REHABILITATION OF THE TANA DELTA IRRIGATION PROJECT KENYA

AN ENVIRONMENTAL ASSESSMENT

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EXECUTIVE SUMMARY

To be successful, conservation investments must consider the natural resource base, traditional cultures, tenure of all resources, economic aspects, as well as the history of activities in the area.

This environmental assessment strives to address all these aspects in equal regard in order to provide recommendations to the Tana and Athi River Development Authority (TARDA), the Japanese Bank for International Cooperation (JBIC), communities reliant upon the Lower Tana Forests and other relevant stakeholders. These findings will help ensure that any re-establishment of the Tana Delta Irrigation Project (TDIP) will have positive impacts on sustainable community livelihoods, long-term conservation of the forests, and the survival of the two Critically Endangered primates, the Tana River red colobus *Procolobus rufomitratus* and Tana River mangabey *Cercocebus galeritus,* flagships for all the threatened species that rely on these forests.

These recommendations are made on the basis of three independent, but intrinsically linked, studies:

- Socio-economic study
- Botanical/Ecological study
- Census of the Tana River red colobus and Tana River mangabey

The three studies presented in this report represent the current state of the area for the proposed rehabilitation of TDIP (established in 1986) that was severely damaged by the floods associated with the El Nino in 1997/1998. The history and details of this development are available elsewhere and need not be reiterated here.

Each of above studies stands alone as an independent statement of the current status of the specific sector. However, there are several concurrent themes in each of the studies that form the basis of this executive summary.

These recommendations present a once off opportunity in re-establishing the TDIP that, if combined, will:

- Alleviate poverty amongst the local Pokomo and Orma tribes, as well as other pastoral groups that seasonally rely upon this area and;
- Expand forest cover and forest health and, ultimately, improve the long-term conservation of the two species of threatened primates.

This is a rare opportunity that combines development investment with conservation priorities to repair the environmental damage and negative community attitudes in a critical area of Kenya.

To achieve these goals will require a long-term and creative approach. Commitments by all stakeholders' to any new approach needs to be honoured in a timely fashion.

The conclusions and recommendations from the three studies are as follows:

Socio-economic Study

Significant levels of poverty and vulnerability characterise the Pokomo agricultural and the Orma or Wardey pastoralist communities associated with the Lower Tana River. The greatest constraint to their livelihoods stated by the communities was the low and highly seasonal rainfall. The communities believe that the irrigation rice scheme holds the potential to contribute significantly to improvement of their lives by allowing dry season production of crops, at little cost to the TDIP. However, the historic relationship between TARDA and the communities is characterised by mistrust and bad feeling.

These communities identified (1) that there are three types of woodlands integral to their livelihoods, and (2) express the desire for the forests to be conserved, rehabilitated, and expanded. The three forest types are:

- Riverine forests adjacent to the river course;
- Floodplain forests ('madzini') a short distance from the river course and of greatest importance to the local communities;
- Thicket woodlands ('gubani') on dryer areas away from the flood plain.

This environmental assessment focuses on the riverine and floodplain forests.

The major perceived causes of forest decline include:

- Increased community demand;
- Lack of seasonal flooding due to the change in the course and flooding regime of the Tana River and
- Poor enforcement of use regulations.

Communities believe the most effective solutions for forest conservation lie in increased community management allied to appropriate technical assistance.

The 'headline' recommendations are that:

- The proposed rehabilitation should attempt to redress the TDIP communities' state of livelihood vulnerability and lack of development options, which will also serve to reduce pressure on the declining natural resource base.
- Appropriate design and implementation must engage the communities as partners, and be characterised by information sharing, consultation and collaboration.
- Participatory forest management (PFM) be piloted and based on the twin goals of indigenous forest conservation, and forest expansion (both indigenous and exotic).
- Community-related interventions – whether concerning forest or livelihoods – are implemented through mutually agreed agencies and processes.

Botanical/Ecological Study

The forests of the Lower Tana River are of great importance for the conservation of biodiversity for there are many species of plants and animals that are dependant upon these forests, including several endemic, threatened species. This study has identified 320 plant taxa in the area; 58 of them tree species, of which two can be considered Critically Endangered in a global sense. Twenty one per cent of the plants are of conservation concern. All of these threatened species need to be taken into account in designing the programme to re-establish that Irrigation Scheme.

The most significant find is that the forest cover has declined by 37% over 10 years with a related reduction in the quality of the cover. Past interventions have aggravated the situation by the introduction of invasive plants and the exacerbation of community differences and conflict.

The impact on these critically important forests of the Lower Tana River has been devastating; both by the El Nino weather event of 1997/8 and the increasing human pressure. The latter is due directly to the lack of livelihood alternatives as promised at the inception of this donor funded Tana Delta Irrigation Scheme.

Assessment of the current size, composition, health and conservation status of these forest fragments shows an urgent need for bold and innovative intervention if the habitat of two of the world's most threatened primates, and the livelihoods of the local communities, are to be protected and improved.

Opportunities for practical actions to achieve positive change both in primate habitat and in the lives of the local people are many. These include: an increase in environmental awareness; the full involvement of the people in participatory forest management (PFM) and

design; the immediate start of nurseries for selected indigenous and exotic species; the linking of existing forests by corridors; the establishment of woodlots; and the initiation of simple, effective community income generating ventures.

Primate Study

The most fundamental finding of the primate study is a decrease from the 2001 group numbers for both the red colobus and mangabeys, as well as changes in distribution of these primates in the forests of the survey area.

The total number of red colobus has declined significantly from the 1994 census, decreasing from 260 to 127. Mangabey individuals have stayed stable (144 in 1994, >149 in 2005).

This study found approximately 20 groups of red colobus in 11 forests (46 per cent of the forests surveyed) and 14 groups of mangabey in nine forests (38 per cent of forests surveyed). As illustrated in the table below, there is a direct relationship between the size of the forest and the number of primate groups present. Red colobus were observed in varying forest sizes while mangabeys appear to have favoured the larger forests, as they were found only in the six largest forest blocks censuses and two small isolated patches.

Forests with one or more groups of red colobus and mangabey

Forest Name	Forest #	Area of forest			Number of red colobus groups	Number of Mangabey groups	Human Activity 2004
		1994 (ha)	2001 (ha)	2005 (ha)			
Hewani West 1	58	34	65.7	20.83	7	3	Clearing
Hewani East 2	60	2	4.2	1.9	2	0	Moderate
Hewani South 2	64	124	116.4	48.51	1	4	
Wema West 3	55	13	45.1	16.86	1	0	Light
Lango La Simba	67	15	79.2	9.88	1	0	
Kulesa West 1	49	1	11.1	3.76	1	0	
Hewani East 1	59	3	11.4	1.57	1	0	Clearing
Bvumbwe North	65	53	136.5	46.16	0	1	
Wema East 4	68	63	63.2	43.14	0	1	Clearing
Kulesa East 1	48a	30	19.3	30.4	0	1	
Sailoni 1	46	5	12.5	2.83	0	1	
Mitapani 1	69	3	27	1.15	0	1	Light

There are two subpopulations of red colobus in the study area; a small subpopulation in the northern part of the TARDA managed area and a larger subpopulation centred on the Hewani West 1 Forest (58). Many of these forests important to these two species of primates are also cited in the socio-economic study as providing important resources for the local communities.

Forest Hewani West 1 (58) and Hewani South 2 (64) are important for mangabeys as they are the only forests with more than one troop (three and four respectively), only #58 had significant troop numbers of both mangabeys and colobus making it the most crucial forest in terms of requirements for conservation.

The primate study recommends that:

- Assessments should be made on the two groups of colobus in the northern section of the census area to determine their long term survival risk and to review potential management strategies to incorporate them into the main population area depending on appropriate available forest habitat.

- An assessment should be made to establish the suitability of erecting *colobridges* between isolated trees, forest patches and over the Main Canal, the Tana River and Main Access Roads to allow movement between forest fragments and across barriers.

Overall Recommendations
There is no one simple and immediate solution to the conservation of the forests and species of the Lower Tana River. The recommendations described below, if applied in a cautious and sustained approach over many years, may contribute to alleviating poverty, and to improving the forest health and forest cover to ensure the long-term survival of the Critically Endangered primates. They may also create opportunities for alternative livelihoods.

In order to overcome the current situation: all actors; especially the local communities involved in development, humanitarian and conservation initiatives along the Lower Tana need to work together. Their activities, whilst distinct, must complement each other so that the overall impact is greater than the sum of the individual actions.

There is an urgent need to develop a concerted effort to alleviate the current levels of poverty that ultimately threatens the remaining forest fragments.

There are several proposed creative solutions proposed which need acceptance by the local communities if they are to be regarded as viable opportunities that satisfy both community livelihood aspects and the habitat needs of the primates.

Raising awareness
There is paucity of understanding and awareness of the importance of the forests, their functions and benefits to the local communities, as well as to the conservation the threatened primates.

As a first step in building trust between the communities and other organisations, a programme of environmental awareness needs to be established that serves as a means to introduce subsequent stages of the rehabilitation project. There are a number of village-based committees that would serve as an appropriate entry point into the community. Ultimately, it is envisaged that these committees would be involved in reforestation activities and act as village scouts to protect the newly planted seedlings.

Priority sites
The three studies identify several forests that are vital both to the local communities for their livelihoods and also to the red colobus and mangabey. These forests should be targeted for reforestation efforts. This would serve to increase the much needed forest resources, improve the connectivity of the forests, and expand the habitat available to the primates and hundreds of other forest-dependant species. There are two main aspects to achieve this.

Riverine forests
It is vital to restore the riverine forests along both sides the Tana River course to a distance of 30 meters. The benefits of this are manifold including (but are not limited to) stabilising the riverbank, providing many of the forest products used by the communities, and increasing connectivity the preferred habitat of the primates. In so doing, the tree planting should encompass all of the Hewani West 1 Forest (58) to allow for easier movement of colobus and mangabeys between this important forest and other fragments, and to expand the forest habitat available to both species.

An immediate step to reforest this strip could be achieved by planting pole-sized fig cuttings of *Ficus sycomorus* as a pioneer species. This will encourage other forest tress species to regenerate. These forests could also be enriched with mango trees to provide as additional source of fruit.

Floodplain 'madzini' forests
These floodplain or 'madzini' forests were acknowledged by the communities as the primary source many for their basic needs including; medicinal products, building materials and fuel wood. The socio-economic study also highlighted the fact that these forests have declined significantly and that communities would consider replanting programmes to expand the forest area. Specific recommendations include.

- Expand the area of natural forest through planting indigenous trees.
- In forest blocks used extensively by communities, planting important species around the periphery should reinforce the remaining forest.
- Expand the forest habitat by linking the following forest fragments to create three corridors, each of which is linked to the riverine corridor.

    - Kulesa East (48) and Bvumbwe North (65).
    - Bvumbwe South (66) Wema East 4 (68), Wema East 1 (56) and Wema East 2 (d) (57).
    - Lango La Simba (67), Hewani South 1 (63) and Hewani South 2 (64).

- Conduct enrichment planting of important medicinal and primate food plant species in existing forest fragments.
- Create new floodplain forest through tree planting and irrigating polders. This will increase the diversity of habitat types available.
- Establish community-managed woodlots of both exotic fast growing and indigenous trees.
- Explore the potential of planting *Jatropha curcas* and other species to produce biodiesel.
- Include fruit trees in the mosaic so that the fruits can be consumed locally as well as sold in local markets. Communities should also engage in activities to preserve the fruit (drying and juicing fruit).

As can be seen from the map (Figure 1) that was produced as part of the botanical assessment, implementing these recommendations will dramatically transform the area of forest cover. Compromises will have to be negotiated both with the communities and with TARDA.

Ethnobotanical survey of important species

It is clear from the socio-economic study that medicinal plants were some of the most important forest resources, however, the species harvested have yet to be described. An ethnobotanical survey identifying the most important species should be undertaken to ensure that these are planted as part of the reforestation scheme.

Diversifying livelihoods

Poverty is recognised as being directly responsible for environmental degradation and this is clearly demonstrated in the Lower Tana Forests. Most households exist in an extremely precarious state. Households are unable to meet their own subsistence requirements, especially during exceptionally wet years and during exceptionally long dry seasons, and consequently rely heavily on forest products during these times. This situation has been exacerbated by a shift, caused by a natural change in the Tana River's course, from traditional land-use practices, in tune with the seasonal inundation of the floodplains, to the current and unstable system of rain fed crops.

The irrigation scheme provides an opportunity to produce food crops other than rice and maize. This would have the added advantage of not only improving the health of the local populations but also create a local economy through selling excess produce in markets, especially supplying vegetables throughout the dry season.

Methods aimed at reducing the waste from harvests, especially mangos, needs to be introduced. New markets and opportunities for novel products such as dried mango and other products that can be extracted locally need to be exploited.

In addition, the promotion of other alternative nature-based livelihood activities should be investigated that would consolidate the relationship between the forests and livelihoods through the non-destructive use of the natural resource base. Examples of this include the introduction of modern bee-keeping techniques, harvesting wild silk (*Gonometa* sp) and natural products based upon neem and compounds from other plants that could be extracted locally. Alternative crops that would yield good harvests on a commercial scale under irrigation should also be investigated.

Ensuring the long-term conservation of the primates
The conservation status of the Tana River red colobus and mangabey is directly related to the extent of forest cover and overall health of the forests. Not surprisingly, the larger forests hold more groups of red colobus and mangabeys than the smaller forests. Whilst there are some similarities in the needs of both species, mangabeys are more tolerant of fragmented forests and able to move across the grasslands.

The most important conservation intervention in the long run will be to increase the area of suitable forest available for the primates and in so doing, linking the existing remnants of forest. Artificial connections (i.e. *colobridges*) between forest patches may distribute pressure on individual forests until newly planted trees have matured sufficiently.

Crop protection
The socioeconomic study shows the need for both the Orma and Pokomo villagers to guard their fields from March through June. For the communities to have faith in the commitment of any development and conservation initiatives this problem needs to be addressed.

Several primate pest management strategies have been developed by Colobus Trust that may be implemented as part of the actions to assist the communities in crop protection while maintaining local primate populations.

Ecotourism opportunities
Part of a long-term approach to securing community benefits from tourism would be to assess the market potential for ecotourism ventures. As the tourist destinations Lamu, Malindi and Watamu within a few hours drive, there may be commercial potential for tourists to visit the Lower Tana to view the red colobus and mangabeys, and other species of plants and animals, and learn about the natural history and traditional cultures of the area.

Potential for carbon storage and trading
Forests and high biomass landscapes represent a solid carbon store, reducing atmospheric greenhouse gas levels in the atmosphere, and mitigating climate change. Kenya's recent ratification of the Kyoto Protocol opens the door to trading carbon emission reduction credits (CERS) though the Clean Development Market and voluntary carbon markets.

Glenday (2005) found that riverine forests adjacent to the Tana River have significantly greater carbon densities (250 metric tons carbon per hectare) than the nearby drier forest and woodlands (170 metric tons carbon per hectare). Thus improved forest management in the TDIP area has the potential to preserve existing terrestrial carbon stores and sequester added carbon dioxide.

Tree planting in open areas and maintaining forest along riverbanks are likely to produce the greatest carbon benefit per unit area. Reforesting the corridors proposed within TDIP (Figure 1) could store a total of 90-120 thousand metric tons of carbon that could be traded. Most pertinent to this area is the possibility of obtaining saleable carbon emission reduction credits through a small-scale afforestation-reforestation project as part of community based initiatives.

The Lower Tana River forests represent a rare and declining habitat that has been negatively affected by developments. If this trend continues unabated it will result in a significant increase in poverty levels of the local communities leading to further environmental degradation and the extinction of many species reliant on these forests - not just primates.

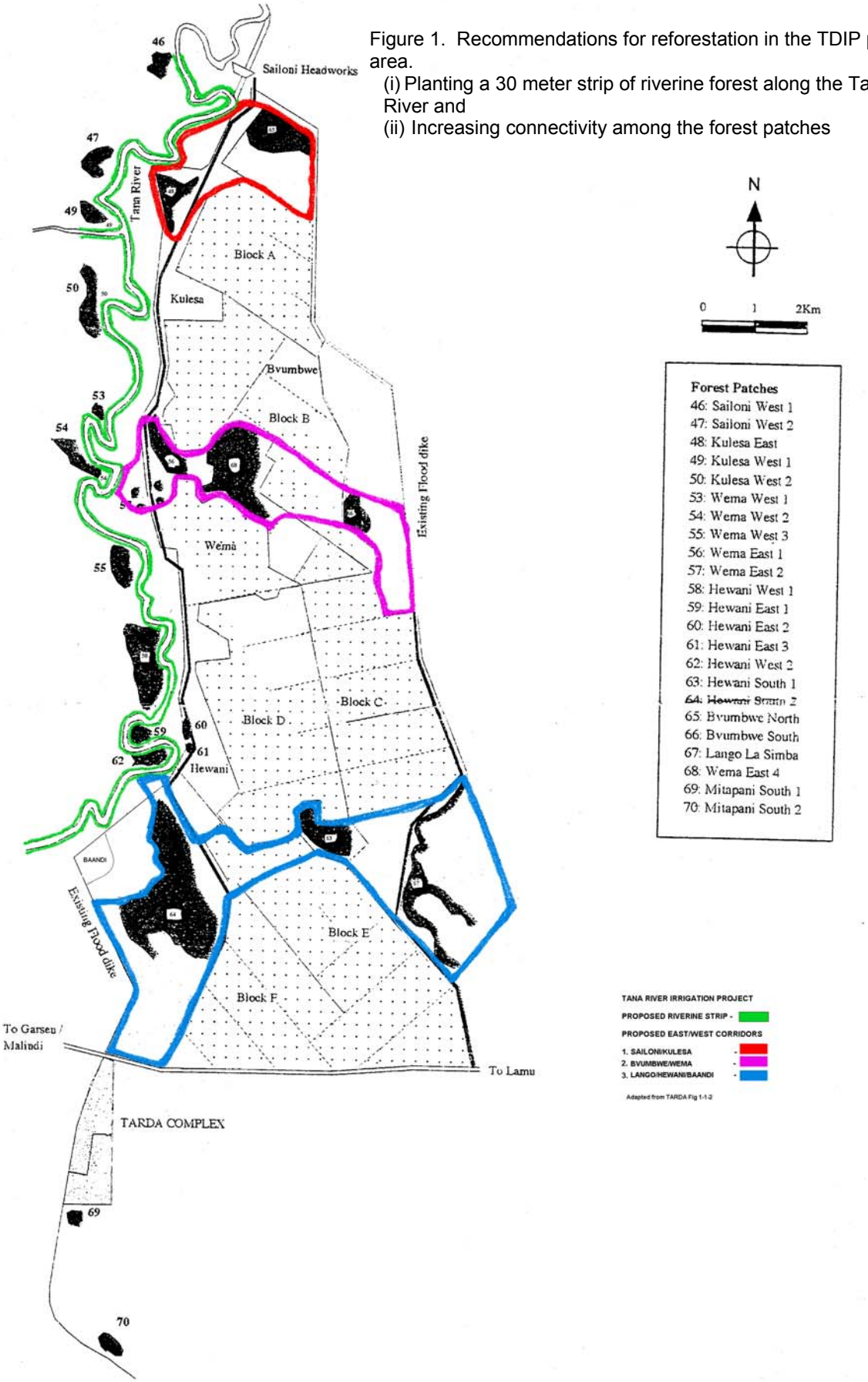

Figure 1. Recommendations for reforestation in the TDIP project area.
(i) Planting a 30 meter strip of riverine forest along the Tana River and
(ii) Increasing connectivity among the forest patches

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SOCIO-ECONOMIC ASSESSMENT

By

Richard Hatfield

SUMMARY
Following extensive damage resulting from the 1997 *El Nino* rains, it has been proposed that Polder 1 of the Tana Delta Irrigation Project (TDIP) be rehabilitated. In relation to the socio-economic context dynamics, pertinent conclusions and recommendations relevant to the future of proposed rehabilitation of the rice irrigation scheme (TDIP) are summarised in Section 6 of this report. The 'headline' conclusions are:

- Communities acknowledge the importance of the forest patches to their livelihoods – particularly for coping mechanisms during the long, dry season, and express the desire for the forests to be conserved - and even expanded.
- Communities acknowledge the decline of forest patches. The major perceived causes of forest decline include (i) increased community demand (ii) lack of seasonal flooding due to the change in the course of the Tana River (iii) poor enforcement of use regulations
- Communities believe the most effective solutions for forest conservation lie in increased community management; allied to appropriate technical assistance.
- Significant levels of both poverty and vulnerability characterize the TDIP-associated communities, with the greatest constraint being lack of rainfall. At the same time, the irrigated rice scheme – if targeted correctly - holds the potential to contribute significantly to livelihood improvement and, by extension, more sustainable use of forest patches, at relatively low cost to the project.
- However, the relationship between TARDA and the communities is characterised by mistrust and bad feeling, due to historical factors.

