desired species, and

c) The abundance and population structure of tree / shrubs species most likely to be used. The proposed vegetation survey should identify such sites for future monitoring.

Database
Limited funds constrain the development of geographic information system (GIS) database. Therefore, the database will necessarily be analogue in nature and consist of the original data collection and summary forms, lists, tables, graphs and summary sheets referenced to specific vegetation types shown on an updated vegetation map. Most of this information can also be stored in computerized form.

Incorporation of woody vegetation use and conservation into village and district level management plans

There are several possibilities:

a) District Forest and Bee-keeping Department staff could reassess the boundaries, purpose and usefulness of existing gazetted forest reserves.

b) Some other, unprotected, areas, such as the apparently highly diverse Kichi Hills forest, may warrant being placed within some form of reserve.

c) The District may find that it can positively influence the degree of tree cutting by restricting the sale of tree cutting licenses.

d) Selected villages can be given the responsibility to control tree cutting in their areas (establish village forest / woodland reserves)

e) The Department of Forests and Bee – Keeping (in cooperation with the district government) could encourage honey production through development of the appropriate policies as well as introduction of appropriate technologies.

f) Where appropriate, villagers could be assisted in obtaining and growing tree and shrub species of particular value to them.

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1 Terms of Reference

The terms of reference (TOR) call for the development of a strategy for the assessment of the types and distribution of woody vegetation within the project areas as well as of their status, complexity, usage and values to people. They also ask for the identification of indicators to be used for monitoring the status of the woody vegetation; provision of advice o0n how to recognize, describe and monitor biodiversity "hot spots"; and advise on how to establish the basis for long-term monitoring, as well as on how to incorporate woody vegetation use and conservation into village and district level management plans. A separate report is requested on a strategy for the survey and monitoring of livestock within the project areas.

2 Assessment of Woody Vegetation: General Approach

He assessment (or vegetation survey) should include the following components:

a) Identification and mapping of the major woody vegetation types and characterization of the physical site,

b) Determination of species composition and physiognomic structure

c) Determination of the diversity of woody plant species,

d) Description of the impact of human use, and

e) Of the uses to which woody plant species are put by the local people

According to discussions with staff of the IUCN Eastern Africa Regional Office and the Rufiji Environment Management Project, funds for carrying out the survey of woody vegetation, which available, are somewhat limited. Therefore, the survey should probably concentrate on providing a simple "first approximation" characterization of the vegetation rather than an intensive sample that includes all of the vegetation types within the project areas and which is accurate within statistically narrow confidence limits. As so little is presently known about the vegetation of the Rufiji area, even a simple characterization will provide an order of magnitude increase in knowledge.

2.1 Identification and mapping of vegetation types

2.1.1 Preparation of base map

In order to plan and carry out the vegetation survey some sort of base map is required. This will assist the survey team in choosing which vegetation units to sample and where to place their sample plots within these units. The base map will subsequently be modified based on the results of the survey before it is redrafted and printed for use by the project management team. It becomes part of the project database and is used for planning purposes.

There are three alternatives for preparation of the base map for the Rufiji Project areas:

a) Aerial photography

b) Satellite imagery and

c) The existing map of land cover and use prepared by Hunting Technical Services.

The pros and cons, including costs, of the each are discussed below (although the decision has already been made to use aerial photograph).

Aerial photography
Aerial photograph is first acquired for the area. Then a base map showing roads, villages, rivers and preliminary vegetation mapping units is prepared from the photographic mosaic which, basically, a photo map of the area. It does not have the accuracy of a topographic or planimetric map prepared from points surveyed on the ground but, if the photos are of good quality, usually provides a quite clear picture of landscape and gross vegetation features as well as of roads, villages etc. Photo mosaics are prepared using every other photograph of those taken for the project area. Therefore, if further, more detailed, photo interpretation using stereoscope is desired, an extra set of photos will have to be obtained.

Costs of obtaining aerial photography for the project area, as provided by PHOTOMAP are as follows:

- 1:250,000 black and white photos USD 56,000
- Uncontrolled photo mosaics (same scale) USD 6,300

- 1:50,000 b/w photos USDF 44,000
- Uncontrolled photo mosaics (same scale USD 2,400

- 1:400 b/w photos USD 48,240*
- Uncontrolled photo mosaics (same scale) cost not provided*
- 1:10,000 bromide enlargements @USD 60 each*

(*the project decided for this latter alternative, the number of 1:10,000 bromide enlargements to be determined at a later date)

Photo interpretation
Photo interpretation of detail (possible vegetation type boundaries, roads, streams etc.) may be carried out in the standard way with a second set of aerial photographs and a stereoscope (or) a faster, more approximate interpretation can be done by eye using only the photo mosaic. The latter approach can use the existing Hunting Technical Services vegetation map and the visual patterns seen by eye on the mosaic as guides in the interpretation of detail. The detail is then traced onto a clear overlay which is used directly as the base map of further transferred onto paper (by a blue print process?).

During the survey the survey team can mark new details, such as new vegetation type boundaries, directly onto the mosaic with grease pencil or onto a clear overlay with grease pencil or pen. Details are then incorporated into a new base map ready for use by project management staff.

Photo interpretation and preparation of the base map may be done by the Institute for Resource Assessment at the University of Dar es Salaam. However, if only the mosaic (and the HTS vegetation map) is used (and not three-dimensional views of photos provided by a stereoscope) then the survey team should be able to do both the photo interpretation and transfer of details onto an overlay.

Scale of aerial photography
Large scale photography, such as 1:25,000, allows good definition of smaller objects on the ground such as houses, crowns of individual trees, small fields and gaps in forest caused by cutting a large tree etc. However, there are proportionally more large scale than small scale photos per unit areas so photo interpretation, preparation of photo mosaics (if these are desired) and other related activities also take proportionately more time and expense. Based on my admittedly brief stay in the project area, I feel

that, for the purposes of the proposed survey, a smaller scale of, say 1:50,000, (or 1:40,000) would provide an acceptable trade – off between definition of detail and expense.

Satellite imagery

Satellite imagery provides a cheaper, faster way of preparing a base map and can be obtained in colour and at scales as large as 1:100,000 and 1:50,000 (using spot satellite imagery). Because it is generally at a smaller scale satellite imagery is easier to handle than aerial photography (only 5 images, at a scale of 1:250,000, were used to prepare the portion of the HTS vegetation map covering Rufiji District). Satellite imagery provides good views of gross vegetation patterns especially where these are strong influenced by physiographic landscape, soil and soil moisture features (hills, benches, plains, riverine and other high water table areas, etc.). It can also be used as an effective wall display of the project area.

Interpretation of detail

Three-dimensional viewing is not possible. Therefore interpretation is done by directly viewing each image. Interpretation and preparation of the base map can be done by the Institute for Resource Assessment or by the survey team. The HTS map should be used as a guide for some of the detail. For the present survey it is hoped that the imagery world, at the very least, help define the boundary between the miombo-type vegetation of the Kichi Hills and the vegetation on the adjacent beach between the higher ground and the flood plain. As with aerial photos and photo mosaics, satellite images should be taken into the field wile the survey is being carried out. Detail is marked directly on the image or onto a clear overlay.

Scale of image

Although it is possible to get scales of 1:100,000 o0r even 1:50,000 Spot imagery, it is probably best to get 1:250,000 Land sat Thematic Mapper imagery which is the type primarily used in preparation of the HTS vegetation map. The spatial patterns of the vegetation I viewed in the project are would seem to be adequately defined by imagery at this scale.

Obtaining satellite imagery

a) Institute for Resource Assessment (IRA) / Tanzania Natural Resource Information Centre (TANRIC), University of Dar es Salaam

The policy of IRA/TANRIC is that it will obtain satellite imagery for a client, such as the Rufiji Project, if the Institute is to subsequently be involved in other activities for the client, such as interpretation of detail on the image and the preparation of maps.

IRA staff were unable to provide me with costs of imagery. Consultancy fees for photo interpretation, preparation of maps etc. range from USD 174 – 304 / day depending on the professional level of staff involved. These are minimum fees.

b) Regional Centre for Services in Surveying and Mapping and Remote Sensing, Kasarani, Nairobi, Kenya

I spoke with Mr. Luka Isavwa. This agency presently has Land sat MSS imagery of the coast of Tanzania for the period 1972 – 1989. Land sat MSS is the older type of Land sat. It has a resolution of 80 meters on the ground. More recent Land sat Thematic Mapper imagery is available at Kasarani only for the immediate area of Dar es Salaam. The purchase of a single scene at 1:250,000, which is I meter by 1 meter in size (for which up to five are required for the project area) will cost USD 160. Smaller scenes, which are 16 by 20 inches in size (still at 1:250,000) cost UDS 80. However, as they are smaller, a large number will be needed to cover the project area. If all materials are available at Kasarani when the order is made, receipt of the images is possible in one week's time. Otherwise it could take up to a month.

More recent imagery can be ordered through the Regional Centre. They contact the appropriate agency in the USA (for Land sat imagery) or France (for Spot imagery) and request a film positive for each image or scene required. Cost for each film positive is USD 2,000 (again, up to 5 scenes are required for the Project areas at a scale of 1:250,000). If the images are available in USA or France at the time of order they will arrive in Kenya in about a month. Otherwise there will be a delay.

Thus, cost of obtaining satellite imagery for the project areas from the Regional Centre, depending on the type of the imagery, ranges from USD 800 to 10,800. It can be delivered in from one week to over two months.

Hunting Technical Services vegetation map

This is actually termed a Land Cover and Land Use map. However, it presents a number of basically physiognomic vegetation types, such as natural forest, woodland, dense bushland, and open grassland (seasonally inundated), which could be used as a basis for planning the vegetation survey of the project areas. It should be used in any case, as a guide in interpretation of aerial photography, aerial photo mosaics or satellite imagery in case any of these are used to prepare the base map. However, it is also an adequate base map of the vegetation units of the area in itself. Its use for this purpose would do away with the immediate need for purchasing aerial photography or satellite imagery and doing photo/image interpretation. This, it is by far the cheapest and fastest means of obtaining a base map for the vegetation survey.

Interpretation

The initial interpretation of vegetation and infrastructure detail has already been carried out. Vegetation types are approximated by land cover and land use types.

Further detail based on compositionally – defined vegetation types would come from ground truthing/field checks during the survey (some of the land cover/use types probably include more than one compositionally defined vegetation type while other may have to be split between two or more compositionally defined types).

Scale : 1:250,000

Observation from a light aircraft

A light aircraft might be useful in providing some of the information that is needed on the initial vegetation base map.

I entered only one stand classified as Natural Forest by the HTS map. However, several other stands were entered which, seen from the river, appeared to be Natural Forest from a distance but were actually dominated by (or had a significant admixture of) mango trees. If any of the other stands of Natural Forest stands on the HTS map also are actually stands of mango trees then it would be worthwhile to determine which are before the survey takes place so that time is not wasted entering them. This should be possible by visiting each mapped stand (using the HTS vegetation map as a guide) and viewing it from a light airplane. A further distinction should be possible between natural forest dominated by broad leaved trees and that dominated by broad leaved trees and that dominated by Acacias.

While in the project area I identified three major vegetation types in terms of species composition. It might be possible, by observing these areas from the air, to determine some characteristics of the tree canopy or physiographic features of the land which can be used to identify the area extend of these vegetation types and determine possible boundaries with other vegetation types. One immediate use of

this approach would be to try and determine the boundary between vegetation along the road from Utete eastward to Nyamwage and that on the more hill area to be the south.

2.1.2 Definition and delineation of the project area

Project staff have made it clear that the vegetation survey is to be of the project area rather than of the district as whole, although they also hope that the survey results will have some district-level implications. The "Project Areas" needs to defined and delineated so that it can be put onto the base map and be used by the survey team for planning their work.

I am still unsure as to what is understood to be the project area. I assume that, strictly speaking, it consists of the floodplain and the delta. A further assumption is that, strictly speaking, the flood plain is defined by the HTS land cover/land use type called Grassland with Scattered Cropland, which occurs on either side of the river; the smaller units of other types of vegetation, such as Natural Forest and Swamp/Marsh, which are included within this larger type; and any adjacent vegetation types that are seasonally inundated.

However, many of the people using the floodplain actually live at least part of the time on higher ground adjacent to it and make significant use of non-flood plain vegetation.

Vegetation near settlements is used primarily for materials, such as poles for constructing houses, (Rose Hogan says that most of this kind of use of woody vegetation seems to extend only a few km away from settlement) while that further away produces larger trees for lumber, furniture etc. Therefore, the project area must actually include a least some of the land adjacent to the flood plain. The question is where to draw the line.

I suggest, as a compromise between surveying the entire district and surveying only the flood plain and delta, that the northern boundary of the project area be defined by the southern edge of the HTS land cover/use type, Closed Woodland, as this also roughly coincides with the beginning of higher elevation land rising off to the north. South of the river (and east of Utete) the project area could similarly extend to the bottom of the higher elevation land to the south which leads up to the Kichi Hills and the Matumba Range. However, this boundary is not demarcated on the HTS map by a change in vegetation and will have to be defined and delineated during aerial photo / satellite image interpretation; the vegetation survey or, possibly, from a light airplane, such as during a systematic reconnaissance flight)SRF) (see above). West of Utete, however topographically higher land seems to be much further away from the river. In this case, I suggest somewhat arbitrary distance of about 10 km away from the edge of the floodplain. This zone includes Closed Woodland, Wooded Grassland, Open Woodland and Bush Grassland (seasonally Inundated) HTS land cover/use types. Thus defined, the project area covers (very roughly) about half of Rufiji District (Appendix 8.1).

2.1.3 Field Checks/ground truthing

Mapping units with similar features (but especially compositi9onal features, such as dominant species) are initially grouped into the same potential vegetation type. Examples are visited on the ground and their composition, structure, use, and physical site conditions noted. Except for use data, which may vary according to accessibility, this information is assumed to hold true for other mapping units in the vegetation type. Occasionally, however, it may be found that some mapping units, originally thought to be similar, actually significantly differ in terms of species composition. These may represent a different vegetation type.

2.1.4 Updated base map

An updated base map is prepared from information obtained during the vegetation survey. Vegetation types will be named and, where this has been found to be necessary, type boundaries changed. When combined with infrastructure detail (roads, villages, rivers etc.) this comprises the map that will be used by project and strict staff for management planning. It should be further updated as new information becomes available.

2.1.5 Identifying and classifying vegetation types

This requires information on species composition and structure and the side on which the vegetation type occurs.

Species composition
Species composition can be expressed in terms of simple occurrence, as in a species list, and relative abundance.

Species List
Preparation of a list of species found within each vegetation type is straightforward. Every woody plant species encountered is placed on the list. Where possible, each species is identified by both scientific and local name. As some woody plant species are likely to be rare in occurrence, it is unlikely that the survey will be able to develop a complete species list for any of the vegetation types. However, the species lists that are developed will provide good "first approximations" of the species found within each vegetation type and, as such, are useful indicators of biodiversity.

Plant species should be identified by both scientific and local names.

Abundance
Abundance (and, therefore, relative abundance) may be expressed in terms of frequency, which reflects distribution of a species throughout an area, density (pants, per until area), and cover % or basal area/hectare. Of the latter two attributes (which are in fact, the best indicators of abundance), the % total cover provided to a vegetation type by each species will be the most difficult and imprecise to measure because the trees found within the project area are typically tall and dense. However, with the exception of some of the broadleaf forest stands on the flood plain, most of the woody vegetation has a relatively open understory which is easy of access and provides clear views for some distance. Therefore, relative abundance should be measured and expressed in terms of % total basal area/ha for each species (basal area is derived from measurement of the diameter of the bole of each tree taken at beast – height).

Physiognomy
Physiognomy, which is the term used to describe the physical aspect of vegetation (forest, woodland, wooded grassland etc) is expressed in terms of growth form (tree, shrub, liana etc), height and cover. For the purposes of this survey, a description of vegetation physiognomy is less important than species composition or population structure. However, a minimum amount of information is still needed for purposes of characterization of each vegetation type.

Growth form
Identification of the growth form of a woody plant species is usually straightforward and can be made at the time the species encountered in the survey. An exception may be when a relatively small woody plant is unfamiliar to the surveyor. Whether it is a shrub or young tree can usually be determined by asking a local person how tall that particular species will eventually grow.

Height

The most important height attributes are

a) Canopy height

b) Height of under story canopies, where these exist and,

c) Height of emergent tree species that grow up through and above the general level of the upper canopy.

Tropical forests often have multi-layered canopies. However, Chidumayu (1997) notes that miombo vegetation – which is closely related to the woodland vegetation of the project area – seldom has more than a single canopy. I would say that the woodlands of the project area usually have a single fairly dense upper canopy with occasional tall emergents and a relatively sparse shrub understory. The forest vegetation tends to have a denser understory and more emergents. However, I was unable to determine whether the understory consisted primarily of shrubs or of young sapling trees that will eventually grow into the upper canopy.

Cover
Cover here is canopy cover or the amount of the surface area of the ground that is covered by the crowns of the trees that comprise the overhead canopy. Although it would be interesting to know the canopy cover of each canopy layer this will take too long to measure. Instead, it is best to estimate total cover contributed by all height levels of woody vegetation with a possible maximum of 100% cover.

Population structure
Population structure is the number of plants per age class for a given shrubs or tree species. As age is difficult to determine accurately in many tree/shrub species, diameter (at breast height) is used instead as it has a least a relative relationship with age. A knowledge of population structure helps determine the general health of a plant species population, such as whether there are enough round plants to maintain the population, and can be used to determine the relative availability of certain useful tree sizes, such as poles for building.

Site description
Knowledge of the physical site on which a vegetation type occurs is useful to project management because it gives insight into the ecological underpinning of the vegetation. Further, the inclusion of a simple descriptive term for the site as part of the name of vegetation type often considerably increases the power of the information to be obtained at a single glance when reading that name. For instance, some examples of vegetation types identified and namely by Vollesen (1080), in his Annotated Check List of the Vascular Plants of the Selous Game Reserve, are: Coastal forest and thicket on sand, Coastal thicket on clay, Riverine forest and thicket and woodland on shallow stony or clay soil.