The 'headline' recommendations are that:

1. Participatory forest management (PFM) be piloted, based on twin goals of indigenous forest conservation and forest expansion (both indigenous and exotic)
2. The proposed rehabilitation should attempt to redress the TDIP communities' livelihood vulnerability and lack of development options, through which will also serve to reduce pressure on the declining natural resource base.
3. In order for sustainable outcomes to be achieved, appropriate design and implementation must necessarily engage the communities as partners, and be characterised by information sharing, consultation and collaboration.
4. Community-related interventions – whether concerning forest or livelihoods – are implemented through mutually agreed, third party agencies rather than through the TDIP managing body, TARDA.

INTRODUCTION
The study terms of reference (see Annex 1) with respect to the socio-economic aspect of the TDIP rehabilitation in broad terms involve rapid assessment of the socio-economic context; forest resource use; and the interaction between the two; specifically:

- Description of community livelihood strategies
- Assessment of reliance of livelihoods on the natural resource base
- Identification and analysis of key natural resources: use, access, attitudes, behaviour
- Assessment of constraints to community livelihoods

The expectation was that the results would lead to the identification of and recommendations for opportunities to mitigate threats to the forests, in an economically viable and socially acceptable manner.

This approach is broadly based on the Sustainable Livelihood Assessment framework developed by IDS (Institute of Development Studies, University of Sussex, UK) and adopted by DFID (Department for International Development, UK) - an approach increasingly recognised as an sector standard for assessing socio-economic real or potential intervention impacts. The central premise behind the approach is that any intervention – conservation-related or otherwise – must be considered in the context of livelihood dynamics in order to arrive at meaningful conclusions and/or design.

Further background complimentary to this report can be found in a number of other reports commissioned by TARDA (the Tana and Athi River Development Authority)[1].

STUDY AREA DESCRIPTION

The study area involves the Polder 1 development of the TDIP (Tana Delta Irrigation Project), an approximately 2000 hectare area of fertile floodplain converted to commercial rice production from 1991-1999, with assistance from the Japanese Government and managed by TARDA (Tana and Athi River Development Authority). The *El Nino* floods of 1997 subsequently significantly decreased the size of the viable production area, with the rehabilitation of the original area now proposed.

Six villages are commonly associated with the TDIP Polder 1 area, and are therefore considered to be legitimate stakeholders. Land falling with the traditionally-demarcated boundaries of three of these - Kulesa, Wema and Hewani – was incorporated into the project, whilst the other three villages – Bfumbwe, Sailoni and Baandi - border the project area, and have traditionally utilized 'common property' resources within the project area, and continue to do so - typically the floodplain forests, and available grazing areas.

All the villages are inhabited by traditional Pokomo cultivators, with exception of Baandi, which is inhabited by traditional Orma pastoralists. Baandi has existed on a permanent basis in close proximity to Hewani village since 1988 after being forced to leave their previous permanent village, Gardeni – a few hundred metres further south – due to flooding as a result of government road construction of the nearby Malindi-Lamu highway. The Orma residents of Baandi distinguish themselves amongst pastoralists as being 'permanent' within the Tana River delta, as opposed to 'nomadic', as is characteristic of the majority of pastoralists using the delta for dry-season grazing– whether Orma, Wardey, or Somali.

Other villages, both Pokomo cultivators and Orma or Wardey pastoralists, located further away from the project area have also traditionally used the project area; however, this study confines itself to the immediate six villages, and therefore does not consider the impact the outlying villages. During the course of the study, it was found that, according to the study villages, the "stake" in forest resources by outlying villages is not significant. However, this claim would require further validation in the event of any planned intervention impacting forest management.

METHODOLOGY

The socio-economic rapid assessment involved three methodology types:

A. Household 'occupational structure' questionnaire survey. Key informants from each village were asked to ascertain the distribution of each village's population between what they perceived to be 'poor', 'medium' and 'rich' categories. A sample of 15 households per village was selected, stratified according to the relative size of the wealth categories for that village i.e. where a village contained 50% 'poor', 50% of households sampled (N=7) were 'poor'. Key informants then completed an occupational/activity questionnaire for each selected household, in order to determine livelihood dependence.

B. Household 'vulnerability' and 'forest use' questionnaire survey. 20 households were randomly sampled from each village, but stratified according to the same wealth category distribution as in (A) above. The survey focused on forest benefit- and cost-types; importance to the household; and perceived trends in demand and supply.

[1] A. 'Analysis of the Situation on the Ground report 12-27th September 1999' - draft, TDEAP (Tana Delta Environmental Awareness Programme), Oct. 1999
B. 'Environmental Interface', Chapter 14 Tana River Irrigation Project (Extension) Feasibility Study Vol. 11, August 1983
C. 'Environmental Study', Annex 5 Tana Delta Irrigation Project Definitive Development Plan Vol. IV, year unknown.

C. Village focal groups. Two focus group discussions were held in each village – one consisting of mixed age-and-gender 'elders'; and one consisting of mixed gender youth. The discussions were structured around five topics:
   - Occupational structure, seasonal calendars (for men and women), and level of dependence on external inputs
   - Constraints to livelihoods and coping strategies
   - Institutional linkages, both external and internal, either positive or negative
   - Key resources, use patterns, issues and solutions
   - Attitudes towards and conflicts concerning natural resource conservation

   The purpose of the focus groups was two-fold:
   (a) To complement the surveys, in terms of reinforcement or contradiction of survey findings.
   (b) To understand the factors driving the current dynamics of community livelihoods and natural resource use.
   (c) To discuss possible management solutions.

Tests of statistical significance have not been employed, due to the rapid and exploratory nature of the study, a priority that precluded incorporation of sufficiently large sample sets: in this regard, the study is more useful in setting up such studies.

RESULTS

Results are organised as follows:

- Community Livelihood Strategies
- Livelihood Vulnerability and Constraints
- Institutional Linkages
- Natural Resources: key resource patterns, dynamics and challenges

Relevant background and specific methods are also provided under each component, where relevant.

COMMUNITY LIVELIHOOD STRATEGIES

Basic demographics

Table 1 contains basic demographic data, illustrating village population and a sample average household size of 6.8 people, with 40% actively contributing to household livelihood, on average.

Table 1: Demographic information on 'TDIP villages'

Villages	Estimated No. of households*	Sample average household (HH) size (n=20)	% active members in sampled HHs
Bfumbwe	70	5.85	58
Kulesa	120	7.35	48
Sailoni	123	6.5	28
Wema	210	7.9	46
Hewani	150	6.1	34
Baandi	200	7.5	23
AVERAGE	**145**	**6.8**	**40**

* estimates by key informants

Occupational structure

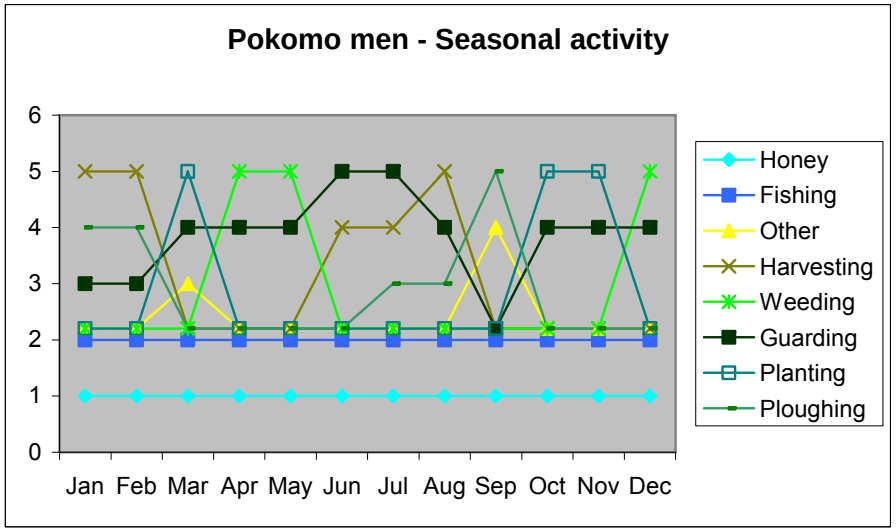
Table 2 illustrates activities (irrespective of significance level) engaged in by households, from the key informant questionnaire. The main result of interest is the percentage of households engaged in a particular activity. This shows a high reliance on natural resource based activities: farming (Pokomo) / livestock (Orma) (99%); fishing (48%); natural resource for home consumption (100%); and natural resources products – either as an input into livelihoods, or for sale (78%). 46% of households sampled were engaged in casual, as well as full-time employment, respectively (the role of TARDA/TDIP being significant, employing 54% of those sampled in casual employment and 42% full-time).

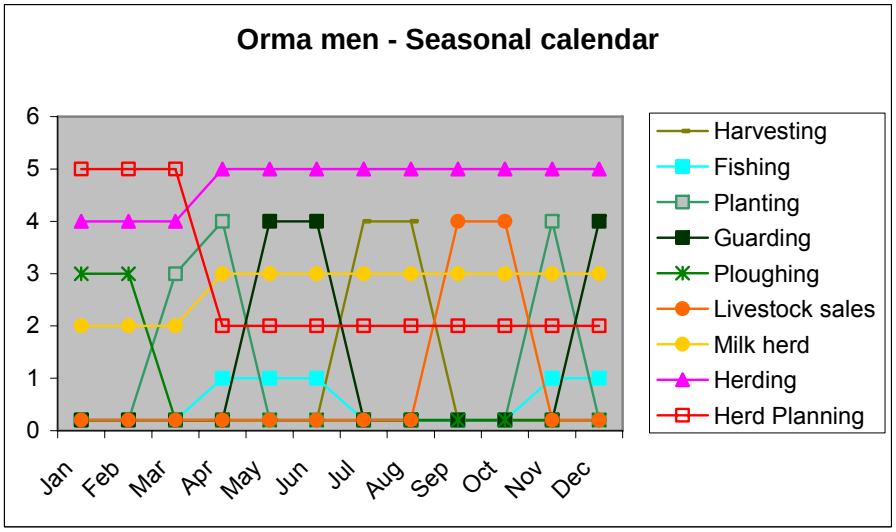
Table 2: Household occupational structure of TDIP villages (composition of activities)

Sampled households (n=120) engaged in:	Farm / livestock	Fish	Natural resource home use	Natural resource products	Business	Artisan	Casual labour	Employed	Other
TOTAL: (%)	119 (99)	58 (48)	120 (100)	94 (78)	22 (18)	32 (27)	55 (46)	54 (46)	45 (37)
Bfumbwe	20	13	20	17	4	11	8	13	13
Kulesa	19	10	20	19	5	4	2	4	2
Sailoni	20	19	20	20	2	2	1	3	10
Wema	20	12	20	18	4	11	16	15	17
Hewani	20	2	20	19	4	3	11	8	1
Baandi	20	2	20	1	3	1	17	11	2

Seasonal Calendar

The following set of graphics illustrates type, importance and timing of specific tasks carried out by farming (Pokomo) and pastoralist (Orma) men and women, respectively – as elucidated by focal groups. They are largely self-explanatory, depicting organisation of Pokomo activities around the (double rainy season) farming calendar; and the dominance of livestock in Orma activities. Of particular note are: the amount of effort expended on crop protection ('guarding'); and the incorporation of (limited, river bank) cultivation by Orma.


Pokomo men - Seasonal activity
0
1
2
3
4
5
6
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Honey
Fishing
Other
Harvesting
Weeding
Guarding
Planting
Ploughing


Orma men - Seasonal calendar
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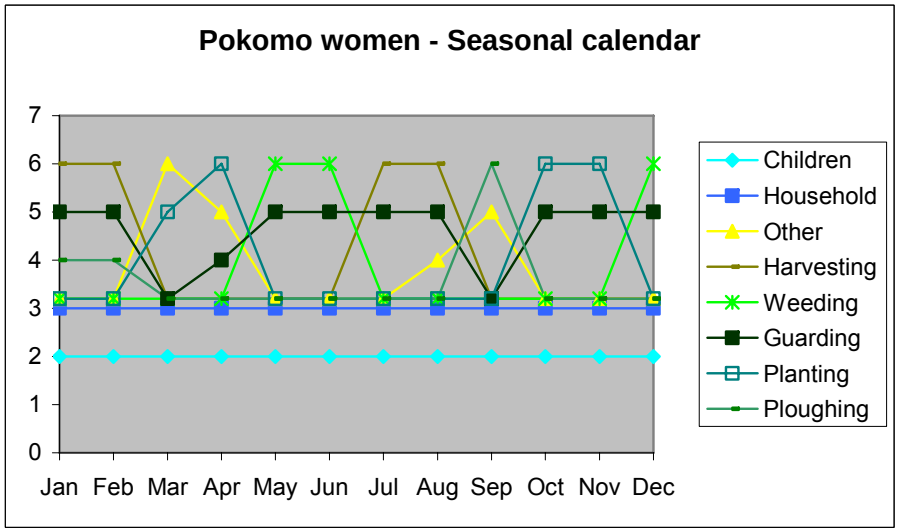
Harvesting
Fishing
Planting
Guarding
Ploughing
Livestock sales
Milk herd
Herding
Herd Planning


Pokomo women - Seasonal calendar
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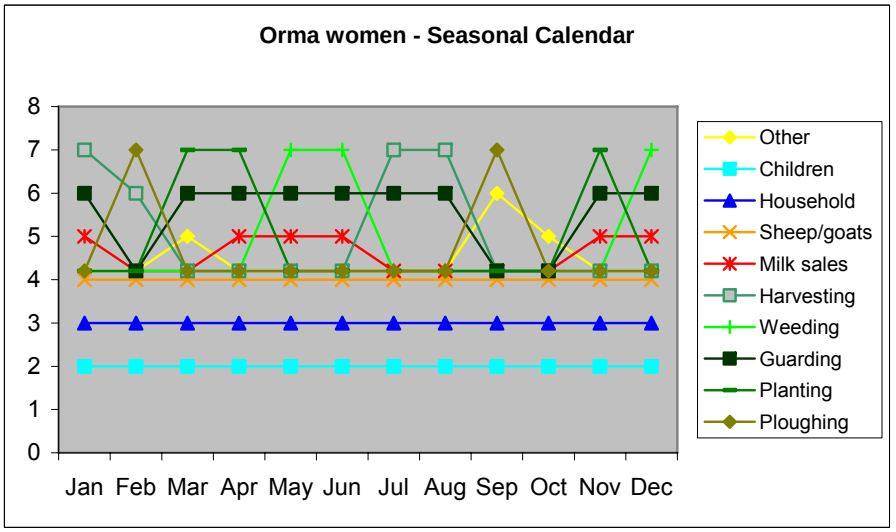
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Children
Household
Other
Harvesting
Weeding
Guarding
Planting
Ploughing


Orma women - Seasonal Calendar
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Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Other
Children
Household
Sheep/goats
Milk sales
Harvesting
Weeding
Guarding
Planting
Ploughing

Market Linkages and Investment Vehicles

External versus internal needs (determined from focal groups) are summarised as follows:

Internal supply	External supply (cash market)	Market location
Tilled crops	Sugar / tea / rice	Garsen*
Fruit crops	Salt	Garsen
Fish	Cooking oil	Garsen
Poultry	Posho mill	Malindi
Goats	Generator	Malindi
Cattle/sheep (Orma only)	Diesel	Garsen
Honey	Kerosene	Garsen
Firewood	Doctor/medicine	Garsen
Building materials/thatch/rope	Clothes	Garsen*
Limited charcoal	School education	Local
Other wood-related raw materials	Market/personal transport	Garsen
Micro-finance (merry-go-round)	Corrugated iron ('mabati')	Malindi
	Roof timbers	Malindi
	Nails	Malindi
	Mattresses	Garsen
	Radio	Garsen*
	Bicycle	Garsen*

* Malindi preferred due to lower prices, if the opportunity arises

The above chart shows a relatively limited reliance on outside supplies, limited to essential staples. This is largely a factor of distance combined with lack of transport.

In addition, investment options are limited to:

1. Livestock (Orma)
2. Postbank savings (Garsen) – cheaper than conventional bank
3. Village business e.g. food kiosk, hotel, posho mill (no outside business)

Coping strategies

The following two tables summarise focal group information concerning survival, or coping, mechanisms utilised by households during stress periods (which typically occur particularly in the long-dry season each year). Table 3 indicates mechanism types and importance, and includes perceived trend in availability/viability. Of note is that some 50% of mechanisms are seen to be in decline, with no alternative replacement. Table 4 summarises mechanism sources. The latter indicates that the forests play a vital role in coping strategies, followed by the Tana River and associated lakes. The dry land woodlands ('Gubani') beyond the floodplain area are also important (being the dominant source of building poles); whilst casual employment by TARDA is also an important coping mechanism (however, the value of the latter as a viable coping mechanism source has been severely compromised due to delayed (up to one year) and/or partial payment for labour carried out).