For the purposes of this survey, site description should be relatively simple and straightforward, consisting of a broad soil texture classification (sand, clay, loam) which can be estimated by feeling the surface soil with the fingers and a simple classification of the physiographic site (seasonal inundated shallow depressions, hill slopes riverine, lakeside etc.

2.2 Biodiversity

2.2.1 Biodiversity indices

Biodiversity of woody vegetation can be expressed in terms of richness (the number of taxa in vegetation type), evenness (the distribution of abundance among taxa in a vegetation type), and/or number of endemic and rare species. The number and spatial distribution of different vegetation types within an area also contributes to biodiversity.

List of Plant species
The simplest measure of diversity to obtain is a list of plant species encountered during the survey of each vegetation type. Separate lists can be presented for:

a) species,
b) genera,
c) families,
d) genera with "x" number of species and
e) families with "x" number of genera

The presence of endemic and rare species should also be noted. (Intensive collecting is required to adequately record endemic and rare species). Lists for individual vegetation types may later be combined into lists for larger, more inclusive ecosystems, such as, for example, floodplain vegetation and – for want of a better term at the moment – miombo vegetation.

Species / area curves
Species / area curves, which plot the accumulative number of species that occur as plot size increases, are another indicator of diversity. Curves which taper off quickly with increasing plot size, are not diverse. Those which taper off slowly indicate the probable presence of yet further, less abundant, species that have yet to be found. Species/area curves are thus both indices of diversity and show whether further searching is likely to yield additional plant species. Increasing plot size can be calculated by adding up the cumulative area of all of the fixed – area sample plots placed with a vegetation type.

Biodiversity formulas
Simpson's index of diversity, which includes both richness and evenness components of diversity, can be calculated for each vegetation type. The calculation of this index requires:

a) Number of species in a sample and
b) Number of individuals for a species.

The number of individuals per species will be obtainable from the fixed area sample plots. (The principal vegetation surveyor should be asked to look up a relevant formula, such as Simpson's Index of Diversity, and bring it with him to the study areas.

2.2.2 Biodiversity/conservation "hot spots"

The project area lies with the East African Coastal Forest Eco-Region which, according to the World Wildlife Fund is one of 200 Global 200 Eco-Regions, which are especially important because of a combination of species richness, levels endemism, taxonomic uniqueness, unusual ecological or evolutionary phenomena and global rarity of the major habitat type. Also present within the project area is vegetation which is either part of or very similar to that of the Zambesian Woodlands and Savannas, which is yet another of the global 200 Eco-Regions (WWF, No date). Thus, the vegetation of the project areas is already known to be important from the viewpoint of its uniqueness and diversity.

Definition of "hot spot"
Much of this uniqueness and diversity may occur with specific localities. Biodiversity/conservation "hot spots" are areas of especially high diversity and/or which contain endemic and/or rare species. "Hot spots" may also occur where the spatial juxtaposition of significant differences in important

environmental factors, such as topography, altitude, soils and drainage, result in a relatively dense mosaic or steep gradient of relatively diverse vegetation types. "Hot spots" should be given priority for conservation activities.

Some possible "hot spot" areas

Examples of individual vegetation types known or suspected to have high biodiversity and to contain endemic and rare plant species are the Kichi Hills south of Utete and the forest reserves in the Matumbi Range in the southeast of the District (Waters & Burgess, 1994). A potential (i.e. possible) "hot spot" of diversity comprising a number of adjacent or nearby vegetation types, occurs along the topographic gradient from dense bushland in the Tawi and Nangaluanga areas along the southern boundary of the district, northwest to the top of the Kichi Hills and then north-eastward and downslope, crossing the flat bench along the Nyamwage road (including here some of the small pockets of shallow depressions within that bench) and ending in the lake – side forest adjacent to the Rufiji River. Another possibility is a transect running southwestwardly from the Rufiji River in the upper floodplain near Zombe (upstream from Mtanza) to the Selous Reserve Boundary. This transect crosses eight vegetation types (most of which contain at least a minor woody component) in a relatively short distance of about 17km (Appendix 8.2).

Due to the probably very diverse pattern of sediment deposition within the Rufiji floodplain and, therefore, a diverse pattern of soil texture, depth and drainage conditions, it is likely that the stands of woody vegetation that occur on the floodplain, although mostly small in individual area, are also equally diverse in botanical composition when viewed over the whole area.

The mangrove vegetation of the Rufiji delta, although not botanically diverse, is unique in the large number of mangrove species (8) that it contains. This is one of the two best mangrove systems of the East African coast (Lind & Morrison, 1974).

According to its Project Manager, Peter Sumbi, the World Wildlife Fund Conservation of Lowland Coastal Forests Project, has carried out an initial survey of the forest in the Nyamuete Forest Reserve in the southeast of the district and plans to begin collecting plants in the forest on the Kichi Hills at the first opportunity. Therefore, survey activities are already under way in some of the potential biodiversity "hot spots" in (or near) the project areas. Both projects would benefit from cooperating in this activity. Discussions should be held with Mr. Sumbi as to how such cooperation can best be carried out. Perhaps the Rufiji Project could assist with the description of the composition, structure and biodiversity of the Kichi Hills forest. It could certainly make use of the Coastal Forests Project's information on plant species present in the forest and their names and uses.

2.3 Impact of human use

2.3.1 Direct evidence of use

The impact of human usage on the woody vegetation of the area can be estimated directly from observations in the field of stumps of felled trees and of damage to standing trees where part has been cut away. These observations can be carried out simultaneously with the field survey of composition and structure of the vegetation.

2.3.2 Indirect evidence of use

The degree of usage can be inferr3ed in a broad way from indirect evidence such as the number of bags of charcoal piled along the road for sale, counts of people carrying loads of poles from the forest,

numbers of pit sawing sites in the field (if such exist in this area) or the opinions of the local people about the trends in relative availability of useful tree species or size class of tree. However, this sort of information is probably best carried out as part of a long term monitoring program, possibly integrated into the community development component of the project.

Inferences about the impact of use may also be drawn from the population structure of tree species that are known to be used. Limited numbers of trees in the size classes most frequently used imply the possibility of heavy use. A lack of young, regenerating trees implies the possibility that the site has been ecologically modified in some way by use so as to constrain regeneration of this particular tree species. However, in order to be most reliable, this approach to determining the impact of use, requires some knowledge of the patterns of population structure to be expected of the tree species in question and on the species and size classes most like to be used. On the other hand, it is a much more reliable method of determining the availability of those size classes of trees that are preferred for use by the local people (see Section 4.2).

2.3.3 Uses and values of woody vegetation

His sort of information is best obtained by going directly to the people through an ethnobotanical survey which will provide such information as the local name for the plant (which must then be matched with the scientific name), types of use, parts of the plant used, type of people collecting or using it, methods of storage, time of year collected as well as people's perceptions about abundance and the extent of usage.

Some of this information can be collected in the field ruing the survey of vegetation composition and structure. However, most of it will probably have to come from questionnaire – type surveys made in the villages. Again this might be best carried out as part of the community development component of the project.

3 Assessment of Woody Vegetation (Specific Approach and Methods)

3.1 Areas and locations to survey

Generally, the survey should be confined to the project areas as described in section 2.1.2 except for "hot spot" areas, such as the Kichi Hills, which occur outside of this areas. The mangrove ecosystem of the delta need not be surveyed because of the previous work done there by other agencies.

Within the project area (as defined above) the survey should concentrate on the accessible parts of the flood plain and the adjacent higher benches to the north and south. The survey should be planned so that it includes land near and around the two pilot villages at the edge of the flood plain. In this way a component of the results should be more easily related to the needs and uses of these two villages.

Again, generally (and if allowed by the available resources), at least one (accessible) mapping unit of each type class of vegetation which has a significant woody component and is free of cropping should be entered and sampled during the survey. It may be discovered during the field work that some of the preliminary mapping units contain vegetation from more than one compositionally (botanically) – defined vegetation type. The newly discovered vegetation types should then also be sampled separately.

Several stands)mapping units) on the flood plain shown as Natural Forest on the HTS map, should be sampled, including some on both sides of the river and in the lower and upper parts of the flood plain.

There appear to be at least two types:

a) Broad leaved forest

b) Acacia forest

Both types should be sampled although Acacia forests, which are probably the least diverse of the two types, can be samples less intensively. An effort should also be made to include both riverine and lakeside stands. Stands found to have a significant component of mango trees should not be sampled during the survey. In some cases stands of forest (at least Acacia forest) Occur on the flood plain that are not represented on the 1:250,000 HTS map. Two such stands occur along streams flowing through the flood plain between Ikwiriri and the large lake to the west. Another stand occurs on the south bank of the river several miles upstream from Utete. These should be delineated on the 1:40,000 photo mosaic and visited in the field.

Potential 'hot spot" stands (mapping units) within the project area should be included in the survey if resources allow. Further, the survey should be so planned that the inclusion of potential "hot spots" outside of the project area can be included with a minimum amount of additional time and energy expended. Thus, the survey should include not only vegetation near and around the two pilot villages on the north side of the river but also samples of the stands (mapping units) of vegetation located along the two transects described in Section 2.2.2 south of the river (Appendix 8.2).

The accessibility of the vegetation stands along the 'hot spot' transect across the river from Mtanza is questionable. However, the "transect" should be regarded more as model than as a specific line of travel. It is completely acceptable to enter the different types of vegetation found west of Utete and south of the river at different places as access allows. However, there may insufficient funds to allow sampling of this particular "hot spot" transect at present (see below).

This amount of funds available for the vegetation survey; probable time require to carry out field work presence of potential "hot spot" areas, and proximity to the two pilot villages along the end of the flood

plain have been used to prioritise areas and vegetation types for survey. The assumptions used in the prioritisation are:

a) Available funds – approx. USD 25,000

b) Cost of survey (consultants fees etc) – approx. USD 500 per day

c) Required number of sample plots per vegetation type – 10

d) 2-3 sample plots done per day

e) A certain amount of travel time will be required for the consultants to travel to and from the project area and from one part of the area to another to carry out the sampling and to carry out the appropriate office work required to analyse the data and write a report.

Using these assumptions it is theoretically possible to survey nine vegetation types over a period of from 32 – 48 days (Forty eight days would use up most of the USD 25,000).

With that in mind, the priority areas for sampling are:

a) Woodland vegetation in and around the two pilot villages south of the river

b) Natural Forest vegetation on the upper and lower flood plain and adjacent high ground (including lake – said riparian forests);

c) Woodland vegetation along the Utete – Nyamwage – Mohoro road; and

d) Woodland and forest vegetation along the potential "hot spot" transect from near Utete south to the Kichi Hills (Appendix 8.3)

3.2 Methods of survey

3.2.1 Type, placement and numbers of sample plots

These will, ultimately, be the responsibility of the principal surveyor and will reflect his experience and the conditions, such as visibility and compositional variability, found within each vegetation type. However, some generalizations can still be made at this point.

Type of sample plot (sample unit)

Sampling for composition and structure
Some form of fixed – area plot will probably be needed. Burgess et al, (no date) used 20m x 509m plots (0.1ha) in their survey of montane forests in eastern Tanzania and Kenya. Rogers at al (1983) used 25m x 10m subdivided into 5m x 5m subplots in the Kimboza Forest Reserve in eastern Tanzania to determine the population structure (species, density and diameter) of trees less than 30 cm diameter at breast height (dbh). Chidumayo (1997) mentions fixed – area plots of several sizes that have been used in surveying miombo vegetation. At present a 25 c 10m plot looks like it might work best within the project area.

Sampling for evidence of cut and lopped trees and shrubs
This is best done while surveying for composition and structure. A fixed area belt – transaction placed over, or beginning from, the other survey plot is searched for stumps of cut trees or evidence of parts of trees having been cut away (branches, stripped back etc.) Each is identified as to species (if possible); size class (diameter class of trees over a minimum diameter (to be determined by the surveyor based on ease of measurement) or height (for trees/shrubs less than the minimum diameter); and type of use. This method provides information on the number of used plants (by size class and species and type of use) per hectare. Plot dimensions are again up to the surveyor. However, Burgess et al (no date) used

a belt transect 10m wide which passed from one side of each forest stand to the other. It will not be necessary to have such long belt transects in this survey because there will be usually be several sample plots placed within each vegetation type.

Location and number of sample plots
The placement and number of sample plots in a vegetation survey reflects the objectives of the survey, accessibility, the variability of the vegetation and the resources at hand (such as funds and equipment). Optimally, sample plots, if limited in number, should be located in the most representative portion of a vegetation type. Otherwise they should be placed in such a way that they occur across the entire spectrum of variability within the type. In the present case, there are some limitations on resources and accessibility and the vegetation appears to be, at least in the woodlands, often highly variable as to composition. The objectives of the survey are to obtain an initial characterization of the vegetation which will allow the development of preliminary plans for management, further surveys and research. Therefore, some compromise must be made regarding placement and number of sample plots during the survey.

Number of sample plots
Ideally, there will be enough sample plots to adequately sample the inherent variability of every major attribute (such as cover, height, diameter) being measured. However, this is unrealistic, especially when funds are limited. Given the restricted number of sample plots that will be possible it may even be difficult to adequately sample the variability of dominant species. However, it does appear possible to characterize woodland vegetation types (at least) within the project area with a relatively small number of sample plots based on constancy (an association of species which occur in most sample plots within a vegetation types (Appendix 8.4) by 6-8 sample plots. Therefore, sample size can be based on constancy.

Location of sample plots
Ideally, sample plots should be located systematically or randomly throughout the vegetation type so as to encounter as much of the inherent variability as possible. However, the vegetation survey is to be limited to three (priority) parts of the project area so not all of the vegetation will be sampled. Further, sample plots need not be located randomly, because the objective of the survey is to characterize the vegetation rather than obtain a statistically significant description. Rather, they should be located at systematically determined intervals throughout the mapping unit(s) chosen to represent each vegetation type within the parts of the project areas given priority for sampling.

3.2.2 Other methods of sampling and measurement

Height and cover of tree canopies
A few measurements of height and total canopy cover can be made in the vicinity of each plot, whether it be variable or fixed – area plot. These can be averaged out for all of the sample plots within the vegetation type as a whole. Height can be measured with a clinometer and survey tape. Cover has been measured by the Coastal Forest Project using an optical device but, for the purposes of this survey could probably simply be estimated by eye into one of a few broad cover classes. After some experience has been gained with the clinometer and tape it will probably be easy enough to estimate tree height into broad height classes by eye as well.

Biodiversity
Biodiversity as calculated by the Simpson index of diversity or some similar index, as well as determined from species / area curve, can be determined from the date on species occurrence, species composition and population structure obtained from the fixed area plots.

Species identification
Tree and shrub species will be identified as to scientific and local name by an expert in the field who is part of the survey team and by a local person who is similarly knowledgeable bout local names (and uses). This wok will not be restricted to plants found within the plots. Where time permits the expert should range over a wider area in order to identify as many species as possible and to collect those the identities of which he is unsure. Species identification and collection should similarly be carried out during ethnobotanical surveys made at / around the two pilot villages. A very preliminary list of scientific and local plant names of a new tree and shrub species in the project area is given in Appendix 8.7

3.3 Survey output

- Base map of the project area
- Baseline data on the woody vegetation of the project area
- Important vegetation types and their composition and structure (ht. Cover)
- Species lists with scientific and local names, values and uses
- Biodiversity
- Present health/status/condition of the vegetation (especially some of the most important species)
- An increased understanding of the type and degree of use of the vegetation
- Possible discovery of biodiversity "hot sports"
- Possible recording of some species known to be endemic and/or rare
- Identification of stands of vegetation usable for study of secondary succession
- Identification of potential monitoring "sites" (see Section 4.0 below)

3.4 Data recording and analysis

See appendices for examples of field forms for recording data.

- List species found within each vegetation type by scientific and local name
- List uses and values for these species
- List endemic and rare species
- Note general apparent past and present use of the area (type and degree)
- Data from fixed – area plots to be analysed by vegetation type for:

  a) Species composition based on constancy of occurrence and on % total basal area

  b) Dominant species (as above)

  c) Frequency of occurrence by species (number of plots in which a species occurs as a % of the total number of plots in the vegetation type).

  d) Basal area by species, diameter class (as well as total)

  e) Population structure from diameter class distribution. (The Team Leader decides on the specific classes to use. However, the following classes (in cm dbh) might be used: <10, 10-19, 20-29, 30-39, 40-60 and 60 +). This to be done for all species combined and for the most important and/or dominant species and should be expressed in terms of density (trees/ha) and basal area (sq. meters / ha)

  f) Identification of the principal vertical layers (storeys) of trees / shrubs (for instance: understory, main canopy and emergents). Give average height or range of heights and identify the principal species in each layer.

g) An approximate estimate of the amount of total canopy cover, which is a total of that provided by the main canopy, understory and emergent trees.

h) A simple site description, such as gently sloping shallow, stony or clayey soil, or level sandy soil with scattered termite mounds etc.

i) Density and basal area / ha (by species and diameter class) of trees and shrubs utilized (cut and damaged).

j) Biodiversity
- Species list (see above)
- Species area survey (graph number of species encountered against increasing area sample.
- Indices of diversity (as, fo0r example Simpson's index of diversity)
- Identify biodiversity "hot sports' (if encountered) woody species).

k) Modify the base map to reflect new information on names of vegetation types and their boundaries.

l) Provide a name for each vegetation type that should include either the dominant species or the dominant genera, physiognomic class (woodland, forest etc), and physical site.

3.5 Personnel required for the survey

a) A team leader who should be a qualified vegetation ecologist and/or forester experienced in forest inventory. This person will be responsible for planning and overseeing survey activities including data analysis, preparation of the data base and preparation of the final report.

b) An expert in identifying tree and shrub species of the coastal regions of Tanzania. This person will accompany the survey team to assist with identification. He/she will collect specimens of plants which are unknown, as well as any which are known to be endemic and/or rare. These specimens will be taken to an appropriate herbarium for identification. Whenever the situation allows, he/she will carry out independent collecting. Local names and uses will also be recorded for each species. This expert may also be able to teach some selected local people in how to collect and preserve pant specimens.

c) A local fundi in local plant names, uses and values (and in the past and present type of use of the areas being surveyed) to accompany the survey team and work with the expert in plant identification. (Further information on local plant names, values and uses can be obtained within the context of community development activities by one or more local people under the direction of TA (Community Development) and the C.T.A.

d) Two people to help mark out plot boundaries, take measurements and, perhaps, assist in the data analysis. This might be a good chance to incorporate the assistance of district forest staff. At present this office does not have the capability to plan and implement a vegetation survey. However, it may be possible to have one or two graduate officers from the Forest Department transferred to Utete for this work. Assisting` in this survey would provide them with a considerable amount of field experience in vegetation inventory, allow them to see some vegetation types that they might not otherwise encounter and give them insight into how to plan and carry out further survey and monitoring activities.

e) Some local labour may occasionally be needed to help in clearing plot boundaries in dense Natural Forest thicket vegetation.