Table 3: Household coping mechanisms during stress periods (income generators, unless otherwise stated). H=high reliance M=medium reliance L=low reliance Blank=no reliance

Village	Group/ Tribe	Livestock**	Share food*	Fish**	Water lilies*	Building poles	Firewood	Charcoal burning	Weaving mats	Edible forest foods*	Rope	Honey**	Casual labour (TARDA)	Banana**	Mango**
Kulesa	Pokomo			L	L	M	L	L	L	L	L	L	L		
Bfumbwe	Pokomo		H	L		H	L	L	L				L		
Sailoni	Pokomo			L		M	L	L	L	L			L		M
Wema	Pokomo			L	L	M	L	L	L	L	L	L	L	H	
Hewani	Pokomo			L	L	M	L	L	L	L	L		L		
Baandi	Orma	H				M	L	L	L			L	L		
Frequency cited		1	1	5	3	6	6	6	6	4	3	3	6	1	
RESOURCE SUPPLY TREND		⇨	⬇	⬇	⬇	⇨	⬇	⇨	⇨	⬇	⬇	⇨	⬇	⇨	⇨

* for home consumption

** for both home consumption and sale

Table 4: Summary of coping sources cited across villages:

Activity	Frequency cited	% of options
Forest products ('Madzini' or 'floodplain' forests)	23	51
Lakes/river	7	16
Forest products ('Gubani' or dry land forests/woodlands)	5	11
Casual labour (TARDA)	5	11
Agriculture	2	4
Livestock (Orma)	1	2
Relief food	1	2
Share food	1	2

LIVELIHOOD VULNERABILITY AND CONSTRAINTS ASSESSMENT

Vulnerability

Vulnerability can be assessed from three measures:

1. Key informants assessment of distribution of population between wealth levels within each village (also used to stratify the household forest survey sample)
2. A simple set of four standard vulnerability indicators, measured by the household survey: housing; food supply; income options; and capacity to school children
3. Village focal group discussion results

A. Key informant vulnerability results

The distribution of village populations across three wealth categories – poor, medium, rich – was estimated by key informants from each village, as follows:

Table 5: Distribution of village populations amongst wealth categories

	% Poor	% Medium	% Rich
Bfumbwe	50	43	7
Hewani	47	40	13
Kulesa	75	21	4
Sailoni	64	24	12
Wema	71	24	5
Baandi	60	30	10
Average across villages	61	30	9

B. Household survey vulnerability results

In the household forest survey, households were ranked 1-4 for each vulnerability category (housing, food supply, income, education) according to the following classification:

Vulnerability category & rank:	1	2	3	4
HOUSING	Permanent house	Mabati roofed house but not permanent house	Thatched/patched roofed house	Thatched/patched roofed and patched walls
FOOD SUPPLY	Produce enough food for the household from the farm	Adequate food and reliable (but not significant) sources of income	Struggles or cannot produce enough food from the land	No land farmed
INCOME SOURCES	Regular access to significant cash income i.e. source of off-farm income	Assets (farm land) is a more important source of livelihood than cash income	Dependent on selling labour for food or cash	Dependent on selling labour for food or cash
EDUCATION	Household can support children in primary & secondary schools	All children will complete primary schools, with only some in secondary school	Children will/have completed primary school only	Children did not/will not complete primary school, or no children in primary school

Table 6 summarises results by average score for each vulnerability category, where '1' represents lowest vulnerability and '4' represents highest vulnerability. The scores indicate that, on average, households live in non-permanent houses; struggle to produce sufficient food; are either reliant on the land for income, or on selling labour in the absence of a viable land base; and either have enrolled some of their children in secondary school, or not at all.

Table 6: Average household vulnerability by village and basic indicator

	Housing	**Food supply**	**Income source**	**Education**
Bfumbwe	2.2	2.7	2.6	2.4
Hewani	1.9	2.4	2.9	2.8
Kulesa	1.9	1.9	2.1	2.3
Sailoni	2.5	3.1	2.9	2.8
Wema	2.6	2.2	2.8	2.2
Baandi	1.5	2.5	2	2.1
Average	**2.1**	**2.4**	**2.6**	**2.5**

C. Village focal group vulnerability results

A third measure of vulnerability was obtained from the elder focal groups, from which it was estimated that on average, in a normal year, 54% of the population suffers food shortage. In addition, in only two villages – Bfumbwe and Baandi – did a proportion of the population (40% and 30% respectively) produce surplus crops for sale over-and-above food needs. In Bfumbwe this is credited better farming methods; whilst Baandi's surplus is represented by their livestock herds – their primary coping mechanism.

Table 7: Focal group vulnerability indicators

Indicator:	Per cent population encountering food shortage in normal year	Per cent population producing surplus crops for income	Per cent enrolled in primary school	Per cent enrolled in secondary school	Per cent completing secondary school	Per cent population externally employed
Bfumbwe	30	40	100	100	90	N/A
Hewani	75	0	98	80	50	N/A
Kulesa	80	0	100	50	30	N/A
Sailoni	60	0	100	50	30	N/A
Wema	50	0	100	90	60	15
Baandi	30	30	60	30	30	N/A
Average	54	12	93	67	48	

Constraints to livelihoods and development

Figure 1 below summarises constraints and barriers to development, as articulated by village focal groups. The central constraint identified by all villages is poverty. Further constraints are either depicted as contributors to - or 'causes' of - poverty (below), or 'effects' of poverty (above).

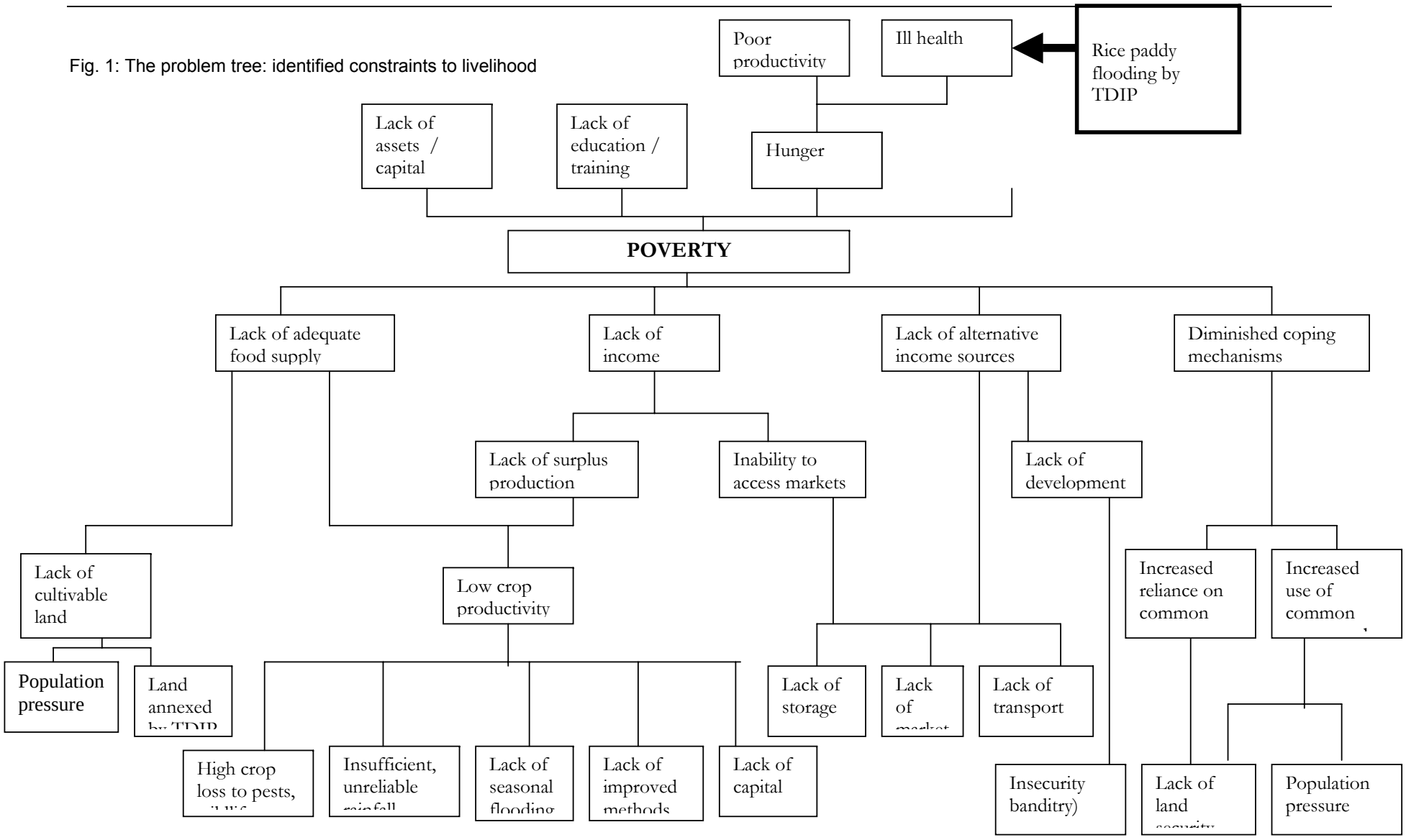
The underlying causes can be divided into groupings (left to right): lack of cultivable land; low per-acre productivity; lack of infrastructure to access markets; and insecurity of land tenure as well as property.

These result in a set of conditions that reinforce poverty: lack of adequate food supply; lack of income;
lack of alternative income sources; and diminishing coping mechanisms; accompanied by a set of concomitant effects - indicated in the top part of the diagram - that tend to continue the cycle of poverty.

Implications & Conclusions

- The matrix of multiple underlying development challenges associated with subsistence farming results in a lack of community capacity to accumulate needed capital, in order to precipitate investment into strategies that break the cycle of poverty.
- These underlying challenges are exacerbated by insecurity of land tenure; banditry; and loss of primary resource to TDIP.
- It should be noted that the 'problem tree' diagram is also useful in identifying potentially effective development interventions: for example, it is interesting to note that if villages farmers were allowed to cultivate rice on their traditional land within the (improved) TDIP project area, selling to TDIP – as has been suggested in the past, and indeed expected by villages at the project's inception (see Section 5.3.2) - the rehabilitation of the TDIP, directly and indirectly, has the potential to contribute positively towards diminishing all four basic causes of local poverty, as identified by communities, namely:
    - lack of cultivable land
    - low per-acre productivity
    - lack of infrastructure to access markets and
    - insecurity of land tenure, as well as insecurity of property

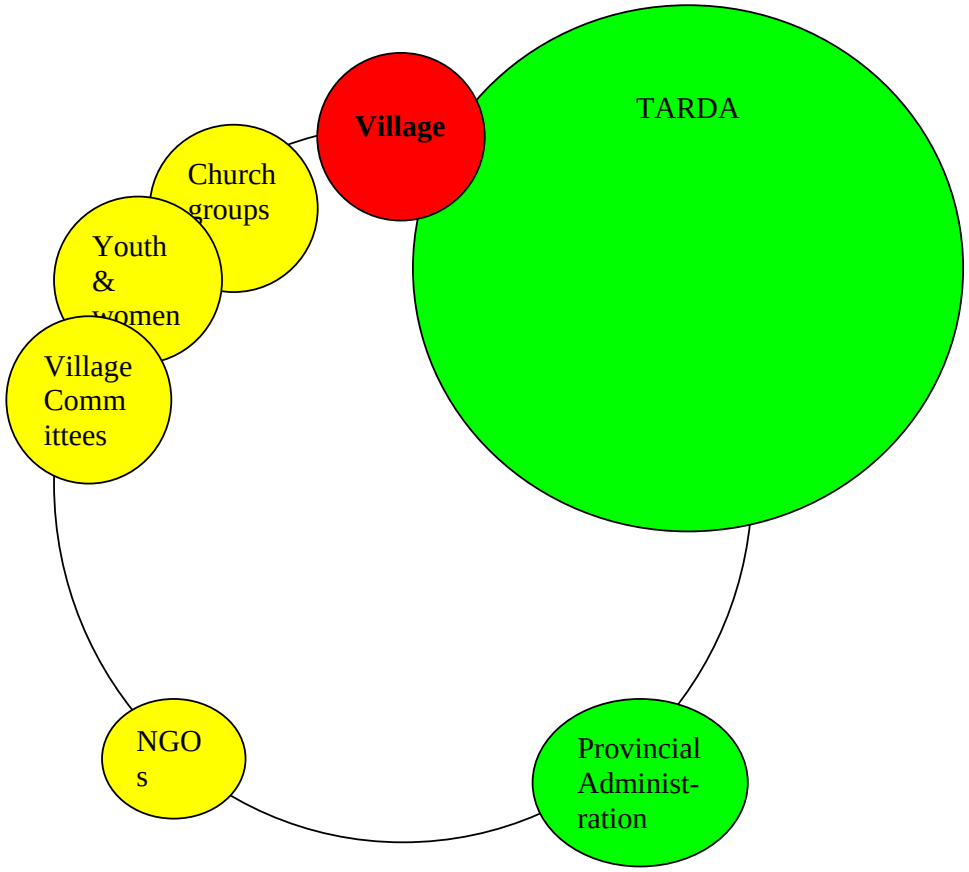
Fig. 1: The problem tree: identified constraints to livelihood



INSTITUTIONAL LINKAGES

Primary linkages
The following diagram summarizes village focal groups' perception of *existing* linkages between their village and both internal and external institutions, in terms of:

(a) closeness of institutional relationship with village (represented by distance from 'village' below)
(b) positive or negative relationship (positive to the left of village; negative to the right)
(c) impact of institution on village welfare (represented by size of institution's circle)



POSITIVE IMPACT (yellow) NEGATIVE IMPACT (green)

Note: lack of depiction equates to lack of existing relationship

Relationship with TARDA
As can be noted above, the dominating institutional relationship for villages is the proximal and negative impact of TARDA. Heated expressions concerning the negative impact of TARDA were encountered in every village, without exception, and in some cases threatened to derail focal group discussion. The negative impacts of TARDA fall into three general categories:

1. Loss of resources to the TDIP. Effects include:
   - Loss of both use and ownership of prime agricultural land, villages' central resource (subject of an unresolved court case brought against TARDA in 1994 by Hewani, Kulesa and Wema villages, the latest hearing/possible verdict being expected in February 2005).
   - Loss of prime dry-season grazing, a key component of pastoralist livelihood (Orma)
   - Increased illness and disease, especially malaria, due to TDIP rice-paddy flooding

2. Non-delivery of promised benefits from TARDA/TDIP that constituted a commitment on TARDA's part, in return for Hewani and Kulesa[2] agreeing to transfer (traditional) ownership of prime village land to the TDIP, principally:
   - Rice cultivation by the communities on the portion of village lands annexed by the project, accompanied by sale of rice to TARDA at a fair market price. The expected available area per household in Wema, for example, was 2 hectares.
   - Building of schools and clinics.
   - Building of a bridge over the Tana River connecting upper TDIP area (Sailoni) with Garsen town, to assist with transport and market access.
   - All-weather road connecting villages to main Malindi-Lamu highway, to assist with transport and market access.
   -
3. Arrogant attitude of TARDA towards villages :
   - Whilst TARDA actions can and do impact negatively on village livelihoods, TARDA neither consults with villages before taking action, nor informs villages when/after taking action.
   - TARDA does not pay casual workers in a timely manner, or always in cash as agreed.
   - TARDA only engages the villages when problems are encountered on TARDA's part, and does not take the subsequent views expressed by the community seriously.
   - A benevolent attitude by TARDA towards communities is expected, given that TDIP represents a development-focused project in a poverty-stricken area.

The only aspect in which TARDA has been seen to deliver benefits during the 15-year course of the project was the pre-1997 *El Nino* period, where the TDIP provided significant casual employment to villages, paid in a timely manner. Such a source of non-farm cash income represented an important contribution to household livelihoods, particularly as an additional coping strategy in dry-season periods of stress. However, since 1997, whilst the TDIP has continued to employ villagers as casual labour (to a lesser degree), such employment is considered to be of little value due to late (up to one year) and often partial payment; payment in rice rather than needed cash; and the fact that the real value of casual employment is seen as a coping strategy in periods of food stress – a strategy made relatively worthless in the face of late payments.

One of the problems contributing to continued disaffection is the (apparent) lack of a written 'contract' between TARDA and the communities outlining the nature and details of the relationship surrounding TDIP – certainly the communities have not aware of the existence of such a document. Whilst

Other institutional relationships

Remaining institutional relationships – either positive or negative – are relatively undeveloped. The greatest institutional influence is derived from village-based community organizations, principally women, youth, and church groups – which are well represented in each village. Many groups are involved in poultry propagation, whilst the youth groups play an active role in HIV-AIDS education. However, many of these groups lack financial resources to meet expectations (for example, women's micro-finance "merry-go-round groups), however groups appear to be active and motivated. There is little reliance on external organizations beyond support from the region's sizeable array of church denominations, including Catholic, Anglican. Pentecostal, and Seventh-day Adventist amongst others.

Otherwise, a number of NGOs – principally CRS (Catholic Relief Services), Red Cross and World Vision – have provided limited but significant help, principally with hand pumps (CRS, Red Cross) and limited school bursaries (World Vision).

[2] The case of Wema Village is different: Wema never agreed to transfer of its lands to the TDIP. Whilst the TDIP did annex that part of Wema traditional lands, the project to date has never utilized this land – in recognition of this fact.

The local Provincial Administration is seen neither as an aid, nor a hindrance – except in terms of withholding information from the village populations. Other government institutions, most notably the Forest Department (under whose jurisdiction the forest patches lie), KWS (the Kenya Wildlife Service, responsible for wildlife-related issues), and the Ministries of Water, Agriculture and Livestock are perceived to have, effectively, no presence in the area. For example, villages claim they have not seen an agricultural extension agent during the last 20 years.

Implications & Conclusions

- The attitude of villages towards TARDA is extremely negative, based on tangible losses to livelihoods; perceived unfulfilled agreements on the part of TARDA; and the arrogant attitude of TARDA towards the community.
- Any attempt on TARDA's part to engage in partnership with the community will likely not succeed, due to the community's distrust of TARDA
- Short-tern advancement of the relationship between TARDA and the community will, out of necessity, need to based on TARDA's willingness to provide villages with tangible benefits, under community control
- A necessary pre-requisite to the long-term advancement of the relationship between TARDA and the community is the engagement of the community by TARDA as equal partners
- Villages lack strong positive links with external institutions, with only occasional and low-level assistance from development NGOs
- Internal institutions play the most significant role in community development. The effectiveness, however, is hampered by lack of resources
- Positive engagement and/or assistance from government agencies is, essentially, non-existent

Natural Resources: key resource patterns, changes & challenges

There are three key resources critical to TDIP community farming (Pokomo) livelihoods:

- Water
- Land
- Forests

Each is considered, followed by a summary of key resources relating to the single pastoralist (Orma) community (Baandi).

Water

A. Traditional use pattern

All the farming villages of the TDIP are located in close proximity to the Tana River, on its eastern bank. The greatest implication of this was the reliance on seasonal (usually semi-annual) flooding of the fertile flood plains by the river, affording then the benefit of both costless 'irrigation' supply and rich alluvial soil deposits. This process supported a diverse array of crop types suited to differing moisture levels, and resulting in an extended growing season, thereby minimising food supply stress.

B. Current situation

The current situation is vastly different. According to villages, in 1994 - shortly after the advent of the TDIP scheme (although unrelated to it) - the Tana River changed its course between Mnazini (upstream) and Dumi (downstream), moving westwards (away from the village flood plains). This halted the seasonal flooding of community lands, and heralded a fundamental shift in the viability of their livelihoods. Today, villages are solely reliant on rain-fed agriculture. The result is both decreased as well as erratic levels of crop production; accompanied by a shift towards a more monoculture-based farming based on maize, which appears to be more suited to rain-fed cultivation. Yields, however, remain low.

C. Implication/Conclusion

Water currently remains the greatest single constraint to crop production – and by extension, food and livelihood security.

Land

A. Traditional Use Pattern
The most important farming resource is the low-lying, fertile flood plains adjacent to the Tana River, flooded seasonally and supporting crop diversity. All Pokomo land, including flood plains, is allocated between villages along traditionally demarcated boundaries. Each village in the TDIP area contains two major land-use zones: the fertile flood plains, and the surrounding 'gubani' woodlands at higher altitude beyond the flood plains. All activity is concentrated on labour-intensive, low capital-input subsistence farming in the floodplain area, where up until recently, the land area per village has been sufficient to allow increased crop production through expansion of the tilled area as population (and therefore labour supply) increased. By contrast the 'gubani' woodlands are little used, being infertile and difficult to till. The Orma pastoralists of Baandi move out of the sodden Tana delta during the long rains (March-April), utilizing outlying grazing areas until stocks are diminished, and returning to the delta as the long dry-season progresses (August-September). They then remain in the delta until the following year's long rains return. Access to grazing on and around the wetter floodplains of the current TDIP, through both the long and short dry-season, represents a critical component of their livelihood survival.