4 Monitoring

4.1 Alternative methods

4.1.1 Permanent sample plots (PSP'S)

Placement of permanent sample plots (PSP's) in representative and/or special "key" site is the most precise methods of monitoring. However, the plot markers (paint, metal rods placed in the ground, piles of rocks etc); as well as documentation, that are used to relocate PSP's tend to disappear over time. This makes it difficult to precisely relocate the exact boundaries of the original plot again (or, often, even to realize that they once existed). Even were GPS readings used to relocate the approximate area of permanent sample plots there would probably be difficulties in re-finding the precise location of plot corners and boundaries.

4.1.2 Re do entire survey

For the reasons given above this is, technically speaking, a more practical approach as it does not depend on being able to precisely locate the original permanent sample plot. However, because it is expensive, it is unlikely to be cost – effective.

4.1.3 Monitoring specific important ("indicator" or "key") areas

This is the most practical and cost effective approach in monitoring. The area chosen for monitoring should be particularly important for some reason. It may, for instance, be an area the use of which can be taken to be an indicator of trends throughout a larger areas; it may contain especially important plants, or be ecologically sensitive in some way (such as to soil erosion) –or represent the primary area of woody vegetation upon which a particular village depends. A stand of vegetation, which both provides useful materials and is within walking distance of a village is a good example of a potential monitoring site. A site within a vegetation type with especially high biodiversity might be another good example. Such sites, which might be several square km or more in area, can then be monitored by placing a number of sample plots systematically throughout the area and analysis the data in the same way as in a regular vegetation survey (i.e., no attempt would be made to precisely relocate the corners and boundaries of the original sample plots). "Key" monitoring areas should be identifiable from the results of the proposed vegetation survey.

4.2 Indicator attributes to use in monitoring

The indicator attributes used depend upon the reason for monitoring. However, the most likely attributes are:

a) Physical evidence of use (cut and damaged trees and shrubs)

b) The local people's perceptions about the type and degree of use and of the relative availability of desired species (and)

c) Abundance and population structure of tree / shrubs species mot likely to be used.

5 Database

Limited funds constrain the development of a geographic information systems (GIS) database. Therefore, the database will necessarily consist of the original data collection and summary forms, lists, tables, graphs and summary sheets (as per section 3.4) as well as an updated vegetation map. Most of this information can also be stored, analysed and displayed in tabular form using a standard computerized relational database system such as Microsoft Access (a component of Office 97), which is relatively user – friendly and widely used. Two other relational database systems that could be used are Foxpro and dBase. Data to be obtained from further survey and monitoring activities can also be sorted, analysed and displayed with this type of "lo end" database system.

6 Incorporation of Results onto Village and District – Level Management Plans

There are several ways in which the use and conservation of woody vegetation might be incorporated into village and district – level management.

a) The boundaries, purpose and usefulness of officially – gazetted forest reserves could be reassessed by district forest staff. Although there are a number of such reserves within the district, they are often located in odd situations or are quite small. Their boundaries as shown on the topographic maps also sometimes do not coincide with the boundaries as seen by the local people. Neither are the existing reserves well protected for want of adequate funds to pay the guards. This to the point where forest guards are sometimes financially supported by outside organizations, such as the WWF Conservation of Lowland Coastal Forests Project. In at least some cases, it may be more effective to pass responsibility for a forest reserve to local communities, who live close by and have a stake in the sustainability of the reserve's vegetation.

b) On the other hand, some other areas, such as the apparently highly diverse forest on the Kichi Hills, need to be placed within some sort of reserve, whether this be under the authority of the Department of Forests and Beekeeping or some more local authority. To this effect, the WWF Conservation of Lowland Coastal Forest Project which is presently interested in this forest, should be encouraged to organize and implement either an officially gazetted or local community reserve there.

c) Management of woody vegetation at the district level is affected by policy regarding the selling of licenses for cutting. Should it be discovered from the vegetation survey that certain important species are being over cut then it will be important for the district to reduce or stop giving licenses for cutting that species. It might also be well for the district to allow selected local communities to be responsible for the licensing of tree cutting in their areas (and then not confuse their management efforts by continuing to license tree cutting at the district level).

d) In a report by the TA (Community Development) the local people say that they do not involve themselves in honey production because they are afraid of contravening regulations set by the Department of Forests and Beekeeping. I suspect that honey gathering still occurs. Nonetheless, it would be worthwhile for the Department of Forests and Beekeeping (in cooperation with the district government) to take up a more positive approach so that beekeeping is not only allowed by encouraged, such as through the introduction of improved husbandry techniques. I gather that the district presently does not have an officer in charge of beekeeping and honey production. It is important that such an officer is obtained.

e) Establish village forest / woodland reserves. According to Rose Hogan, the project's T.A. (Community Development), the legal framework to allow this is said to exist and some villages are already beginning to attempt to manage their woody vegetation resources in this way. Again, the Lowland Costal Forests Project is presently establishing village reserves in the

Kiwengoma area of the Matumbi Hills in the southwest of the district. The ability of villages to patrol their reserves and control trees cutting could be supported by the provision of bicycles and/or motorbikes (probably at the expense of the Rufiji Project.

f) At least one village described in the report by the TA (Community Development) has a shortage of fuel wood. Villagers are reduced to cutting down old mango and cashew trees and dead grass is used to dry fish. It should be possible to at least partially alleviate shortages in a particular type of desirable woody plant by encouraging the villagers concerned to plant and grow either that species or others which are similarly suited to the villagers' needs. This is another activity of the Lowland Coastal Forest Project which first establishes what type of trees villagers want to grow and then obtains the seed and provides instruction in how to grown the tree. At least 11 exotic and 4 indigenous tree species have been requested and are being grown by villagers associated with the project's activities.