B. Recent Dynamics/Current Situation
Three major dynamics have impacted the productivity of the land resource over the past 15-20 years, both for Pokomo cultivators and Orma pastoralists.

I. The halt of seasonal flooding due to the shifting of the Tana River's course (see 2.1 above).
II. The inception of the TDIP rice scheme, which removed 2500 acres[3] (1042 hectares) of either utilized or available cultivable floodplain land lying within Pokomo-demarcated lands as part of the project's total of 10,000 acres. The TDIP in the process also converted former grazing lands.
III. Natural population growth, necessitating an increase in the cultivated floodplain area available to villages. The result is that currently, all but one village (Wema) is now cultivating all available floodplain land. In addition, according to Baandi residents, continued land degradation outside the delta combined with population growth has resulted in greater pastoralist herd influxes into the delta area, to the extent that movement in search of new grazing within the delta has become constricted due to diminished availability; resulting in individual groups/villages more jealously guarding and defending specific grazing areas – all of which both necessitates and results in increasingly 'fixed' home bases.

C. Implication/Conclusion
- The absence of either irrigation and/or capital to intensify per acre productivity has resulted in a fixed upper limit to household and community food production, directly related to erratic rainfall levels. Whilst the maximum yield of the major crop – maize – is 15 bags per acre during sufficient rains, typical yields average 2-3 bags per acre (this contrasts with maximum yields of 25 bags per acre in other parts of the country, where inputs are available). Most significantly, average production per year is typically lower than basic food needs.
- Conversion of critical grazing lands combined with increased competition for grazing continues to compromise local Orma livelihoods.

Forests
The following section gives a more detailed consideration of forest use patterns, dynamics and issues, since forests are the primary interest of the current study.

A. Traditional Use Patterns
Villages distinguish between 3 types of forest within their lands:
(a) the forest patches immediately adjacent to the existing (or recent) river course.

[3] According to Wema, Kulesa, and Hewani villages

(b) the 'madzini' or 'floodplain' forest patches further away from the river course and located within the farmed floodplain.
(c) the 'gubani' or 'bush' woodlands that characterise the land beyond the floodplain.

Forest use differs amongst the three types: the more mature 'madzini' forests are considered the most important, primarily because they contain species not found in the less mature, river-bank forest patches. Whilst less used, the 'gubani' woodlands are important as a source of building poles (see Section 1.5. As has been seen in Section 1 of this report, in addition to their importance in providing basic needs (e.g. firewood), the forests are particularly important as a traditional coping strategy in regular times of hardship and stress.

Traditional authority of the forests lies with the GASA – the Pokomo Elders Council, a general body in which traditional Pokomo law is vested, who implement and enforce traditional law through GASA representatives within each village. All forests continue to be governed by a similar set of rules and regulations. However, more recently it is the government Forest Government that has official jurisdiction over these forests – administered through its local office in Garsen.

B. Recent Dynamics/Current Situation

Forests Uses/Benefits

(a) Occupational structure results
Table 8 summarises results of household forest activities, based on the occupational structure survey, both for home consumption (e.g. firewood) as well as for livelihood. Results show high incidence of firewood, building sticks, medicinal plants and weaving material use, in addition to traditional beds and sticks for farming.

Table 8: Percentage of households using forest products (occupational survey)

Forest use type (n=120)	Firewood	Charcoal	Medicinal plants	Sticks - building	Poles - building	Sticks - farming	Sticks - livestock	Grazing /thatch	Log hives	Carvers	Weaving	Trad'l beds	Canoes
% HH	94	26	78	94	16	52	16	2	4	12	61	55	19

(b) Household forest survey results
The results from the household forest survey generally reinforce the findings above. Table 9 summarises current forest uses, including importance to the household, use levels, and demand-supply trends. The survey highlights the relative importance of various forest benefits, as opposed to incidence, as per Table 8 above.

Table 9: Household forest product importance, use, and demand-supply trends

Benefit to House Hold (HH)	High importance to HH (% HH)	Collection frequency (weekly)	Increase in HH demand over time? (% HH agree)	Increase in community demand over time? (% HH agree)	Decrease in supply of forest products? (% HH agree)
Firewood	81	1.5	57	65	12
Other tree products (building poles, timber, charcoal)	62	2.2	42	70	12
Grazing	26	5	27	61	11
Medicinal plants	40	1.3	37	40	29
Edible plants	26	1.9	24	26	0
Handicraft materials	36	1.1	31	36	18
Tree seeds/seedlings	0	0	0	0	0
Materials for farming (e.g. stakes)	22	1/7	20	29	12
Income from sale of wood products	13	4.2	15	18	0
Spiritual importance	0	-	-	-	-
Historic importance	13	-	-	-	-
Other	-	-	-	-	-

Highlights:

- The 'high importance' products are identified as firewood (81% of households); other tree products (62%); medicinal plants (40%) and handicraft materials e.g. mats (36%).
- A significant proportion of households (57, 42, 37,and 31% respectively) surveyed agreed that household demand for these uses is increasing over time; whilst demand at a community level was perceived as even greater (70,61, 40 and 36 respectively).
- At the same time, fewer households agree that the availability of 'high importance' products is decreasing.
- These findings reinforced by the village focal (both elder and youth) group discussions, which were unanimous in the agreement that forest resources are dwindling, that the current use levels are unsustainable, and that the continued existence of the forest patches is threatened (see below).

(c) Forest patch use by village

The main forest patches used by villages in approximate order of importance, by patch number, is as follows (please refer to the Botanical study Appendix 6):

- Sailoni village: 65, 46
- Kulesa village: 65, 48, 56, 68, 46, 47, 49, 50, 53, 54
- Bfumbwe village:66, 68 and the 'gubani' forests/woodlands
- Wema village: 68, 56, 57, 53, 54, 55
- Hewani village: 64, 63, 67, 60, 61, 58, 59, 62
- Baandi village: 64 "plus two others not appearing on the map" – one to the north and one to the west of the village, on the east side of the river.

According to villages, use patterns are determined by (a) proximity to village (b) availability of/suitability for particular products (c) village boundaries, whereby use by outside villages is restricted.

No attempt was made to estimate demand/use levels by village due to time constraints, however, such a study is recommended as a primary step in exploring forest management further.

Forest Costs

Table 10 depicts household survey findings relating to forest costs. The greatest costs are crop loss and associated time loss guarding against loss, followed by danger to human life (from e.g. buffalo, elephant, etc.). The majority of those households surveyed believe that

crop and time loss are growing (61 and 64% respectively). A growing trend, according to the focal groups, that is reflected here is the attraction of the forest resource to outsiders. 17% of households listed 'fines for illegal use' as significant; however, it is unclear whether these refer to community-imposed fines, since the Forest Department (as well as KWS) appear to have an almost non-existent profile with respect to management of the forest patches.

Table 10: Household forest costs, levels and trends

Benefit to Household (HH)	High significance to HH	Collected / encountered how many times each week?	Getting worse (better) for HH over time?	Getting worse (better) for community over time?
Loss/damage to human life from wildlife	24	3.2	12 (53)	20 (52)
Crop loss	58	5.7	61(1)	62 (0)
Time lose to crop protection	57	5.8	64 (1)	64 (1)
Children unable to attend school regularly in order to guard crops	18	2.2	16 (46)	28 (42)
Other HH's children are employed to guard crops	0	-	-	-
Fines for illegal access	17	1	11 (36)	0 (33)
Attracts outsiders	21	2.5	34 (20)	43 (17)

Conclusions relating to Forest Benefits and Costs

- Results show high incidence of firewood, building sticks, medicinal plants and weaving material use, in addition to traditional beds and sticks for farming.
- The 'high importance' products are identified as firewood; other tree products (e.g. poles, sticks, charcoal); medicinal plants and handicraft materials.
- A significant proportion of households surveyed agreed that household demand for these uses is increasing over time; whilst demand at a community level was perceived as even greater.
- Fewer households agree that the availability of 'high importance' products is decreasing. However, this is somewhat at odds with the findings from the village focal (both elder and youth) group discussions, which were unanimous in agreement that forest resources are dwindling, that the current use levels are unsustainable, and that the continued existence of the forest patches is threatened
- The greatest costs are crop loss and associated time loss guarding against loss, followed by danger to human life. The majority of those households surveyed believe that crop and time loss are growing.

Forest Management Issues

Four basic conclusions were articulated across all villages during focal group discussion:

1. Communities acknowledge the importance of the forest patches to their livelihoods, particularly in terms of (a) microclimate and (b) coping strategies.
2. Communities acknowledge the current unsustainable decline of forest patches.
3. Communities acknowledge the danger of imminent disappearance of the resource.
4. Communities expressed a desire for the forests to be conserved, and even expanded.

The following section reports on developing a way forward to achieving the objective of conservation and expansion, from the community's perspective – based on discussion of the causes of forest decline, and appropriate mechanisms to reverse that trend.

Causes of Forest Decline

Table 11 below summarises the causes of forest decline as perceived *and volunteered* by (as opposed to systematically asked of) separate elder- and youth-focal discussion groups across all villages. 'X' depicts citation as a cause of forest decline, while 'XX' depicts citation as a major cause. In totalling the frequency with which a particular cause was cited, 'X' was weighted as '1' with 'XX' weighted as '2'.

Table 11: Causes of Madzini (floodplain) forest decline, volunteered amongst elders & youth within villages

		Fire		Poor use/		Population pressure		Poor enforcement	Lack of seasonal flooding	Commercial exploitation from outside	Over-grazing	Wine tapping	TARDA/ TDIP clearing
Internal (I) External (E):		I	E	I	E	I	E						
Bfumbwe	Elders		XX			XX		X	XX	X	X		
	Youth							X	X		X		
Kulesa	Elders		X		X	X		X					
	Youth		X				X						
Sailoni	Elders				X		X	X	XX	X			
	Youth					X	X	X					
Wema	Elders			X		XX	X		XX	X		X	X
	Youth			X		X	X	X					
Hewani	Elders			X		XX		X					
	Youth		X			XX			XX				
Baandi	Elders		X	X									
	Youth					XX		X	XX				X
SCORE			6	4	2	13	5	8	11	3	2	1	2

Ranking the importance of various causes based on the citation frequencies in Table 11 yields the following summary:

Table 12: Ranking of importance of causes of forest decline (frequency in brackets)

Overall rank (score)	**Cause**	**Rank by elders** (score)	**Rank by youth** (score)
1 (13)	Internal population growth	**1** (7)	**1** (6)
2 (11)	Lack of seasonal flooding	**2** (6)	**2** (5)
3 (8)	Poor enforcement	**3** (4)	**3** (4)
4 (6)	Fire	**3** (4)	**5** (2)
5 (5)	External use due to population growth	**7** (2)	**4** (3)
6 (4)	Poor techniques (internal i.e. within villages)	**5** (3)	**6** (1)
7 (3)	Commercial exploitation by outsiders	**5** (3)	**9** (0)
8 (2)	Excessive grazing	**9** (1)	**6** (1)
8 (2)	Poor techniques used by outsiders	**8** (2)	**9** (0)
8 (2)	TDIP clearing of forests	**9** (1)	**6** (1)
11 (1)	Wine tapping	**9** (1)	**9** (0)

As can be seen, there are a number of perceived causes of forest decline, with a large degree of agreement between elders and youth perceptions – particularly on the main causes: pressure due to internal population growth; lack of seasonal flooding; and poor enforcement – with fire (set by pastoralists) ranking as an important cause.

Causes of Forest Decline

Table 13 presents solutions volunteered by focal groups (both elders and youth, separately). Results centred on five options (in order of importance): restore local authority and management; title or allocate forest patches; forestation and afforestation (involving both indigenous and exotic species); raise good-practice awareness; and involve youth in management. These are elaborated below in Section 5.4.3.6

Table 13: Solutions volunteered to halt Madzini forest decline according to elders & youth within villages

		Are forests declining?	Do you think the forests should be conserved?	Restore local authority & management	Forests need allocating &/or titling	Forestation/ reforestation E=Exotics I=Indigenous	Education/ training on good practice	Youth involvement necessary
		Yes/No	Yes/No	**OPTION A**	Option B	Option C	Option D	Option E
Bfumbwe	Elders	Y	Y			E, I		
	Youth	Y	Y	•	•	• E, I	•	•
Kulesa	Elders	Y	Y	•	•			
	Youth	Y	Y					•
Sailoni	Elders	Y	Y	•	•			
	Youth	Y	Y	•			•	•
Wema	Elders	Y	Y	•	•	• E, I		•
	Youth	Y	Y		•	• E, I		•
Hewani	Elders	Y	Y	•	•	• E, I	•	
	Youth	Y	Y	•	•	• E, I	•	•
Baandi	Elders	Y	Y	•			•	
	Youth	Y	Y	•	•		•	•
SCORE		12	12	10	10	12	6	8

Discussion & Elaboration on Causes of and Solutions for Forest Decline

1. **Internal population growth.** Villages acknowledge that the current situation is being driven by increased community demand for forest products, fuelled by primarily firewood needs, coupled with the need for an income source during periods of seasonal food shortage.

2. **Lack of seasonal flooding.** This is resulting in (a) dying trees and (b) depressed forest productivity.

3. **Poor enforcement.** Whilst internal population growth and depressed forest regeneration may be at the heart of the demand-supply equation, villages maintain that the unsustainable situation is being exacerbated by poor enforcement. This is a result of placing forest authority and management under ineffective government organisations, particularly the Forest Department (FD), whose closest office is located at nearby Garsen. Despite the proximity of their office, communities have no interaction with either the FD, claiming that, in particular, commercial utilization of the forests (see below) is being carried out with the blessing – official or otherwise – of the FD. In addition to presiding over poor management, the FD's authority serves to undermine the traditional GASA authority. The result is a situation that equates to 'open access', with concomitant lack of wise use. Such 'open access' has served to attract outsiders, many of whom – it is claimed – have no traditional knowledge regarding forest use, and therefore employ poor techniques e.g. fire; excessive grazing; cutting of immature or inappropriate trees; etc.; or worse, are taking advantage of the current management vacuum in order to commercially exploit the forests.

4. **Fire.** Indiscriminate seasonal burning of pasture against e.g. ticks and old growth by pastoralists in the vicinity is blamed for the continued shrinking of forest patches.

5. **Commercial exploitation of the forests.** The claim of commercial exploitation, primarily for timber, was commonly raised. It is not known who is engaging in this practice, however, trees are cut with chain saws under cover of darkness. Neighbouring villages either do not investigate, believing the activity to be in "another village's forests"; or confront the cutters, who escape before being identified.
6. **Forest demarcation/local management.** These are the primary factors leading to view community's that the forests should be returned to local authority and management, with the necessary accompanying requirement of official (government) demarcation and allocation of forests patches to individual villages – based on existing traditional boundaries.

7. **Village management bodies.** Most villages recognise that the undermining of the traditional regulatory body, GASA, necessitates the development of a more modern regulatory body. In particular, the youth across all villages maintain that they should be involved in order for effective local management to be achieved. The main rationale is that, given the prevalence of outsider use, the youth are need for forest monitoring and enforcement. Two villages (Wema and Bfumbwe) have functioning environmental committees that are actively involved in forest management, and in both cases these incorporate youth.
   Wema. Wema village contains a registered CBO (community-based organisation) 'Chamado Nsugu ya Wayume' whose governing committee consists of both GASA elders and youth, and whose goals are to (i) conserve the forests and (b) develop the long-term tourism potential of their 'gubani (woodland) lands beyond the floodplain area. Current activities focus on monitoring and management of forest use by Wema residents. The CBO falls under a regional umbrella CBO, the 'Salama Mwina Wetlands Farmers' (of which Kulesa and Sailoni villages are also members). Wema's CBO has also proposed that 100 acres of the disputed 2500 ceded by the village to the TDIP, but up-to-now unused, be allocated to forest expansion. Wema youth representatives also sit on the Village Development Committee, which oversees all village initiatives.
   Bfumbwe. Bfumbwe's village Environmental Committee consists of both GASA elders and youth. They continue to set village regulations for forest use; and carry out replanting

of seedlings within their adjoining 'gubani' woodlands, in an effort to counter removal of trees for building poles. The main problem they cite is that much of the damage and/or inappropriate use is being carried out by outsiders and particularly after dark, making identification difficult. **Other villages** contain Environmental Committees, however, a divide tends to exist between what should constitute the appropriate body for local management, with elders maintaining that the GASA should be reinstated; while the youth maintain that the GASA's traditional mode of operating needs modernizing in order to manage what is today a more complex, interdependent environment. In addition, all the villages contain active and organised youth groups involved in other spheres of village development e.g. HIV/AIDS awareness, poultry income generation and, in many cases, today's better educated and exposed youth are educating village elders (see Part 3 'institutional linkages').

8. **Demarcation challenges.** Ideally, villages would prefer to enlist TARDA's assistance in obtaining title to their traditional demarcated lands. Villages would then own and manage the resources, including forest patches, falling within their boundaries – a practice pursued traditionally, and officially sanctioned by the GASA Council following a decision in 1993 that villages should be separate and that "each village looks after its own land". A second challenge is the issue of non-Pokomo claims to the forest resource. Baandi village claims that land, including forests, should be demarcated along the location boundary separating Salama Location to the north (which contains the TDIP-related Pokomo villages) and Galili Location to the south (which, according to them, has traditionally been used by pastoralists). In terms of the TDIP area, the location boundary bisects forest blocks 64 and 67 (see Botanical study Appendix 6). This demarcation would impact on forests/land traditionally demarcated and allocated to Hewani village: in fact, Baandi village was originally established with the permission of Hewani village.

9. **Reforestation and forest education/awareness creation.** As Table 13 above demonstrated, communities indicate that this is a desirable option, and maintain an interest in expansion of both indigenous and exotic species.

10. Implications & Conclusions relating to Forest Management Issues.

- Communities perceive the most important causes of forest decline to be (a) increasing internal demand (b) lack of seasonal flooding (c) poor enforcement and (d) fire.
- Communities perceive the most effective solutions for sustainable forest management to be (a) devolution of forest authority and management to village level, accompanied by (b) issuance of titles of traditional village lands (c) forestation/reforestation and (d) technical assistance and awareness creation on best-practice.
- Two villages, Bfumbwe and Wema, contain functional environmental committees containing youth, active in forest management as well as other conservation actions. The other villages contain functional elder, women and youth institutions, active in various development activities, but not as yet representing functional, active environmental management capacity.

CONCLUSIONS AND RECOMMENDATIONS

For sake of convenience, the various implications and conclusions related to the socio-economic assessment are summarized below. These are followed by recommendations arising from those conclusions.

CONCLUSIONS

A. Livelihood strategies, vulnerability and constraints

- Communities are almost exclusively reliant on subsistence farming (in the case of Pokomo villages) or livestock production (in the case of Orma villages), with the great majority of the population unable to produce surplus for meeting increasing cash needs. In addition, very limited opportunities exist for alternative sources of income. The result is a high degree of vulnerability characterized by regular good shortage; lack of permanent housing; inability to educate children.
- The matrix of development challenges results in a lack of community capacity to accumulate capital, in order to break the cycle of poverty.

- The underlying viability of community livelihoods has been most significantly and adversely impacted by the discontinuation of seasonal flooding by the Tana River, due to its change of course in 1994, shortly before the advent of the TDIP.
- Water currently remains the greatest single constraint to crop production – and by extension, food and livelihood security.
- Communities are cultivating all available productive land which, in the absence of either irrigation and/or capital to intensify per acre productivity, has resulted in a fixed upper limit to household and community food production, characterised by low levels of productivity directly related to erratic rainfall levels. Most significantly, this upper limit is typically lower than food needs.
- Conversion of critical grazing lands combined with increased competition for grazing continues to compromise local Orma livelihoods.
- The nearby forest patches are important for daily needs (particularly firewood and building material). In addition, they play a role as the most important source of coping mechanisms during regularly encountered periods of stress.
- The TDIP represented to villages a significant development opportunity that would compensate for the adverse impact of the shift in river course.
- The matrix of multiple underlying development challenges associated with subsistence farming results in a lack of community capacity to accumulate needed capital, in order to precipitate investment into strategies that break the cycle of poverty.
- These underlying challenges are exacerbated by insecurity of land tenure; banditry; and loss of primary resource - land - to TDIP.
- It is interesting to note that if villages farmers were allowed to cultivate rice on their traditional land within the (improved) TDIP project area, selling to TDIP – as has been suggested in the past, and indeed expected by villages at the project's inception (see Section 5.3.2) - the rehabilitation of the TDIP, directly and indirectly, has the potential to contribute positively towards diminishing all four basic causes of local poverty, that is: lack of cultivable land; low per-acre productivity; lack of infrastructure to access markets; and insecurity of land tenure as well as property.

B. The forest resource

- Communities acknowledge the importance of the forest patches to their livelihoods, particularly in terms of (a) microclimate and (b) coping strategies.
- Results show high incidence of firewood, building sticks, medicinal plants and weaving material use, in addition to traditional beds and sticks for farming.
- The 'high importance' products are identified as firewood; other tree products (e.g. poles, sticks, charcoal); medicinal plants and handicraft materials.
- A significant proportion of households surveyed agreed that household demand for these uses is increasing over time; whilst demand at a community level was perceived as even greater.
- Fewer households agree that the availability of 'high importance' products is decreasing. However, this is somewhat at odds with the findings from the village focal (both elder and youth) group discussions, which were unanimous in agreement that forest resources are dwindling, that the current use levels are unsustainable, and that the continued existence of the forest patches is threatened
- The greatest costs are crop loss and associated time loss guarding against loss, followed by danger to human life. The majority of those households surveyed believe that crop and time loss are growing.
- Communities acknowledge the current unsustainable decline of forest patches.
- A section of the communities acknowledge the danger of imminent disappearance of the resource.
- Communities expressed a desire for the forests to be conserved, and even expanded.
- Communities perceive the most important causes of forest decline to be (a) increasing internal demand (b) lack of seasonal flooding (c) poor enforcement and (d) fire.
- Communities perceive the most effective solutions for sustainable forest management to be (a) devolution of forest authority and management to village level, accompanied by (b) official issuance of titles of traditional village lands (c) technical assistance and awareness creation on best-practice and (d) forestation/reforestation.
- Two villages, Bfumbwe and Wema, contain functional environmental committees containing youth, active in forest management as well as other conservation actions. The

other villages contain functional elder, women and youth institutions, active in various development activities, but not as yet representing functional, active environmental management capacity.

C. Institutional linkages

- The attitude of villages towards TARDA is extremely negative, based on tangible losses to livelihoods; perceived unfulfilled agreements on the part of TARDA; and the arrogant attitude of TARDA as experienced by communities, whereby communities are not even informed of TARDA plans and/or decisions, let alone consulted.
- Any attempt on TARDA's part to engage in partnership with the community will likely not succeed, due to the community's distrust of TARDA.
- Short-tern advancement of the relationship between TARDA and the community will, out of necessity, need to be based on TARDA's willingness to provide villages with tangible benefits, under community control.
- A necessary pre-requisite to the long-term advancement of the relationship between TARDA and the community is the engagement of the community by TARDA as equal partners
- Villages lack strong positive links with external institutions, with only occasional and low-level assistance from development NGOs.
- Internal institutions play the most significant role in community development. Whilst active and motivated, their effectiveness, however, is hampered by lack of resources.
- Positive engagement and/or assistance from government agencies is, essentially, non-existent.

RECOMMENDATIONS

The following is recommended with respect to the proposed rehabilitation of the TDIP, assuming that the rehabilitation contains the twin objectives of environmental and social sustainability:

1. The proposed rehabilitation should take account of, and attempt to redress, the TDIP communities' state of poverty, vulnerability and lack of development options.

The TDIP holds significant potential to contribute to resolving a significant number of the underlying conditions that maintain villages in a cycle of poverty. Specifically:

1. Engage the communities as development partners, through shared consultation, information, planning and implementation.
2. Consider delivering on the original expectation that communities would be able to cultivate rice within those traditional lands that fall within the TDIP, and sell to the TDIP at fair prices.
3. Continue providing employment opportunities, with payment executed in a timely manner.
4. Consider the feasibility of assisting communities with periodic water supply for crops.

2. That efforts be made to conserve the forests by piloting participatory or community forest management (PFM/CFM), given the importance of the forests to community livelihoods; their historical management by communities; and their threatened existence. Specifically:

A. To conduct a detailed forest utilization study, in conjunction with the communities, on use levels, use types, and species involved within each forest patch, in order to identify preferred species, rates of use, and threat status of each.
B. To explore devolution (limited or otherwise) of authority over and management of forests to communities, preferably in conjunction with a co-management agent to provide enforcement and technical assistance, and oversight.
C. Officially endorsed demarcation (by title or otherwise) of forest patches between villages based on traditional village boundaries. Special consideration needs to be given to accommodating Baandi village claims, suggested as the boundary separating Salama and Galili Locations. Consideration will also need to be given to any claims by other communities on the forests associated with the TDIP, to be addressed in an appropriate manner.

D. That PFM/CFM be based on the twin goals of forest conservation and forest expansion, with consideration given to development of (exotic) woodlots, with full ownership of the process by communities.
E. On the basis of A, B and C above: initiate pilot community forest management in the villages of Bfumbwe and Wema; given the organised and active status of their village environmental bodies.
F. That technical assistance be made available, particularly in terms of best practice in forest management; and awareness creation/education within the TDIP villages.
G. To ascertain the stake (if any) of other villages in the target forest patches.

3. That any forest conservation initiative be accompanied by a separate, but linked, community development component, given the relationship between poverty and forest decline, and based on the rationale that forest conservation twinned with positive community development will have a higher likelihood of long-term success as compared to forest conservation carried out in isolation. For example, it is likely that much of the forestation/reforestation work will be carried out in periods where villages are free from crop-growing activities; however, these periods are also stress periods in terms of food supply. Appropriate investment into enhancing food production will ideally decrease food shortage, enabling people to be able to work effectively during stress times. Other examples are potential synergies resulting from a twin forest-livelihoods approach include the ability of households to afford fuel-efficient stoves (that typically burn one-third of normal wood supply), through improved crop production.

4. That interventions emanating from rehabilitation of the TDIP - whether concerning forest management and/or community livelihoods - be managed and implemented through effective, trusted, neutral, and mutually agreed third parties, for example, the East African Wildlife Society (EAWLS) in the case of forest conservation; and World Vision or Action Aid, in the case of community livelihoods – rather than through TARDA, given the level of distrust between villages and TARDA.

5. That TARDA engage the TDIP communities as partners in the rehabilitation of the project - through information sharing, consultation and collaboration - as a necessary process for designing and implementing win-win solutions. It is further recommended that this report be shared with the TDIP communities, as a first step towards engaging them as *bonafide* stakeholders in the process.

ACKNOWLEDGEMENTS

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REFERENCES

Carney D, 2001, 'Sustainable Livelihoods Approaches: Progress and Possibilities for Change', DFID (Department for International Development), UK.

TARDA (Tana and Athi River Development Authority) (1983) 'Environmental Interface', Chapter 14 Tana River Irrigation Project (Extension) Feasibility Study Vol. 11, August.

TARDA (Tana and Athi River Development Authority) (Year unknown) 'Environmental Study', Annex 5 Tana Delta Irrigation Project Definitive Development Plan Vol. IV.

TDEAP (Tana Delta Environmental Awareness Programme) (1999) 'Analysis of the Situation on the Ground report 12-27th September 1999 – Draft', October.

Rietbergen-McCracken J. and D. Narayan (1998) 'Participation and Social Assessment: tools and techniques', World Bank, Washington DC.

Annex 1: Terms of Reference for the Socio-Economic Study

Overview: the research will concern itself with the relevant socio-economic aspects (particularly relating to stakeholder communities) with respect to the proposed protection of existing indigenous forest patches, extension of forest patches, and creation of connecting corridors between forest patches, within the project area.

The socio-economic component will comprise three main elements:

1. Desk Study

Carry out review of extensive existing literature and reports, in order to

- Understand the socio-economic context of the environment
- Understand past initiatives, results and consequences that will impact the project
- Identify the most important issues relating to the livelihoods-environment interface
- Identify data needs

2. Fieldwork

Design appropriate field methodology and supervise data collection to be carried out by locally accepted enumerator(s) over a 2 week period. Participatory research by the community will be used as much as possible, and be tested in advance. Due to prior research exposure and fatigue amongst the community, dependable key informants will also be used to cross-check the validity of participatory findings. In addition the methodology will also incorporate unbiased, independent data collection where possible. It is anticipated that TARDA personnel will be able to assist greatly in the design of representative sampling/data collection. Data needs will be targeted towards:

A. Prior identification of bona fide community stakeholders (both inside and outside the project site – key informants)

B. Assessment of resource and asset base (natural, human and social – participatory/key informants)

C. Assessing the relationship and dynamics of the natural resource-livelihood interface (emphasizing forest-livelihood links) – participatory/key informants through e.g.

- Description of livelihood community strategies
- Assessment of reliance of livelihoods on the natural resource base
- Identification of key natural resources
- Analysis of key resources: access, use, attitudes towards, and behaviour
- Community needs assessment – both general and in relation to key resources
- Assessment of livelihood constraints

3. Data analysis and Report

Conduct analysis of field data and compile a report in conjunction with the other elements of the project. The main elements are expected to include:

A. Threat analysis of the impact of the proposed project on livelihood strategies and key resources respectively, and vice-versa – including (i) direct and (ii) indirect effects

B. Identification of and recommendations for opportunities to mitigate threats. These are expected to include:

- Guidelines for adopting an appropriate form of Participatory Forest Management (PFM)
- Identification of suitable existing structures and resources
- Outline of a process for and the main components of an appropriate FM/NRM action plan

Annex 2: List of participants and enumerators

Participants (* denotes especially articulate individuals, recommended to be included in any follow-up consultation with the communities)

Kulesa

Mixed adults	Mixed youth	Enumerators
Matiya Amuma	Daido Ntusa Komora	Lucas Jillo Philip
John Luku	Peter Kiyesa Komora	
Rahel Wayu	Chudi Omara Diana	
Rahab Luku	Millie Naiko Jillo	
Philip Rhova Amuma	Geoffrey Omara Bilashi	
Daud Igwo Omara		

Bfumbwe

Mixed adults	Mixed youth	Enumerators
Moses Abajila Buya*	Rachel Kyambi John	Buya Moses Keyhodos
Jonathan Komora*	Philemon Maitha	
Paul Rudolf	Jillo Alfayo	
Gideon Eliza	Buya G Keyhodos	
Justin Buya	John Moses	
Komora Soye	Buya Keyhodos	
Komora Eliza		
Juliet Buya		
Jonathan Penina		
Kawuni Kiachu		
Keyhodos Buya		
John Joseph		
Martin Jonathan*		

Sailoni

Mixed adults	Mixed youth	Enumerators
Alpheat Abadeho	Selita Komora	Gabriel Mandisa
Mary Martin	Newtone Kiroti	
John Bekar	Susan Alfayo	
Haron Buko Komora	David Jara	
Alex Komora*	Mramba Enos	
Gerard Komora		
Gedion Wario		
Daniel Ibrahim		
Jillo Luka		
Christopher Komora		
Buya Jilloh		

Wema

Mixed adults	Mixed youth	Enumerators
Geoffrey Enock Malio (Nominated Councillor & Village Environmental Committee)*	Blandwa Nkaduda*	Lawrence Jillo
Benedictus Gololi (Chairman, Salama Mwina Wetlands Framers CBO & Village Environmental Committee)*	Laura Malioh	
Charles Yeziel*	Peter Ndege	
Justin Hiribae (Chairman, GASA Council of Elders)	Timothy Samwana	
Katarina Fanuel	Adrian makanka	
Rehema Mpuye	Lawrence Jillo	
Joseph Mbizi	Blandwa Nkaduda*	
Urban Tito Mshambara (Headman, Wema Village & Village Environmental Committee)*		
Lawrence Jillo		

Hewani

Mixed adults	Mixed youth	Enumerators
Esta Kaumbi	Jillo Sethwalichi*	Levy Jillo
Garise Elisha Mtumaini*	Dara Garise	
Eva Martin	Wachu Waluta	
Mary Ngomango*	Choice Sammy	
Humphrey Garise (Headman, Hewani)	Haigwo Nkuwa	

Baandi

Mixed adults	Mixed youth	Enumerators
Ali Gobole (Headman, Baandi)*	Godana Boneya	Aaliyah Salad
Goriso Gollo	Gobu Alii*	Sofia Salad
Handada Gollo*	Gollo Abdallah	Godana Boneya
Omar Boneya*	Alliyah Salad	Yusuf Mohamed
Dokota Maalim	Sofia Salad*	
Hukicha Sawena	Yusuf Mohammed	
Halima Ali	Ibrahim Guyole	
Kanchoru Gollo*	Hussen Abarea	
	Alii Kanchoru	

BOTANICAL/ECOLOGICAL STUDY

By

W. R. Quentin Luke

SUMMARY

Although intended to be 'rapid', this study has taken twice the intended time. The impact on these critically important forests of the Tana River has been devastating, both by the El Nino weather event of 1997/8 and the increasing human pressure directly due to the lack of alternatives promised at the inception of this donor funded Rice Irrigation Scheme. Assessment of the current size, composition, health and conservation status of these forest fragments shows an urgent need for bold and innovative intervention if the habitat of two of the world's rarest primates and the livelihoods of the local communities are to be protected and improved.

- There are 320 plant taxa in the area; 58 of them trees, and 2 of them can be considered Critically Endangered in a world sense. 21% of the plants are of conservation concern.
- Forest cover has declined by 37% in 10 years AND the quality of the cover has suffered similarly.
- Past interventions have aggravated the situation by the introduction of invasive plants, and the exacerbation of community differences and conflict.
- Opportunities for action to achieve realistic change in both primate habitat and the lives of the local people are many and varied. These include: an increase in environmental awareness; the full involvement of the people in participatory forest management (PFM) and design; the immediate start of nurseries for indigenous and selected exotic species ; the linking of existing forests by corridors; the design of productive woodlots; and the initiation of simple, effective community income generating ventures.

INTRODUCTION

The Project area was first visited by the author in 1988, during the WWF funded Coast Forest Survey (CFS) (Robertson & Luke, 1993). At that time, the irrigation scheme was in the process of implementation and the construction of many of the dykes was causing forest destruction in several of the forest patches (eg 48, 57, 65). Attempts were made to address this and much discussion was entered into with the Japanese (Nippon Koei Company) and TARDA engineers regarding a more environmentally acceptable design (eg Robertson letter 11th August 1989). Further studies were carried out (Medley et al, 1989) with particular reference to the impact on the two endemic primates.

This present study comprises three elements; the primate survey, the socio-economic (S-E) survey and the botanical/ecological (B/E) survey (**Appendix 1**). It was designed after meetings with JBIC and TARDA officials in July/August 2004, followed by approval of funding by CEPF in September 2004. The B/E survey began with a desktop study of all previous vegetation surveys, project reports, EIAs etc in Nairobi, followed by a 10-day field visit in November/December 2004. The other two studies were carried out independently with only a brief overlap in the field with the consultant of the S/E study.

METHODOLOGY

No satellite or aerial photography was available and thus the positions of the forest patches were determined by the 1: 50,000 topo sheet for the area (179/1 & 179/3) and maps in project reports notably Fig 1-1-2 (**Appendix 2**). TARDA officials assisted in meeting and selecting one elder from each of three villages (Sailoni, Wema and Hewani) to act as guides and informants during the fieldwork. Each forest was then visited with the entire team of 4 (3 + one TARDA employee) and was carried out in a roughly north to south order, starting with No 65 and ending with No 69). During the survey the team was joined by the head of TARDA's Environment Department (**Photo 1**).

The survey involved a random walk through each forest patch, attempting to cover all vegetation types and noting species encountered in a purely opportunistic manner. Species readily identifiable were recorded as sight records (sr) and, for plants whose identification was in doubt, a voucher specimen was collected. When the rate of recording new taxa had dropped to almost nil (approximately no new records for more than 30 minutes), the survey

for that patch was considered complete. The local informants were able to give some local names and uses and to explain some examples of disturbance. It became very obvious that the deterioration in forest quality since the visits in 1988 was extremely high and that it would be of little use to attempt to quantify the level of disturbance. All forests were thus noted as experiencing a high level of disturbance.

Larger forests took approximately six hours to survey with the remainder of the day spent in data entry and specimen pressing and drying. It was possible to carry out surveys of two smaller forests in any one day.

On return to Nairobi collected specimens were sorted, labelled and identified using standard botanical references (FTEA etc) and compared with material in the East African Herbarium. The records were then added to the database of previous records for the area and a complete species list prepared.

RESULTS

Although the main focus was on the primate habitat, some grassland species were included but by no means all. Thus the total plant taxa listed for the TDIP area of approximately 40 sq km (4000 Ha) (Butynski & Mwangi, 1994) after this survey is 320 (**Appendix 3**). Additional collections of the grasses, sedges and aquatics within the 'fields' will no doubt increase this by anything up to 10% (350 taxa).

Forest classification and affinities

4.1.1 Phytogeography

The history of East African coastal forest is known to be made up of cycles of wet and dry periods allowing for the periodic expansion and contraction of forested areas with the wettest periods allowing forest cover to extend unbroken across the continent from east to west. During the longer connections, the most recent probably 8000 yrs BP (Butynski & Mwangi, 1994), West African species have been able to spread to the east (and vice versa) and subsequently remain as western or Guinea-Congolian (GC) elements in the East African flora (White, 1983) or to then evolve in isolation. The drier savanna/bushland that has increased as the forests shrink, is very extensive both north and south and the plants particular to this area are classified as Somali-Maasai (SM) and contribute a number of species to the Tana forests. Most of the remaining species in this area belong to a third category, that of the Zanzibar-Inhambane regional mosaic (ZI). A major part of this phytochoria is represented in the CEPF Eastern Arc and EA Coastal Forests Hotspot, and in the WWF Eastern Africa Coastal Forest Ecoregion.

A few examples of each 'regional element' in the TDIP vegetation are as follows:

GC - *Diospyros ferrea; Synsepalum msolo*
SM - *Cyathula coriacea; Phyllanthus somalensis; Megalochlamys trinervia*
ZI - *Ecbolium amplexicaule, Culcasia orientalis, Pteleopsis tetraptera*

There are other elements recognisable such as the Afromontane and the Zambezian, however, in the phytogeographic code used by CFS (Robertson & Luke, 1993), these are not distinguished in the coding. The approached used is to concentrate on the local and ZI endemics (codes 1 & 2) and refer plants that are more widely distributed into another phytochoria as code 3 or ZI + 1.