7 References

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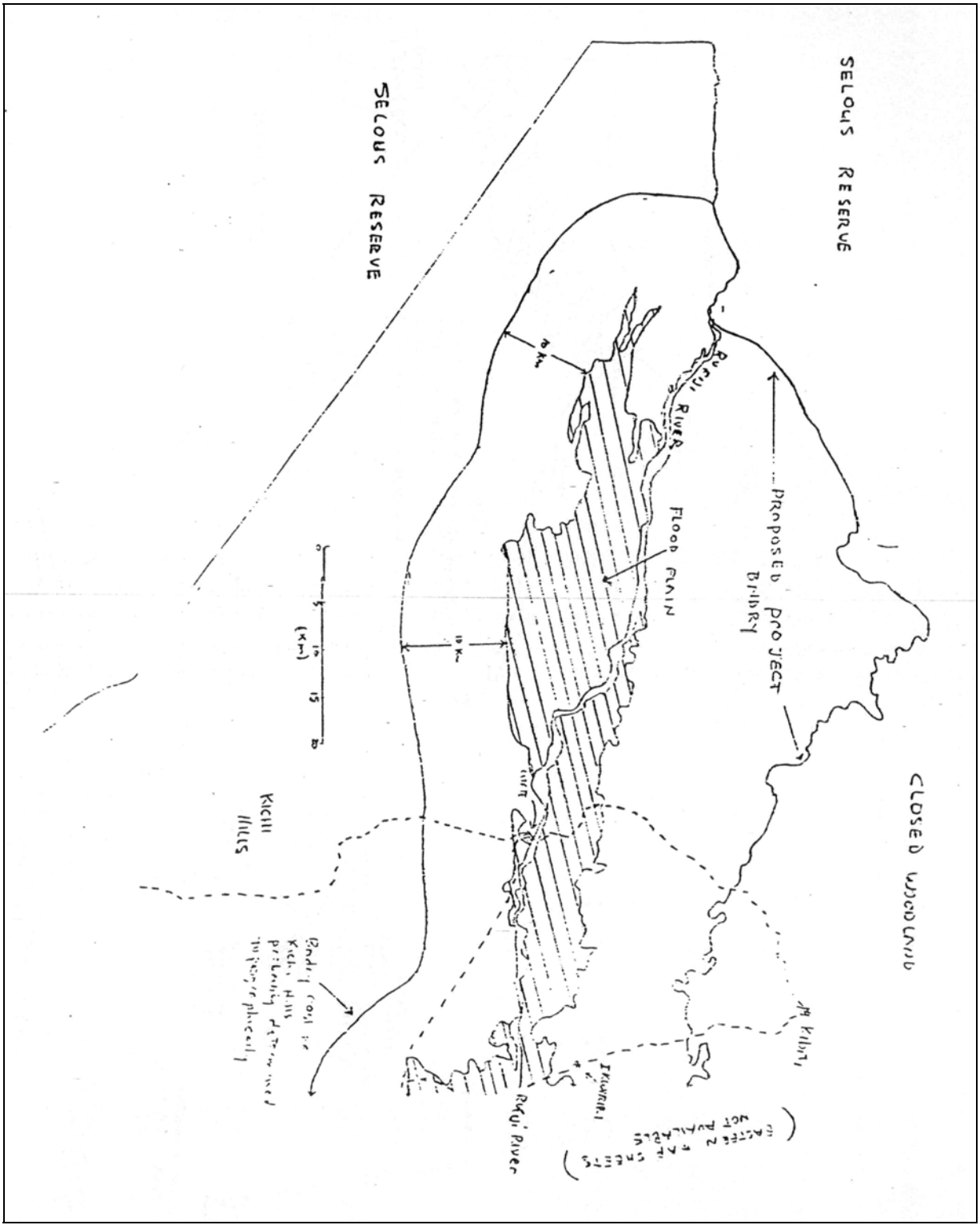
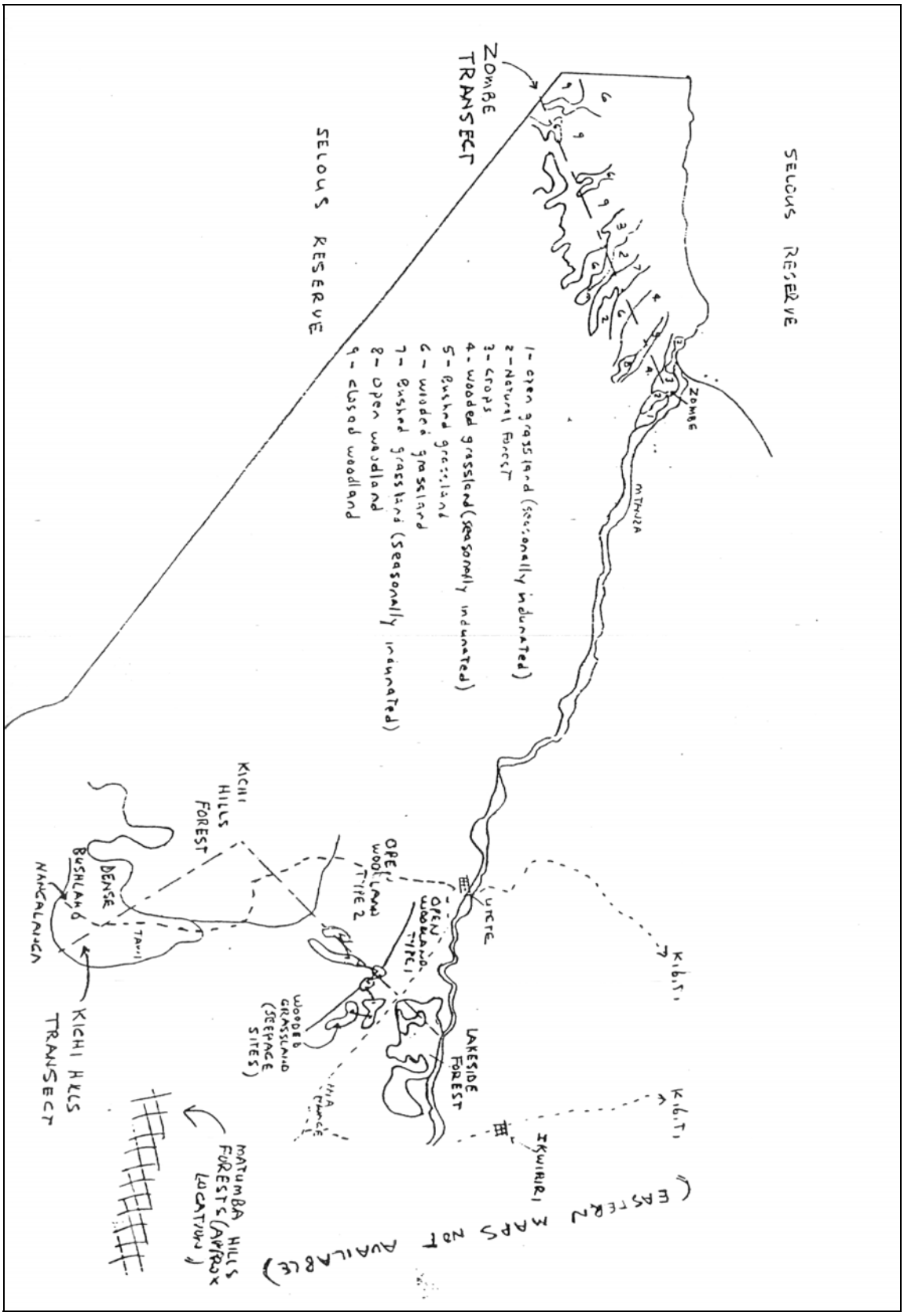
World Wildlife Fund (WWF). No date. Global 200 Eco-Regions. Map.

8 Appendices

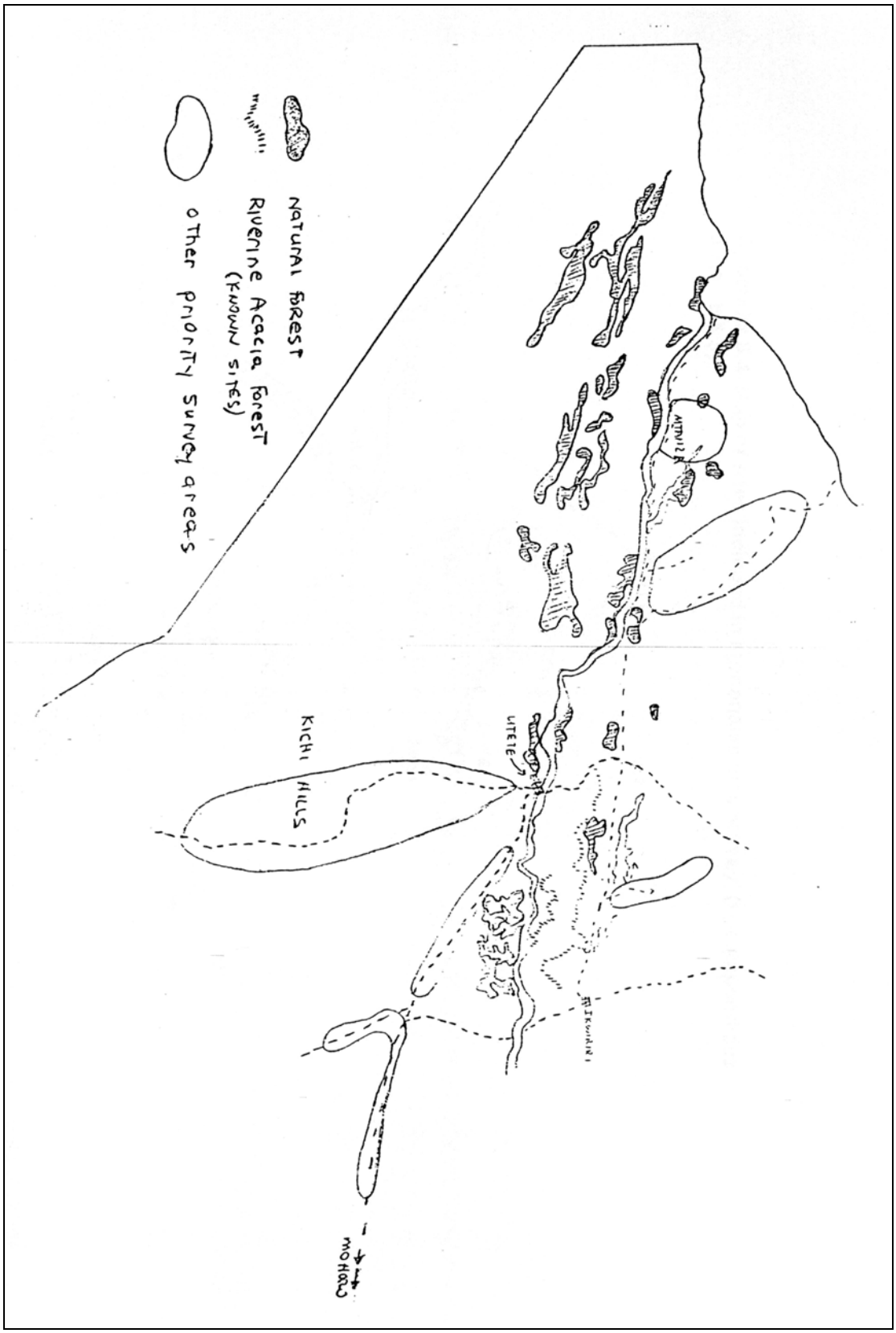
Appendix 8.1: Map of proposed boundary of the Rufiji Environment Management Project