Referring to **Appendix 3**, the following totals for each coding is as follows:

Kenya Coast Endemic (1 or 1?) = 4	ZI Endemic (2 or 2?) = 52
SM endemic (2X, 2X?) = 12	ZI + 1 = 55
Pan African (4 or 4?) = 89	Pan Tropical (5 or 5?) = 96
Not know or taxon not Fully determined (?) = 12	

The total taxa that are classified as local or ZI endemics are 56 or only 17.5%. Comparing this with coastal forests in Kwale or Kilifi Districts, where the percentage is nearer 30%, indicating that TDIP is possibly approaching the landward edge of the ZI region.

Classification
These forests have been sustained within an arid surround by the presence of the Tana River and, in particular in the past, by regular flooding (Andrews et al, 1975). This regime has changed in recent history with the building of hydroelectric dams upriver that have disrupted the rate and extent of the flooding and hence the availability of both water and rich sediment to the forest patches away from the immediate riverbank. This has been further impacted by the change of the main river course in 1989.

The main classification of these forest is therefore « *Lowland Riverine Forest* » with the understanding that, unlike many of the other EA coastal forests, and because they are riverine, they are mostly 'evergreen'. Work on the soils and water availability (Njue, 1992) has shown how rapidly the water table drops with each metre away from the riverbank. Thus it is not surprising that the forest some distance away from water (63, 66, 67,68), show a slightly different composition, with the presence of *Cynometra lukei* being most likely in the forests furthest from the river (**Appendix 4**). Tree species that appear to be common throughout, and therefore characteristic of the TDIP forests, are *Rinorea elliptica*, *Garcinia livingstonei*, *Mimusops obtusifolia* and *Phoenix reclinata.*

Species diversity
These forests have been noted for their low floristic diversity (Medley et al, 1989) and indeed a forest patch of roughly 150 Ha in Kwale District, Kaya Muhaka has a list of 337 taxa as compared to the 4000 Ha of TDIP with 320 taxa.

The TDIP area has plant taxa in 80 families distributed amongst some 235 genera. The family represented with the most species is Rubiaceae (23), closely followed by Euphorbiaceae (22). The most represented genus is that of *Diospyros,* in the family Ebenaceae, with 7 different species.

Growth Forms
Again referring to **Appendix 3**, the plants have the following numbers in each « habit » class:

Tree (T) = 58	Scandent Shrub (SS) = 21	Woody Herb (WH)= 40
Small tree (ST) = 56	Liane or Climber (L) = 63	Herb (H) = 41
Shrub (S) = 36		Epiphyte (E) = 1
		Hemi-parasite (P) = 2
		Fern (F) = 2

The exceptional number of scandent or climbing plants is possibly an indicator of heavy disturbance, although a high proportion of lianes has been noted in the forests of TRNPR (Medley, 1992) and is possibly a feature of frequently flooded riverine forest.

Species of Conservation Concern
The last column of **Appendix 4** shows the present IUCN threat category of the plants of TDIP. There are only 7 plants RED LISTED as follows:

Endangered (EN) - *Cynometra lukei*

Vulnerable (VU) - *Oxystigma msoo, Angylocalyx braunii, Dalbergia vaciniifolia, Chytranthus obliquinervis, Diospyros greenwayi, Pavetta linearifolia*

The need for a more complete and up-to-date assessment of all the plants within the Eastern Arc & EA Coastal Forest Hotspot has been recognised (CEPF, 2003) and hence by referring to the list of potentially threatened species (Gereau & Luke, 2003), a further 63 plants are noted in the area as being candidates for review. Thus some 21% of the plants in this area are of conservation concern.

Of particular note is the woody herb *Megalochlamys tanaensis,* previously only known from the type collection by Gillett around 1970, and found during the survey in forests 65 and 68. Both populations were extremely small and the plant should be considered « Critically Endangered » with the need for urgent intervention.
Other species recorded in TDIP that are annotated RARE (R or R?) in CFS are:

Rosifax sabuletorum C.C.Towns.	A woody herb with pinkish inflorescence only know from Somalia and 2 collections in Kenya
Dichapetalum sp 1 of CFS	An un-described liane previously recorded from TRNPR but never found fertile.
Psydrax kaessneri (S.Moore) Bridson	A scandent shrub in the coffee family found in forests 48, 66, 67, 68.
Rytigynia sp L of FTEA?	A shrub, also in the coffee family and most likely this unnamed taxon noted by Verdcourt in FTEA
Tylophora apiculata K.Schum.	A weak twiner, R&L 5308 determined as this species by Uli Meve.
Cynometra lukei Beentje	A tree already noted above as being Redlisted. Only described in 1988 from forest 67.
Marsilea fadeniana Launert?	Probably this species of small aquatic fern, but needs further checking.

There are a further 20 taxa listed as RARE KENYA (RK or RK?) and some 25 listed as RARE KENYA COAST (RKC or RKC?).

The discovery of several trees of *Cassipourea gummiflua* in forest 48 was only the second time this species has been recorded in coastal Kenya and possibly only the 3rd time in Kenya. The other coastal record is from Buda FR in Kwale District (Luke 5958).

Exotics
The most obvious introduced plant in the area is *Prosopis juliflora* or Mathenge, as it is known locally. This has spread to large areas of the unutilised/destroyed paddy fields particularly those near forest 64 and poses a serious problem both for the rehabilitation of the Rice Scheme and for any woodlot establishment. Some form of intervention is critical, perhaps in terms of bounty payments or assisted mechanical removal. The second most invasive species in the TDIP area is *Azadirachta indica,* NEEM or Mwarubaini/Mukilifi. Although an extremely useful tree, it is highly invasive and nearly all the forest patches had seedlings beginning to establish. It is not noted as being one of the endangered primates' 14 food trees (Mbora, 2003) but then neither are several figs nor several very similar species to those listed, which suggests that further study could add many more trees to the list. If Neem was found to be palatable to one or other of the primates, there could be an argument in favour of using more in mixed woodlots but this would be detrimental to the natural vegetation.

Other exotic trees found in the area that have been planted in reforestation programmes (Nippon Koei, 1998) are: *Pithecellobium dulce, Senna siamea, Eucalyptus spp* (Glenday, 2005*), Albizia saman, Leucaena latisiliqua, and Parkinsonia aculeata.* A few species indigenous to Kenya but not to the area were also encountered as planted such as *Spathodea campanulata* (Nandi flame) and *Afzelia quanzensis* (Mbambakofi).

Crops
A fairly standard range of crop species was observed including: *Mangifera indica* (mango), *Anacardium orientale* (cashew), *Musa spp* (banana), *Citrus auratifolia* (lime), *Manihot esculenta* (cassava), *Cajanus cajan* (pigeon pea) and many others.

Utilisation
As mentioned above, all forests were found to be heavily utilised. Charcoal burning of *Newtonia erlangeri* (MUKAMI) and a large *Albizia glaberrima* (MSADSASUMBII) felled in forest 65 were noted (**Photo 2**). Heavy grazing, charcoal pits and the collection of firewood were observed in forest 68 (**Photo 3**). Many forests showed signs of palm-wine tapping from *Phoenix reclinata* (MKINDU), particularly in forest 48 (**Photo 4**). This species is under severe pressure as it is also over harvested for weaving and poles (**Photo 5**). It is the prime food

source for the mangabeys (Butynski, pers. comm.) The tree *Cassipourea gummiflua*, mentioned above as rare in coastal Kenya, was also observed being cut in forest 48.

Several forests showed signs of burning around the edges presumably to increase grazing for the pastoralists in the area.

Woodlots
Previous efforts to establish woodlots using species mentioned above have met with little success. Areas marked on the map by TARDA/Nippon Koei as having been afforested were observed to be mostly empty of trees (**Appendix 2**). Indeed part of the area marked CS for *Cassia siamea* (now *Senna siamea*) outside forest 65 appeared to be the area selected for sugar cane trials (**Photo 6**). It is understood that much damage to the woodlots happened during the El Nino event of 1997 (Nippon Koei, 1998), however further loss must have happened since the report was compiled. The only area with significant cover was that adjacent to the Gamba TARDA HQ.

Carbon Study
The TDIP portion of another CEPF funded study (Glenday, 2005) was carried out soon after the fieldwork for this study. Important quantitative data on biomass, basal areas and frequency were collected from all the TDIP forests giving the baseline from which to measure future impacts on them.

The species dominance levels have been used in **Appendix 5**, although some species recorded as being in the top 5 dominants were not observed by QL. These are highlighted, as are two species not recorded in the TDIP area by QL. Unfortunately some confusion over species identification using local names and conversion to scientific names using published works (Beentje, 1993; KIFCON, 1993) was experienced (Glenday pers. comm.). The three tables, Dominants, Frequencies and Coverage are shown in **Appendix 6**.

DISCUSSION
The prime importance of the Tana forests, both for the conservation of endangered species/habitat and for the support and improvement of livelihoods of the local communities, has been repeated in a multitude of studies. The data have been collected, analysed, summarised and published over more than thirty years. During this time, instead of a halt to degradation and the beginning of some improvement, the downward trend has continued. The socio-economic study (Hatfield, 2005) presents a clear picture of the attitudes of the local inhabitants, their negative feelings towards TARDA, their need for long-term solutions to income shortfalls and their basic desire to preserve the forests.

It was noted during fieldwork that, even now, many of the local residents are unaware of the importance of the primates in a world context. This is being addressed through a new programme under EAWLS. Thus the next stage must be an action based project to provide local employment in a project, outside direct TARDA control, to set up village nurseries and implement a planned expansion of the woodlots and the forest patches using suitable exotics AND indigenous species.

Research on the primates has produced some basic demands that must be met to keep their populations healthy and reproductive. The need for suitable large fruit trees and the apparent positive correlation between forest perimeter lengths and population abundance for the red colobus (Mbora & Meikle, 2004) gives the main direction for the design of interventions.

Photo 1: Survey Team (left to right) Jonathan Wachu, Dismus Wario, Kamora Phanuel, Richard Mwendandu and Shadrack Kibindyo (All photos © Quentin Luke)

Photo 2: Recently poached tree in Forest 65

Photo 3: Woman collecting firewood outside Forest 68

Photo 4: Palm wine tapping from *Phoenix reclinata* (MKIUNDU) Forest 48

Photo 5: *Phoenix reclinata* (MKINDU) poles stacked in Forest 48

Photo 6: Sugarcane trials next to forest 65 (Background)

RECOMMENDATIONS

Awareness

As stated above, there is an urgent need to ensure that the local communities are fully aware of the conservation importance of these forests and the steps that donors are prepared to take to increase their participation and benefit from a conservation agenda. It is understood that EAWLS and CEPF are already designing/implementing such an awareness programme.

Nurseries

The TARDA tree nursery has not been a success (Glenday, pers. comm.), largely due to inappropriate species selection and inadequate understanding of local soil types and water table variability. Trial plots should have been set up in 1989 and monitored. There is insufficient time available to delay rehabilitation until such data is produced, however a concurrent monitoring of successes and failures can be used to modify the proposed programme on a regular 'feed-back' basis. The following indigenous species are a bare minimum of those that should be seed-sourced, wildling-sourced or vegetatively propagated and planted from the outset of the rehabilitation project:

SPECIES	FAMILY	Local Name/Comment
Lannea schweinfurthii (Engl.) Engl. var stuhlmannii (Engl.) Kokwaro	Anacardiaceae	MHANDARAKU*
Sorindeia madagascariensis DC.	Anacardiaceae	MWAMBEMBE, MNYAMBEMBE
Kigelia africana (Lam.) Benth.	Bignoniaceae	M'BWOKA
Cordia goetzei Guerke	Boraginaceae	MDOKO
Cassia abbreviata Oliv. Ssp beareana (Holmes) Brenan	Caesalpiniaceae (Leguminosae)	
Cynometra lukei Beentje	Caesalpiniaceae (Leguminosae)	MKUNUMBI, MPAKATA
Oxystigma msoo Harms	Caesalpiniaceae (Leguminosae)	MTSO, MCHO?
Tamarindus indica L.	Caesalpiniaceae (Leguminosae)	MKWAYU
Pteleopsis tetraptera Wickens	Combretaceae	MKURUBO BARA
Diospyros abyssinica (Hiern) F.White ssp abyssinica	Ebenaceae	MUYUHI
Diospyros bussei Guerke	Ebenaceae	
Diospyros ferrea (Willd.) Bakh.	Ebenaceae	MUNYIZA, MNYIZA
Diospyros kabuyeana F.White	Ebenaceae	
Diospyros mespiliformis A.DC.	Ebenaceae	MKURU
Bridelia micrantha (Hochst.) Baill.	Euphorbiaceae	MKULOTSO
Drypetes natalensis (Harv.) Hutch. var leiogyna Brenan	Euphorbiaceae	
Spirostachys venenifera (Pax) Pax	Euphorbiaceae	MCHALAKA, MTSAKA
Garcinia livingstonei T.Anderson	Guttiferae (Clusiaceae)	MCHOCHOZI, MPEKETSO. FRTS, UJI
Strychnos mitis S.Moore	Loganiaceae	MUWARE
Ekebergia capensis Sparrm.	Meliaceae	
Trichilia emetica Vahl	Meliaceae	MUWAHI*
Acacia robusta Burch. Ssp usambarensis (Taub.) Brenan	Mimosaceae (Leguminosae)	MUNGA. CHARCOAL
Acacia rovumae Oliv.	Mimosaceae (Leguminosae)	MUNGA NGOWE*
Albizia glaberrima (Schumach. & Thonn.) Benth. var glabrescens (Oliv.) Brenan	Mimosaceae (Leguminosae)	MPHUMPE, MSADSASUMBII. CANOES
Newtonia erlangeri (Harms) Brenan	Mimosaceae (Leguminosae)	MUKAMI. CHARCOAL
Ficus bubu Warb.	Moraceae	

Ficus bussei Mildbr. & Burret	Moraceae	HIDOLE
Ficus natalensis Hochst.	Moraceae	HIDOLE, MVUMA*
Ficus scassellatii Pamp. Ssp scassellatii	Moraceae	
Ficus sycomorus L.	Moraceae	MKUYU, MKUJU*. CANOES
Phoenix reclinata Jacq.	Palmae (Arecaceae)	MKINDU
Zanthoxylum chalybeum Engl. var chalybeum	Rutaceae	
Dobera loranthifolia (Warb.) Harms	Salvadoraceae	MUKUPHA, MUKUBFA*. FRTS
Blighia unijugata Baker	Sapindaceae	MUBO
Lecaniodiscus fraxinifolius Baker ssp scassellatii (Chiov.) Friis	Sapindaceae	MHUMBI-MWEUPE, KIWAMBWE-KINKUNDU
Majidea zanguebarica Oliv.	Sapindaceae	
Manilkara mochisia (Baker) Dubard	Sapotaceae	MURAIDHE
Mimusops obtusifolia Lam.	Sapotaceae	MNGUVWE
Sideroxylon inerme L. ssp diospyroides (Baker) J.H.Hemsl.	Sapotaceae	
Synsepalum msolo (Engl.) Pennington	Sapotaceae	MCHAMBYA
Cola clavata Mast.	Sterculiaceae	MNOFU-WA-NKUKU
Sterculia appendiculata K.Schum.	Sterculiaceae	MFUNE

All these 42 tree species occur naturally in the TDIP area. There are several other species that are indigenous to the coastal areas of Kenya, but not to this area. Some examples of species that could be included in trials are as follows:

Acacia elatior	Delonix elata
Acacia tortilis ssp raddiana	Dialium orientale
Albizia adianthifolia	Dobera glabra
Albizia amara	Drypetes reticulata
Albizia gummifera	Erythrina sacleuxii
Albizia versicolor	Ficus usambarica
Antiaris toxicaria	Grewia plagiophylla
Apodytes dimidiata	Gyrocarpus americanus
Bivinia jalbertii	Milicia excelsa
Boscia angustifolia	Millettia usaramensis
Boscia mossambicensis	Parkia filicoidea
Calophyllum inophyllum	Populus ilicifolia
Cassia afrofistula	Ricinodendron heudelotii
Cephalospaera usambarensis	Sterculia schliebenii
Combretum molle	Syzygium guineense
Combretum schumannii	Terminalia prunioides
Cordyla africana	Terminalia sambesiaca
Croton megalocarpoides	Terminalia spinosa
Croton sylvaticus	Warburgia stuhlmannii
Dalbergia boehmii	Xylopia spp

This list is not exhaustive. It has been suggested that the local schools could play a major part in these trials as part of their environmental education programmes. The recommendation is that these trials be supervised either by TARDA or by a local NGO. Once some direction is evident from this experimentation, then the nursery operations should be « privatised » i.e. handed over to village environment committees or to individuals who are interested in the business. All enrichment planting, corridor planting and woodlots would be contracted out to these nurseries.

Exotic and Invasive species
TARDA has so far relied on 4 exotic tree species for its woodlot programme:

a) *Azadirachta indica.* As stated previously (4.5), the invasive nature of Neem disqualifies this as a suitable species for reforestation and, unless it is found that the primates utilise the leaves or fruits, a programme of removal of the existing trees and seedlings should be planned.
b) *Pithecellobium dulce* has not been very successful in the woodlots but was seen growing very well as individuals in the villages. It is probably a potential food species for the Mangabeys and perhaps more work is needed to determine whether this is a tree valued by local communities and whether establishment can be improved.
c) *Senna (Cassia) siamea*. This widely used species probably has its value in further reforestation efforts but should be evaluated against other species.
d) *Eucalyptus camaldulensis.* It is not known how successful this species has been, however, with the worldwide advances made in selecting new and better Eucalypt hybrids, their pole wood and firewood values cannot be discounted and they should continue to be evaluated within the woodlot programme.

An additional species that has shown great promise further south, in Malindi District, is *Albizia lebbeck.* This should be included with any other novel species suggested by KEFRI or ICRAF in trials.

The *Prosopis* problem is now countrywide and cannot be solved by TDIP alone. However, every effort should be made to remove it where feasible and to persuade local pastoralist communities to stop feeding pods to their livestock which assists greatly in spreading « Mathenge ». Innovative ideas must be sought to at least tame this weed even if there is little hope of eradication.

Strengthen/establish Village Environment Committees
As the first stage in moving towards some form of village management of the forest or PFM, the village committees need to be strengthened and an environmental subcommittee created where none exist. In a similar manner to the approached used by CFCU in Kwale and Kilifi Districts (now also Malindi District), these village committees should be encouraged to appoint Forest Guards or Wardens that draw some honoraria, initially from the donor project, but eventually from committee funds raised from sale of wood products and from fines.

Village Guards/Wardens
These should be appointed by the Village Committees on the following basis:

i. Must be local resident of village
ii. One guard or warden per 10 Ha (with obviously a minimum of 1 guard for forests less than 10 Ha). Thus Forest 48 with its reported size of 30 Ha would initially have 3, increasing as necessary with expansion and corridor creation).
iii. The 'honorarium' should not be considered a salary. This needs further discussion as to whether the « Kaya system » is workable, but a possible combination of nursery contracts with these 'honoraria' should be explored.

Riverbank Strip Forest Development
Two of the most striking facts about the primates' habitat preferences are that they like riverine forest and that they like the forest perimeter. One of the most effective ways of creating new habitat is thus to utilise the riverbank and the protection this is afforded by Kenyan legislation. Prior to the enacting the Environment Management Act, it was standard that 30m on either side of a river should NOT be cultivated. Although this was often contravened with impunity, it is probable that it is enforceable using the new legislation. With the advantage of the high water-table, it should be the quickest and easiest place to establish a forested strip using fig stakes of *Ficus sycomorus*. Overtime a more generous strip can be negotiated with the village committees, extending it to perhaps 100 metres (**Appendix 6**). The use of this strip to interplant mango trees will be beneficial to both the villagers and the endangered primates.

It should be noted that the S-E study produces evidence that the pastoralist communities use some of this strip for cultivation. The use of the law to move them should be coupled with integration into the irrigation project with the allocation of their own plots.

East/West Connections
Concurrent with the roughly north/south establishment of the 'River Strip', these then need to be cross linked to the existing forest patches. Three corridors are envisaged (**Appendix 6**):

- Sailoni/Kulesa – linking 65 to 48 to the riverbank
- Wema/Bvumbwe – linking 66 to 68 to 56 to the riverbank
- Lango ya Shimba/Hewani/Baandi – linking 67 to 63 to 64 to the river bank

Although somewhat bigger that the area originally set aside by TARDA for reforestation, the only real loss to the paddy fields are two areas, one in Block B between forests 66 and 68 and another in Block E between forests 63 and 64. The width of the corridors has been chosen arbitrarily and can be adjusted to suit various parameters.

Woodlots - Flood irrigation
Both the Socio Economic and the Primatological studies suggest that the irrigated fields should not be operated for rice production alone. Diversification into other irrigated crops (vegetables, fruit trees etc) will be of huge benefit to the local communities and, with the inclusion of some cattle fodder production, be a much needed mechanism for bringing the pastoralist community into the scheme and lessen the historical conflict between them and the agriculturalists.

It is recommended here that, as part of this diversification, the mixed woodlots and some of the proposed corridors are flood irrigated where possible. This will have a huge impact on the rate of establishing them (therefore lessen the time before first harvest) and increase production of wood products per unit area.

Buffer zones
This is a possible idea for the bigger areas in which fuel wood harvest is allowed on edges only, with faster growing species planted on outside and indigenous nearer the core. Management issues that should be considered are:

i. The areas where different extractive forest uses are permitted must be very clearly defined so that there can be no misunderstanding about it.
ii. Community members must be involved in mapping, demarcating and deciding how these areas are utilised. (Similar to what is being done at Dida, in Arabuko-Sokoke FR. Perhaps a visit to this area for some TDIP community members should be planned).

Recovery Programme Redlisted Species
The two species that deserve some consideration are the tree *Cynometra lukei* and the woody herb *Megalochlamys tanaensis.* The former is known from a similar habitat in the Selous GR and Kalunga forest, both in Tanzania. It is also known from further upriver in TRNPR and is therefore not considered in need of major intervention at this time. The efforts to preserve and extend the existing *Cynometra* rich forests 66, 67, and 68 should be sufficient.

On the other hand, the *Megalochlamys* appears to be very much « critically endangered » and immediate effort should be made, in conjunction with NMK, to collect some material and begin cultivation and multiplication. This plant will probably respond well to vegetative propagation, but seed collections should also be made. The TARDA nursery should hold a reservoir and supervise the eventual reintroduction programme to the forests when and where suitable.

Baboon control
Much ill feeling was expressed by villagers towards forest conservation and enlargement if this meant increased numbers of baboons. It was stated that, although TARDA had encouraged KWS to remove baboons from the area early in the history of the project, very

little was being done to keep the numbers under control. This is one of the prime opportunities for TARDA to repair its relationship with the local communities and thus baboon control must be made a priority.

Pastoralists

The conflict and distrust that exists between the two groups, the Pokomo on the one hand and the Wardey, Somali and Orma on the other, impacts negatively on all aspects of natural resource management. Efforts were being made by TARDA and at a political level to improve the situation. It is imperative that more effort is made towards understanding and integration. Part of the solution lies in ensuring that the pastoralists do not continue to feel ignored/dispossessed, and that the agriculturalists do not continue to feel threatened. A donor-funded rehabilitation project should include a component of livestock health and improvement alongside the suggested experimentation with irrigated fodder crops.

Community Development Projects – Income Generation

Tourism

It is well understood within TARDA management that there is a strong potential for tourism activities in the area. It is easily accessible to low budget tourists that travel by bus to Lamu. Offering an affordable night's stay/campsite with bird and monkey walks could encourage them to stop for a night on their way. Higher budget tourist who fly to Lamu or stay at Watamu/Malindi could be offered day trips. This income source can only be tapped if some investment is made in training local guides.

Mangos

The primates like mangos and so do the people, they grow fast, and often intermix with indigenous species. However, production during the fruiting season is greater than demand. In every village there is a huge pile of rotting, unused mangos from the last season. There is an urgent need to improve marketing and seek new markets for novel products: export dried mango; mango juice; mango jam; and mango yoghurt (there is never a shortage of milk there either!). Increased income from the Mango crop will directly improve the community's financial status and make conservation less of a luxury.

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REFERENCES

Andrews, P., Groves, C.P. & Horne, J.F.M., (1975). *Ecology of the lower Tana River flood plain (Kenya)*. J. East Afr. Nat. Hist. Soc & Nat. Mus. 151:1-31.

Beentje, H.J. (1993). *Kenya Trees, Shrubs and Lianas*. NMK, Nairobi.

Butynski, T.M. & Mwangi, G., (1994). *Conservation Status and Distribution of the Tana River Red Colobus and Crested Mangabey*. Report for: Zoo Atlanta, Kenya Wildlife Service, National Museums of Kenya, Institute of Primate Research, and East African Wildlife Society.

Critical Ecosystem Partnership Fund (CEPF). (2003). *The Ecosystem Profile of the Eastern Arc Mountains & Coastal Forests of Tanzania & Kenya Biodiversity Hotspot*.

Flora of Tropical East Africa (FTEA). (1952-). Authors Various. Crown Agents, London & Balkema, Rotterdam.

Gereau, R.E. & Luke, W.R.Q. (2003). *List of Potentially Threatened Plants of the Eastern Arc Mountains & Coastal Forests of Tanzania & Kenya Biodiversity Hotspot.* Unpublished Report. CEPF.

Glenday, J. (2005). *Preliminary Assessment of Carbon Storage and the Potential for Forestry Based Carbon Offset Projects in the Lower Tana River Forests of the Tana Delta Irrigation Project and the Tana River National Primate Reserve*. Unpublished Report to CEPF.

Hatfield, R. (2005). *Rehabilitation of TDIP (Tana River Irrigation Project) Polder 1: Rapid Environmental Impact Assessment - Socio-Economic Assessment*. Unpublished Report to CEPF.

IUCN. (2002). *The 2002 Red List of Threatened Species.* IUCN, Cambridge and Gland.
Kenya Indigenous Forest Conservation Project (KIFCON). (1993). *Tana River National Primate Reserve Forests Survey Report*. Unpublished Report.

Marsh, C. W. (1976). *A Management Plan for the Tana River Game Reserve*. Report to the Kenya Department of Wildlife Conservation and Management, Nairobi.

Medley, K. E., Kinnaird, M. F. & Decker, B. S. (1989). *A survey of the riverine forests in the Wema/Hewani vicinity with reference to development and the preservation of endemic primates and human resources*. Utafiti 2(1):1-6

Medley, K. E. (1992). *Patterns of forest diversity along the Tana River, Kenya*. Journal of Tropical Ecology 8:853-371

Mbora, D. N. M. (2003). *Habitat quality and fragmentation and the distribution and abundance of the Tana River red colobus* (Procolobus rufomitratus) *in eastern Kenya*. Ph. D. Dissertation. Miami University.

Mbora, D. N. M. & Meikle D.B. (2004). *Forest Fragmentation and the Distribution, Abundance and Conservation of the Tana River Red Colobus* (Procolobus rufomitratus)*.* Biological Conservation, 118:67–77

Nippon Koei Co. Ltd. (1998). *The Environmental Impact Study of Tana Delta Irrigation Project, Final Report*. African Biodiversity Institute Group. Unpublished

Njue, A. (1992). *The Tana River Forest, Kenya: hydrologic and edaphic factors as determinants of vegetation structure and function*. PhD Thesis, University of California, **Davis.**

Robertson, S.A. & Luke, W.R.Q. (1993). *Kenya Coastal Forests*. Unpublished report. WWF, Nairobi.

Wakuluzu: Friends of the Colobus Trust. (2005). *Census of the Tana River Red* Colobus (Procolobus rufomitratus*) and Tana River Crested Mangabey (*Cercocebus galeritus galeritus*) in the TDIP Area: Population and Distribution Changes 1972 – 2005.* Unpublished report to CEPF.

White, F. (1983). *The vegetation of Africa*. A descriptive memoir to accompany the UNESCO/AETFAT/UNSO Vegetation Map of Africa. Paris, UNESCO

Wieczkowski, J., Mbora, D.N.M., Kariuki, A., and Strum, S., (2002). *Tana River primate and habitat monitoring project*. Unpublished progress report for Conservation International – Margot Marsh Biodiversity Foundation.

Appendix 1. Terms of Reference for Botanical/Ecological study
Desk study

a) Carry out review of previous reports and surveys with regard to species inventories, forest composition, impacts and trends

b) Interpretation of Satellite/Aerial photos to give historical perspective on change in forest cover throughout range

Fieldwork

Rapid assessment of current status of forests in the project area, select methodology that can give rugged results in short period. Select with assistance from TARDA and train 2-3 community workers in survey techniques.

Visit each patch, set out permanent sample plots if feasible time-wise (part of long-term monitoring?)

Measure forest quality in terms of acceptable primate habitat – mean basal area of 14 food tree species (Mbora & Meikle 2004). Select 3 for survey? Spatial-temporal trends to help set priorities

Update species list (Robertson & Luke 1993) – comments on endangered/threatened species (IUCN 2002), potentially endangered/threatened species (Gereau & Luke 2003), and species of economic value to the local communities. Exotic species imported by previous development eg *Prosopis spp*

Measure of human impact on forest and compare level of impacts in different forests. Select methodology consistent with other CEPF projects (Frontiers TZ?)

Data Analysis and Report

Complete species identifications and analyse field data to produce recommendations in the following main areas:

A. Design and Impact of Woodlots

Selection criteria for exotics with minimum adverse affect
Estimate production figures and demand (from Socio-economic study)
Mix in suitable 'fast' growing indigenous species eg *Albizia versicolor*, *Milicia excelsa* and primate food species *Ficus sycomorus* etc, depending on ground water availability (distance from river)
Check potential invasive species eg Neem. *Prosopis* eradicate?

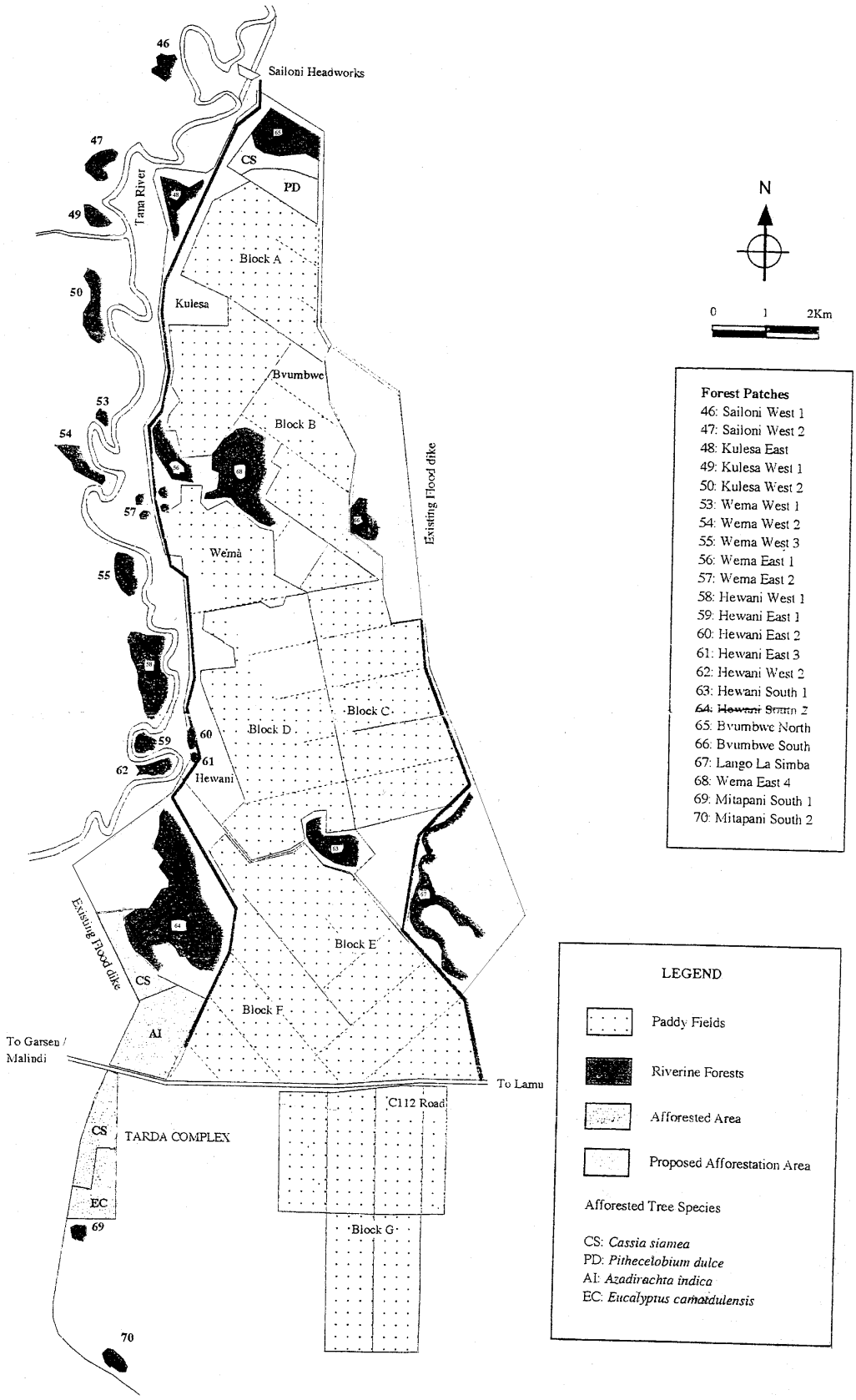
B. Corridors

Design as per primatologist recommendation (recent history of connectivity, the meta-population question)
Economics – land lost to scheme and per hectare cost of planting
Methodology – Nurseries, Planting schedule, Controls

Enrichment Planting
Selection of Sites
Selection of Species
Methodology (as per B above)

Orma
Design of corridors for access to water
Fencing necessary? Cheaper alternatives – provide water beyond project area or Pokomo cultivated strip?

Appendix 2. TARDA Figure 1-1-2. Distribution of Riverine Forests, Afforestation and Proposed Afforestation



Appendix 3. Species Checklist of the Tana Delta Irrigation Project (Families alphabetical)

SPECIES	FAMILY	Collector No.		Sublocality	Rarity	Phyto g	Habit	Local Name/Comment
Anisotes sp	Acanthaceae	R&L	sr	Forest 66 - Bvumbwe South		?	S	
Asystasia ansellioides C.B.Clarke	Acanthaceae	L	10731	Sailoni Village	RKC	3	H	photo
Asystasia gangetica (L.) T.Anderson s.l.	Acanthaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 – 653		5	WH	
Barleria ramulosa C.B.Clarke forma	Acanthaceae	R&L	5340	Forest 66 - Bvumbwe South		2X	WH	Glandular form
Ecbolium amplexicaule S.Moore	Acanthaceae	R&L	5341	Forest 66 - Bvumbwe South		2	S	
Elytraria acaulis (L.f.) Lindau	Acanthaceae	L	sr063	Forest 67 - Lango la Simba, Pt 666 - 66		4	H	
Justicia schimperiana (Nees) Lindau	Acanthaceae	R&L	5328	Forest 66 - Bvumbwe South		3	WH	
Justicia stachytarphetoides (Lindau) C.B.Clarke	Acanthaceae	R&L	5337	Forest 66 - Bvumbwe South	RK?	2	WH	
Megalochlamys tanaensis Vollesen	Acanthaceae	L	10727	Forest 68 - Wema East4, Pt 657 - 659	R	1	WH	photo. RARE ENDEMIC. 2nd Collection
Megalochlamys trinervia (C.B.Clarke) Vollesen	Acanthaceae	L	10726	Forest 68 - Wema East4, Pt 658		2X	WH	photo
Rhinacanthus gracilis Klotzsch	Acanthaceae	R&L	5338	Forest 66 - Bvumbwe South		4	WH	
Ruellia amabilis S.Moore	Acanthaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		3	WH	
Ruellia patula Jacq.	Acanthaceae	L	sr053	Forest 48 - Kulesa East, Pt 654 - 656		5	WH	
Glinus oppositifolius (L.) A.DC.	Aizoaceae	L	sr112	Forest 63 - Hewani South1, Pt 670		5	H	
Alangium salviifolium (L.f.) Wangerin ssp salviifolium	Alangiaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653	RK?	5	ST	MULUNAE, MULONAE, MNUNAE*

Limnophyton obtusifolium (L.) Miq.	Alismataceae	R&L	5324	Forest 66 - Bvumbwe South	RKC	5	H	
Achyranthes aspera L.	Amaranthaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		5	WH	
Cyathula coriacea Schinz	Amaranthaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		2X	WH	
Digera muricata (L.) Mart. ssp trinervis C.C.Towns. var trinervis	Amaranthaceae	L	sr	Nr Wema		4	WH	
Gomphrena celosioides Mart.	Amaranthaceae	L	sr	Nr Wema		5	H	
Psilotrichum scleranthum Thwaites	Amaranthaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		5	WH	
Pupalia lappacea (L.) A.Juss.	Amaranthaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		2/5	WH	
Rosifax sabuletorum C.C.Towns.	Amaranthaceae	L	10760	Forest 63 - Hewani South1, Pt 670	R?	2X	WH	1st Tana District
Crinum sp	Amaryllidaceae	L	sr	Nr Wema		?	H	
Scadoxus multiflorus (Martyn) Raf. ssp multiflorus	Amaryllidaceae	L&R	sr	Forest 65 - Bvumbwe North		5	H	
Lannea schweinfurthii (Engl.) Engl. var stuhlmannii (Engl.) Kokwaro	Anacardiaceae	L	sr	Wema Forest Patch pt 665		4	T	MHANDARAKU*
Mangifera indica L.	Anacardiaceae	L	sr001	Forest 59 - Hewani East1, Pt 669		5	T	Naturalised. MUEMBE*
Rhus natalensis Krauss	Anacardiaceae	R&L	5353	Forest 66 - Bvumbwe South		5	ST	
Sorindeia madagascariensis DC.	Anacardiaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		5	T	MWAMBEMBE, MNYAMBEMBE
Annona muricata L.	Annonaceae	L	sr035	Forest 59 - Hewani East1, Pt 669		5	ST	Cultivated
Asteranthe asterias (S.Moore) Engl. & Diels ssp asterias	Annonaceae	L	sr066	Forest 48 - Kulesa East, Pt 654 - 656		2	ST	