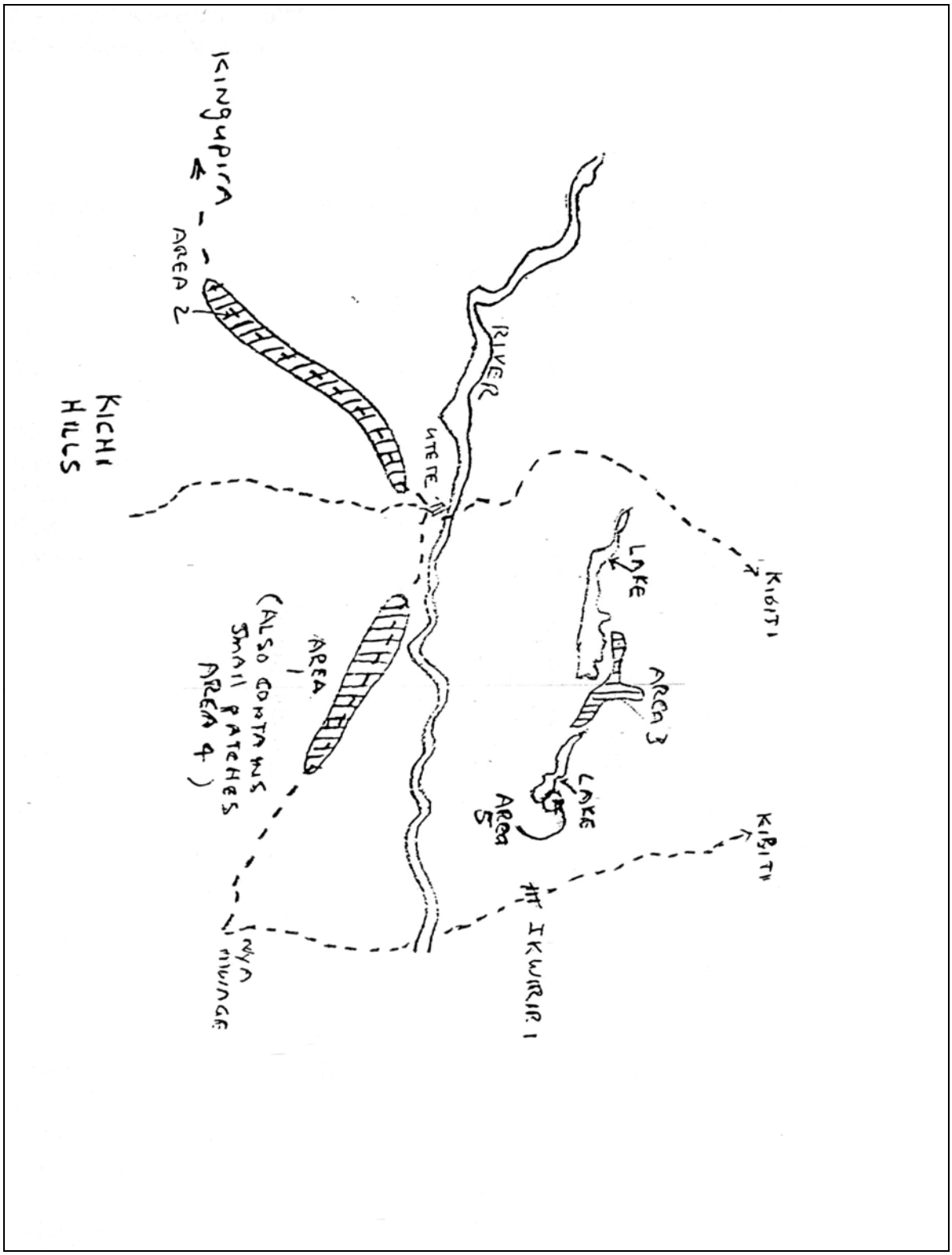
Appendix 8.2: **Map of potential biodiversity "hot spots" and "hot spot" transects**



Appendix 8.3: Map of priority areas for vegetation survey



Appendix 8.4: Map of sites included in reconnaissance survey (see Appendices 8.5.1 – 8.5.5.)



Appendix 8.5: Results of reconnaissance survey

8.5.1 Woodland along the road east of Utete towards Nyamwage (Area 1)

x = Most abundant species
x = Species present in plot
Mkariankiga = Most constant species

	PLOT NUMBER						
		9	**10**	**11**	**13**	**14**	**16**
Mkariankinga		**X**	X	X		**X**	X
Mkoche			X	X	X	X	X
Kikuragembe			X	X	X		
Mnecke			X		X	**X**	
Mpumbili		X	**X**	**X**			X
Mtumba		X	X		X	X	
(Cashew)							
Kiguruchangondo		X					X
Kiligo			X	X			
Kinoga	X		X				
Kipomi							X
Kituno			X				X
Majimaji					X		
Mbelebele				X			
Mbunju							X
Mchondo(a)					X		X
Mdaa			X				
Mfulu		X					
Mgama					X		X
Mgumbhili				X			
Mguruti		X					
Mitika mutwe			X				
Miyajembajemba		X					
Myonde							X
Mjigija		X					
Mkamba ®a				X	X		
Mkibu	X					X	
Mkokoba						X	
Mkulo							X
Mkumbara		X					
Mkombasiko			X	X			
Mkumbe				X		X	
Mkwaju			X		X		X
Mlambungu						X	
Mlandondo				X			
Mlalangai				X		X	
Mnyande			X		X		X
Mnyenzi						X	
Mnungu				X			
Mnyurenyure			X				
Mpangapanga		X					
Mparambru		X					
Mpingo			X		X		X

	PLOT NUMBER						
		9	10	11	13	14	16
Mpodo						X	
Mpogopogu						X	
Mpugupugu		X					
Msaria	X		X				
Msekese				X			
Msenga						X	
Msolo (Msoro)				X			X
Mswili (Grewia)		X		X		X	
Mswiri				X			
Mtandarus		X			X		
Mtanga					X		
Mtasi				X	X		X
Mtete (Mteti?)						X	
Mtetedume		X					
Mtogo				X		X	X
Mtondo				X		X	
Mtongotongo (Mtonga)				X			
Mtopetope					X		
Mungo		X				X	X
Muyombo							X
Mwakaa					X		
Mwamail(i)							X
Mwangalaya					X		
Mwekia				X			
Mwuya					X		
Ntikamutwae		X					
Nyonda			X				
Tikanumba						X	X

8.5.2 Woodland on sloping sandy soil along the road to Kingupira (Area 2)

	PLOT NUMBER					
	4	**5**	**6**	**7**	**8**	**17**
Mkarienkiga		X	X	X	X	
Msoro	X	X	X	X	X	X
Mtogo		X	X	X	X	X
Mtondo	**X**	X	X			X
Jekese	X					
Kiguruchagondo(a)		X	X	X		
Kiguragembe				X	X	
Kiligo						X
Kinoga(i)			X			X
Kipomi						X
Kitutuma		X	X			
Mchuele					X	
Mdondo				X		
Mfuru						X
Mkambara			X		X	
Mkarito						
MS(a)iombasiko		X				X
Mkongo	X					
Mwaju	X		X			
Mkundikundi						
Mnecke		X		X		X
Mninga				X		
Mnyenzi		X	X			
Mpangapanga	X		X			X
Mpariamburu		X				
Mpingapinga						X
Mpingo						X
Mpingi						X
Mpugupugu			X			
Mpumbili			X			X
Msaria		X				
Msekseke		X				
Msenga		X			X	X
Msufi pori						
Msuyu				X	X	
Mtaba						X
Mtanga	X					
Mtasi	X					
Mtete	X					
Mtete dume			X		X	
Mtonga		X			X	X
Muyondo						X
Mweka						X
Nguruti	X					
Ntikamutwe		X				
Tandarusi	X					

8.5.3 Woodland on level sandy soil between the two lakes.
(Lake Ruwe on the east and Lake on the west) (Area 3).

	PLOT NUMBER							
	20	**21**	**22**	**22A**	**23**	**24**	**25**	**26**
Mkarienkiga	X	X	X		X	X	X	X
Mtondo	X	X	**X**	**X**	**X**	**X**	**X**	**X**
Mkoche	X	X	X	X	X		X	
Mjembejembe					X	X	X	X
Mnyamwea		**X**	X	X		**X**	X	X
Msegese		X	X	X		X	X	
Nyakatoga			**X**	**X**	X		X	X
(Bauhinia sp) X								
Kajusi	X							
Kiagembe		X						
Kilimandembo		X		X				
Mchekea	X	X	X				X	
Mdandam							X	
Mfulu Mwengere	X		X					
Mingawuka				X				
Mkibu							X	
Mlandando						X		
Mkongo						X		
Mkulo		X						
Mninga	X	X						
Mkibu					X			
Mkolwa	X		X		X		X	
Mkwaju			X					
Mkwelanani			X					
Mlandando			X				X	
Mnecke						X		X
Mnginga dume				X				
Mnungu			X					
Mnyalanala				X				
Mnyenzi						X	X	X
Mpilipili			X					
Mpingo	X							
Mpugupugu				X		X		X
Msegese dume		X						
Msegeseke								X
Mtasi								X
Mtogo						X		X
Mtonga						X		X
Mtopetope				X	X		X	X
Mtukao						X		
Mtumba	X		X	X	X		X	X
Mtumbaku		X			X		X	X
Mtonga								
Mwagingo							X	
Mwiru		X		X		X		

8.5.4 Wooded grassland in shallow depressions, often with standing water, along the road from Utete towards Nyamwage (Area 4)

	PLOT NUMBER			
		12	15	13
Mkoche			X	X
Mneke(i)		X		X
Mpingo			X	X
Msekese		X	X	
M(w)uya			X	X
Kikulagembe				X
Kiligo		X		
Majimaji				X
Mchondo				X
Mdaa			X	
Mfulu ngere		X		
Mgama				X
Mkambara				X
Mkariankiga		X		
Mkomasikio (Mkambisikio?)		X		
Mkwaju				X
Mlalangai (Mlangai?)	X			X
Mpetapeta			X	
Mpumbili		X		
Msoro (Msolo?)		X		
Mtandarusi				X
Mtanga				X
Mtasi				X
Mtete		X		
Mtonga		X		
Mtongo		X		
Mtopetope				X
Mtumba			X	X
Mungo		X		
Mwangalaya				X
Mwembaemba		X		X
Nguruti		X		
Nyande			X	

8.5.5 Lakeside forest (north of lake) near pilot village (east of Ikwiriri) Area 5)

Mnagu
Mtasi
Mdimu pori

Mbebeti
Mdototo
Mkajusi
Mkibu dume
Mkongo
Mkulo
Mkwaju
Mnecke
Mgombe (liana)
Mnungu
Mnywamanai
Mpakacha
Mpapai pori
Mtambadume
Mtumbu
Munene
Nyamandurnbili

Appendix 8.6: Examples of data collection and analyses sheets

8.6.1 Data collection sheet for the survey of cut and damaged trees

Plot No.: …… Date

……

Plot dimensions …….. Recorders

……

GPS UTM rdg. ……..

Species	Type of damage	Diameter (cm)*	Basal area (m2)

(*Diameter at stump height of cut stumps and diameter at breast height (dbh) for trees / shrubs with other types of damage).

8.6.2 Summary sheet for survey of cut and damaged trees / shrubs

Vegetation type ……..

Plot dimensions ……..

Number of plots in sample ……..

Type of damage And species affected	No.	B.A. (m2/ha)	DBH (cm)* 10-19	20-29	30-39	40-60	60+

(* Estimate dbh for cut stumps based on dia. of stump)

8.6.3 Data collection sheet for fixed –area plot survey of composition and structure

Plot No. …… Date …….

Plot dimension s …….. Recorders ……..

GPS UTM rdg. …….

Dia (cm)	<10	10-19	20-29	30-39	40-60	60+
Midpt	5	15	25	35	50	65
Ba(m2)	0.16	0.47	0.78	1.10	1.57	2.04
Species						

8.6.4 Data summary sheet for fixed – area plot survey of composition and structure

Vegetation type:

Plot No. …… Date …….

Plot dimensions …….. Recorders ……..

No. of Plots ……. Total sample area (ha)

Dia (cm)	<10	10-19	20-29	30-39	40-60	60+	Total	No./	Ba(m2)/
Midpt	5	15	25	35	50	65	no	ha	ha
Ba(m2)	0.16	0.47	0.78	1.10	1.57	2.04			
Species									

No./ha/
Total b.a.
(m2)

Appendix 8.7: A preliminary list of Swahili* and scientific plant names for plant species in the project area

Kikuragembe	- Dichrostachys”
Kiguruchangondo	- Combretum sp. (?)
Kituno	- Commiphora (?)
Mdaa	- Euclea bilocularis, E. fructuosa, Royenamacrocalyx Guerke
Mfulu (Mfuru?)	- Vitex doniana
Miyombo (Muyyombo)	- Brachystegia spp, Isoberlinia globiflora
Mjijaa (?)	- Kigelia aethiopica (sausage tree)
Mkambala	- Acacia nigrescens
Mkariankiga	- Combretaceae (Combretum or Terminalia)
Mkoche	- Doum palms (Hyphaene compressa)
Mkongo	- Afzelia quanzwnsis
Mkuu	- Ficus sp.
Mkwaju	- Tamarindus indica
Mkwanja	- Acacia axnthophloea
Mnienzi (Mnenzi)	- Erythrophloem guinense, Parkia filicoidea
Mninga	- Pterocarpus angolensis
Mpangapanga	- Euphorbia sps?
Mpetapeta	- Combretum sp.
Mpingo	- Dalbergia melanoxylon
Msona	- Acacia xanthopholoea
Msonda (Chonda? Mchonda?)	- Acacia seyal
Msoro	- Caesalpinia bonduc
Mswili	- Grevia sp.
Mtandarus	- Trachylobium verrucosujm
Mteti (?)	- Hymenocardia ulmoides
Mtogo	- Diplorhynchus mossambisensis
Mtondo	- Stophanthus eminii
Mtonga (Mtongotongo)	- Strychonos engleri, S. spinosa, S. volekensii
Mtopetope	- Annona squamosa, A. muricata, A. reticulata, A. chrysophylla
Mvumo	- Borassus
Mwaka (Mwakaa?)	- Allanblackiea stuhlmannii
Mwegea (Mwekeia? Muyegea?)	- Kigelia aethiopica
Nyonda(e)	- Albizia amara?

* Some of these names may not apply in the Rufiji area.

Appendix 8.8: Itinerary of consultancy

May 2 Arrive Nairobi

May 3 IUCN office, Sign contract and review maps of and reports from the Rufiji Project. Fly to Dar es Salaam.

May 4 Meet Rose Hogan. Buy provisions and drive with Rose to Ikwiriri. Stay at the guest house of the Pentecostal Church.

May 5 Take project boat from landing near Ikwiriri up river to Utete. Along the way stop at 3 sites to look at vegetation (sites 1-3). In afternoon meet Mr. Shah, the Project Manager. Look at Hunting Technical Services map of land cover and land use of the for the district

May 6. Attempt to go to the Kichi Hills with driver and local mzee who know the area as well as the local names of trees and shrubs. Car stuck in mud at Km29. Also discover from the GPS reading that we haven't gone to the Kichi Hills but further to the west. However, an able to enter and look at the miombo – type woodland at 5 sites back along that track and a further 2 later in the day along the track eastward from Utete. Mzee was able to provide me with many local names of trees and shrubs. Introduced by Mr. Shah to the District Executive Officer.

May 7 Worked further along the road east of Utete. Car got stuck once. Visited 6 additional woodland and wooded grassland sites. Afternoon in the office. Telephoned Peter Sumbi, Manager of WWF Lowland Coastal Forest Project, in Dar es Salaam for a brief interview on his project's objectives and activities within Rufiji District. Attempted to phone the Department of Botany, Dar es Salaam with a view to finding potential consultants to do the vegetation survey. No answer. Sent email message to Phillipson of the Tanzania National Herbarium, to inquire about that organization's interest in cooperating with plant identification and collecting during the vegetation survey. For the rest of the day I began working up a strategy for the survey. Tried to meet the District Forest Officer but he was not in Utete.

May 8 Took boat upriver with Mr. Shah to check riverine forest stands, previously identified as of interest by Rose Hogan. Didn't bring the GPS so had great difficulty in finding the stands. I hadn't known how difficult it is to navigate with map alone on the river. However, stopped and looked at three likely stands and viewed one dominated by Acacia xanthophloea from the river. Afternoon spent working on survey strategy.

May 9 Tried again to go to the Kichi Hills. This time by the proper track. Car stuck in mud after about 8 km . took about $1^1/_2$ hours to get out. Returned to house to work on ideas for the report.

May 10 In office. Attended meeting of the District Environmental Committee (or similar name). Told them what I was going and answered questions, especially from one of the agricultural officers about the proposed livestock survey. Tried to meet with the District Forest Officer again, as well as the District Livestock and Agricultural Officers but none of them were in Utete at the time. Received email reply from Phillipson (TNH) in Arusha and sent reply. Continued working on strategy.

May 11 Move to Ikwiriri by boat with Rose Hogan. That afternoon we arranged to get someone who know the local names of trees to go with us tomorrow. Drove eastwards looking at the predominantly woodland (often heavily cut over) as far as Rusende and then up the road some km toward Kibiti. Stayed at Pentecostal guest house in Ikwiriri.

May 12 Took the project's small boat across Lake Uba west of Ikwiriri to look at the stand of forest vegetation on the other side. Accompanied by driver Samson and a local expert on plant names. Following that the four of us (including Rose Hogan) looked at several sites within woodland vegetation between and a bit beyond the two large lakes. However, we were not able to go as far as we wanted because the road was eventually blocked by high water. Stayed that night at the guest house again.

May 13 Drove to Dar es Salaam with driver Samson. Met Barnabas the IUCN expeditor. Tried to meet with Peter Sumbi, Manager of the WWF Coastal Forest Project but he was in a long meeting. Put up at the Starlight Hotel.

May 14 Interviewed Peter Sumbi in more detail about the Coastal Forestry Project. Afterward went with Barnabas and Samson to Dar es Salaam University computes to visit the Tanzania Natural Resources Information Centre (TANRIC) and the Institute for Resource Assessment (IRA). Inquired about the availability and cost of satellite imagery. Met the Director of the IRA.

May 15 Fly to Nairobi. Stay at Fairview Hotel

May 16 Began writing report.

May 17-20 At IUCN office preparing final report. Telephone calls to PHOTOMAP and the Regional Centre for Mapping and Remote Sensing at Kasarani.