Monanthotaxis trichocarpa (Engl. & Diels) Verdc.	Annonaceae	L	10703	Forest 65 - Bvumbwe North, Pt 652 - 653		2	SS	
Uvaria leptocladon Oliv. ssp septentrionalis Verdc.	Annonaceae	R&L	5344	Forest 66 - Bvumbwe South		3	SS	MUNDAGONI
Uvaria lucida Benth. ssp lucida	Annonaceae	L	10753	Forest 63 - Hewani South1, Pt 670		2	SS	MUNDAGONI
Chlorophytum comosum (Thunb.) Jacq.	Anthericaceae	R&L	5343	Forest 66 - Bvumbwe South		4	H	
Chlorophytum sp	Anthericaceae	L	10772	Forest 64 - Hewani South2, Pt 673 - 674		?	H	
Adenium obesum (Forssk.) Roem. & Schult.	Apocynaceae	L	sr	nr Forest 66 - Bvumbwe South, Pt 661 -		4	ST	
Alafia caudata Stapf	Apocynaceae	L	10775	Forest 69 - Mitapani South1, Pt 680	RK	4	L	
Alafia microstylis K.Schum.	Apocynaceae	L	10709	Forest 65 - Bvumbwe North, Pt 652 - 653		3	L	
Carissa spinarum L.	Apocynaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		4	S	MUYAANSI
Hunteria zeylanica (Retz.) Thwaites	Apocynaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		3	ST	COMBS. MTSUNGUSUNGU
Landolphia watsoniana Romburgh	Apocynaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653	RK	2	L	
Oncinotis tenuiloba Stapf	Apocynaceae	L	10720	Forest 48 - Kulesa East, Pt 654 - 656	RK	5	L	MUMBUU
Saba comorensis (Bojer) Pichon	Apocynaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		4	L	MAUNGO, MUUNGO
Schizozygia coffaeoides Baill.	Apocynaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		2	S	
Strophanthus courmontii Franch.	Apocynaceae	R&L	5313	Forest 57 - Wema East2		3	L	MUBONGWENA
Culcasia orientalis Mayo	Araceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		2	L	MHUNAYULIMI, MHUNAJWIMI
Gonatopus boivinii (Decne.) Engl.	Araceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		4	H	

Pistia stratiotes L.	Araceae	R&L	sr	Forest 66 - Bvumbwe South		5	H	
Marsdenia sp cf macrantha (Klotzsch) Schltr.	Asclepiadaceae (Apocynaceae)	L	10776	Forest 69 - Mitapani South1, Pt 680	RKC?	3?	L	
Pentatropis nivalis (J.F.Gmel.) D.V.Field & J.R.L.Wood	Asclepiadaceae (Apocynaceae)	L	sr012	Forest 64 - Hewani South2, Pt 673 - 674		5	L	MUNYAMIA
Pergularia daemia (Forssk.) Chiov.	Asclepiadaceae (Apocynaceae)	L&R	sr	Forest 65 - Bvumbwe North		5	L	
Tacazzea apiculata Oliv.	Asclepiadaceae (Apocynaceae)	R&L	5354	Forest 66 - Bvumbwe South		4	L	HONDO
Tylophora apiculata K.Schum.	Asclepiadaceae (Apocynaceae)	R&L	5308	Forest 60 - Hewani East2	R	2	L	
Azolla nilotica Mett.	Azollaceae	R&L	sr	Forest 66 - Bvumbwe South	RKC	3	F	
Kigelia africana (Lam.) Benth.	Bignoniaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		4	T	M'BWOKA
Spathodea campanulata P.Beauv. ssp nilotica (Seem.) Bidgood ined.	Bignoniaceae	L	sr063	Forest 61 - Hewani East3, Pt 672		4	T	Planted
Cordia faulknerae Verdc.	Boraginaceae	L&R	1256	Forest 68 - Wema East4		2	SS	
Cordia goetzei Guerke	Boraginaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		4	T	MDOKO
Cordia sinensis Lam.	Boraginaceae	L	sr001	Forest 66 - Bvumbwe South, Pt 661 - 664		5	T	MUHALI
Commiphora africana (A.Rich.) Engl. ?	Burseraceae	R&L	sr	Forest 66 - Bvumbwe South		2X/4	ST	
Commiphora campestris Engl. ssp glabrata (Engl.) Gillett	Burseraceae	L	sr013	Forest 69 - Mitapani South1, Pt 680		3	T	MUNSUNSU

Afzelia quanzensis Welw.	Caesalpiniaceae (Leguminosae)	L	sr064	Forest 61 - Hewani East3, Pt 672		4	T	Planted
Caesalpinia volkensii Harms	Caesalpiniaceae (Leguminosae)	L	sr094	Forest 69 - Mitapani South1, Pt 680		3	L	
Cassia abbreviata Oliv. Ssp beareana (Holmes) Brenan	Caesalpiniaceae (Leguminosae)	L	sr088	Forest 64 - Hewani South2, Pt 673 - 674		4	T	
Cynometra lukei Beentje	Caesalpiniaceae (Leguminosae)	L&R	1253	Forest 68 - Wema East4	R	2	T	MKUNUMBI, MPAKATA
Oxystigma msoo Harms	Caesalpiniaceae (Leguminosae)	L&R	1240	Forest 61 - Hewani East3	RK	2	T	MTSO, MCHO?
Parkinsonia aculeata L.	Caesalpiniaceae (Leguminosae)	L	sr003	Forest 64 - Hewani South2, Pt 673 - 674		5	ST	Exotic
Senna occidentalis (L.) Link	Caesalpiniaceae (Leguminosae)	L&R	sr	Forest 65 - Bvumbwe North		5	S	
Senna singueana (Delile) Lock	Caesalpiniaceae (Leguminosae)	R&L	sr	Forest 60 - Hewani East2		5	ST	MUBARAKA
Tamarindus indica L.	Caesalpiniaceae (Leguminosae)	L	sr047	Forest 48 - Kulesa East, Pt 654 - 656		5	T	MKWAYU
Cadaba farinosa Forssk. ssp farinosa	Capparaceae	L	10734	Wema Forest Patch pt 665		5	S	
Capparis sepiaria L. var subglabra (Oliv.) DeWolf	Capparaceae	L	10733	Wema Forest Patch pt 665		4	L	
Capparis viminea Oliv.	Capparaceae	L	sr017	Forest 48 - Kulesa East, Pt 654 - 656		4	L	HAMWALI. Cough Medicine
Maerua grantii Oliv.	Capparaceae	L	sr049	Forest 66 - Bvumbwe South, Pt 661 - 664		3	S	MUSANAMAKI
Maerua holstii Pax	Capparaceae	L	sr044	Forest 48 - Kulesa East, Pt 654 - 656		3	SS	
Maerua kirkii (Oliv.) F.White	Capparaceae	L	10715	Forest 48 - Kulesa East, Pt 654 - 656		3	ST	
Maerua macrantha Gilg?	Capparaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		3?	SS	
Ritchiea capparoides (Andr.) Britten	Capparaceae	L&R	1242	Forest 65 - Bvumbwe North		4	SS	MUHI YA FIGO
Thilachium thomasii Gilg	Capparaceae	R&L	sr	Forest 66 - Bvumbwe South		3	ST	

Gymnosporia heterophylla (Eckl. & Zeyh.) Loes.	Celastraceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		4	ST	
Loeseneriella africana (Willd.) N.Halle var richardiana (Cambess.) N.Halle	Celastraceae	L	sr029	Forest 68 - Wema East4, Pt 657 - 659		4	L	CHII
Maytenus undata (Thunb.) Blakelock	Celastraceae	R&L	5332	Forest 66 - Bvumbwe South		5	T	
Salacia erecta (G.Don) Walp.	Celastraceae	L	10710	Forest 65 - Bvumbwe North, Pt 652 - 653		4	L	
Salacia stuhlmanniana Loes.	Celastraceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		3	L	IMPO
Combretum butyrosum (G.Bertol.) Tul.	Combretaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653	RK?	2	L	
Combretum constrictum (Benth.) Laws.	Combretaceae	L	10732	Forest 66 - Bvumbwe South, Pt 661 - 664		4	L	MUSUNGUJAI. Frt causes hiccups!
Combretum hereroense Schinz ssp volkensii (Engl.) Wickens var parvifolium (Engl.) Wickens	Combretaceae	L	10755	Forest 63 - Hewani South1, Pt 670		2X	ST	
Combretum paniculatum Vent. ssp paniculatum	Combretaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		4	L	
Pteleopsis tetraptera Wickens	Combretaceae	L&R	1260	Forest 68 - Wema East4		2	T	MKURUBO BARA
Terminalia brevipes Pampan.	Combretaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		3	ST	MKOKOA
Aneilema calceolus Brenan	Commelinaceae	L	10777	Forest 69 - Mitapani South1, Pt 680	RK	2	H	
Commelina benghalensis L.	Commelinaceae	L	sr069	Forest 67 - Lango la Simba, Pt 666 - 66		5	H	
Commelina bracteosa Hassk.	Commelinaceae	L	10750	Forest 63 - Hewani South1, Pt 670		4	H	
Commelina erecta L.	Commelinaceae	L&R	1248	Forest 65 - Bvumbwe North		3	H	
Commelina sp cf petersii Hassk.	Commelinaceae	L	10778	Forest 69 - Mitapani South1, Pt 680	RKC?	3?	H	
Aspilia mossambicensis (Oliv.) Wild	Compositae (Asteraceae)	L	sr023	Forest 59 - Hewani East1, Pt 669		4	S	

Blepharispermum ellenbeckii Cufod.?	Compositae (Asteraceae)	R&G	6595	Forest 68 - Wema East4	RKC?	2X?	S	
Eclipta prostrata (L.) L.	Compositae (Asteraceae)	R&L	5312	Hewani to Wema		5	WH	
Launaea cornuta (Oliv. & Hiern) C.Jeffrey	Compositae (Asteraceae)	L	sr	Nr Wema		4	H	
Microglossa hildebrandtii O.Hoffm.	Compositae (Asteraceae)	R&L	5351	Forest 66 - Bvumbwe South		2	SS	RIJI
Pluchea dioscoridis (L.) DC.	Compositae (Asteraceae)	L	sr002	Forest 69 - Mitapani South1, Pt 680		5	S	
Pluchea ovalis (Pers.) DC.	Compositae (Asteraceae)	L	10748	Forest 63 - Hewani South1, Pt 670	RKC	4	S	
Tridax procumbens L.	Compositae (Asteraceae)	L	sr049	Forest 61 - Hewani East3, Pt 672		5	H	
Vernonia aemulans Vatke?	Compositae (Asteraceae)	L	10761	Forest 63 - Hewani South1, Pt 670		4?	WH	
Vernonia cinerea (L.) Less. var cinerea	Compositae (Asteraceae)	L	sr029	Forest 59 - Hewani East1, Pt 669		5	WH	
Vernonia hildebrandtii Vatke	Compositae (Asteraceae)	L	sr006	Forest 48 - Kulesa East, Pt 654 - 656		3	SS	MALIWASA
Agelaea pentagyna (Lam.) Baill.	Connaraceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		5	L	
Hewittia malabarica (L.) Suresh	Convolvulaceae	L&R	sr	Forest 65 - Bvumbwe North		5	L	
Ipomoea aquatica Forssk.	Convolvulaceae	L	sr054	Forest 61 - Hewani East3, Pt 672		5	L	
Ipomoea garckeana Vatke	Convolvulaceae	L	sr012	Forest 56 - Wema East1, Pt 660		3	L	
Ipomoea shupangensis Baker	Convolvulaceae	L	10704	Forest 65 - Bvumbwe North, Pt 652 - 653	RK	4	L	1st Tana District
Jacquemontia ovalifolia (Vahl) Hallier f.	Convolvulaceae	L	sr	Nr Wema	RKC	4	L	
Coccinia grandis (L.) Voigt	Cucurbitaceae	L	sr006	Forest 56 - Wema East1, Pt 660		5	L	

Kedrostis abdallai A.Zimm.	Cucurbitaceae	L	10735	Wema Forest Patch pt 665		3	L	
Kedrostis foetidissima (Jacq.) Cogn.	Cucurbitaceae	L	10752	Forest 63 - Hewani South1, Pt 670		5	L	
Momordica trifoliolata Hook.f.	Cucurbitaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		5	L	MHOMBOHOMBO. Smoke for bees
Bolboschoenus maritimus (L.) Palla	Cyperaceae	L	10744	nr 63	RKC	5	H	
Dichapetalum sp 1 of CFS	Dichapetalaceae	L	10717	Forest 48 - Kulesa East, Pt 654 - 656	R?	1?	SS	
Sansevieria conspicua N.E.Br.	Dracaenaceae	R&L	sr	Forest 66 - Bvumbwe South		4	S	
Sansevieria powellii N.E.Br.	Dracaenaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		3	S	
Diospyros abyssinica (Hiern) F.White ssp abyssinica	Ebenaceae	L	10706	Forest 65 - Bvumbwe North, Pt 652 - 653		4	T	MUYUHI
Diospyros bussei Guerke	Ebenaceae	R&L	sr	Forest 66 - Bvumbwe South		2	T	
Diospyros consolatae Chiov.	Ebenaceae	R&L	sr	Forest 66 - Bvumbwe South		3	ST	
Diospyros ferrea (Willd.) Bakh.	Ebenaceae	L&R	1258	Forest 68 - Wema East4		5	T	MUNYIZA, MNYIZA
Diospyros greenwayi F.White	Ebenaceae	L	10728	Forest 68 - Wema East4, Pt 657 - 659		2	ST	MUNYISA
Diospyros kabuyeana F.White	Ebenaceae	L	10770	Forest 64 - Hewani South2, Pt 673 - 674		2	T	
Diospyros mespiliformis A.DC.	Ebenaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		4	T	MKURU
Diospyros natalensis (Harv.) Brenan	Ebenaceae	L&R	1255	Forest 68 - Wema East4		5	ST	1st Tana District?
Euclea divinorum Hiern	Ebenaceae	L	10768	Forest 64 - Hewani South2, Pt 673 - 674		4	ST	2nd Tana District?

Euclea racemosa Murr. Ssp schimperi (A.DC.) F.White ?	Ebenaceae	L	10741	Forest 67 - Lango la Simba, Pt 666 - 66		4?	ST	
Erythroxylum fischeri Engl.	Erythroxylaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653	RKC	4	ST	MLUHI-NDERA. POLES
Acalypha echinus Pax & K.Hoffm.	Euphorbiaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		2	S	MVUNJA KIUNDU
Acalypha fruticosa Forssk.	Euphorbiaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		3/5	S	
Acalypha indica L.	Euphorbiaceae	L	sr006	Forest 64 - Hewani South2, Pt 673 - 674		5	WH	
Antidesma venosum Tul.	Euphorbiaceae	L	10757	Forest 63 - Hewani South1, Pt 670		4?	ST	MSANSUZI*
Bridelia cathartica G.Bertol.	Euphorbiaceae	L&R	sr	Forest 65 - Bvumbwe North		4	ST	
Bridelia micrantha (Hochst.) Baill.	Euphorbiaceae	L	sr044	Forest 59 - Hewani East1, Pt 669		4	T	MKULOTSO
Caperonia fistulosa Beille	Euphorbiaceae	L&R	1251	Forest 65 - Bvumbwe North		4	WH	
Croton menyharthii Pax	Euphorbiaceae	R&L	sr	Forest 66 - Bvumbwe South		4	S	MWALIKADJI
Dalechampia scandens L. var cordofana (Webb) Muell.Arg.	Euphorbiaceae	R&O	6424	nr Wema		5	L	
Drypetes natalensis (Harv.) Hutch. var leiogyna Brenan	Euphorbiaceae	L	sr032	Forest 69 - Mitapani South1, Pt 680		2	T	
Erythrococca kirkii (Muell.Arg.) Prain	Euphorbiaceae	L&R	sr	Forest 65 - Bvumbwe North		3	S	
Euphorbia indica Lam.	Euphorbiaceae	R&L	5309	Hewani-Wema		5	H	
Euphorbia tirucalli L.	Euphorbiaceae	R&L	sr	Forest 66 - Bvumbwe South		5	ST	MTONGTONGO
Flueggea virosa (Willd.) Voigt ssp virosa	Euphorbiaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		5	ST	MUKWAMBA
Phyllanthus reticulatus Poir.	Euphorbiaceae	L	sr013	Forest 67 - Lango la Simba, Pt 666 - 66		5	S	
Phyllanthus somalensis Hutch.	Euphorbiaceae	R&L	sr	Forest 66 - Bvumbwe South		2X	S	

Ricinus communis L.	Euphorbiaceae	L	sr055	Forest 61 - Hewani East3, Pt 672		5	S	MUBONYE. Naturalised
Spirostachys venenifera (Pax) Pax	Euphorbiaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		3	T	MCHALAKA, MTSAKA
Suregada zanzibariensis Baill.	Euphorbiaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		5	ST	
Tragia furialis Bojer	Euphorbiaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		5	L	UGENI
Tragia hildebrandtii Muell.Arg.	Euphorbiaceae	R&L	5311	Hewani-Wema		3	H	
Flagellaria guineensis Schumach.	Flagellariaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		4	SS	MURHURHUKI, MURHURHUCHI
Enicostema axillare (Lam.) A.Raynal ssp axillare	Gentianaceae	L&R	1249	Forest 65 - Bvumbwe North		5	H	
Brachiaria 2	Gramineae (Poaceae)	L	10721	Forest 48 - Kulesa East, Pt 654 - 656		?	H	
Brachiaria 3	Gramineae (Poaceae)	L	10754	Forest 63 - Hewani South1, Pt 670		?	H	
Brachiaria xantholeuca?	Gramineae (Poaceae)	L	sr026	Forest 64 - Hewani South2, Pt 673 - 674		?	H	
Cyrtococcum trigonum (Retz.) A.Camus	Gramineae (Poaceae)	L	sr083	Forest 64 - Hewani South2, Pt 673 - 674		5	H	
Indet	Gramineae (Poaceae)	L	10742	Forest 67 - Lango la Simba, Pt 666 - 66		?	H	
Oryza eichingeri Peter	Gramineae (Poaceae)	L	10756	Forest 63 - Hewani South1, Pt 670	RKC	5	H	
Oryza longistaminata A.Chev. & Rochr.	Gramineae (Poaceae)	L	10763	Pt 671	RK	5	H	
Panicum maximum Jacq.	Gramineae (Poaceae)	L	sr022	Forest 66 - Bvumbwe South, Pt 661 - 664		4	H	
Panicum sp	Gramineae (Poaceae)	L	sr057	Forest 66 - Bvumbwe South, Pt 661 - 664		?	H	
Sorghum arundinaceum (Desv.) Stapf	Gramineae (Poaceae)	L	sr038	Forest 59 - Hewani East1, Pt 669		5	H	

Stenotaphrum dimidiatum (L.) Brongn.	Gramineae (Poaceae)	R&L	5323	Forest 66 - Bvumbwe South		5	H	
Garcinia livingstonei T.Anderson	Guttiferae (Clusiaceae)	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		4	T	MCHOCHOZI, MPEKETSO. FRTS, UJI
Ottelia exerta (Ridley) Dandy	Hydrocharitaceae	R&L	5333	Forest 66 - Bvumbwe South	RKC	4	H	
Iodes usambarensis Sleumer	Icacinaceae	L	10774	Forest 69 - Mitapani South1, Pt 680	RK	2	L	
Basilicum polystachyon (L.) Moench	Labiatae (Lamiaceae)	L	sr040	Forest 67 - Lango la Simba, Pt 666 - 66		4	H	
Clerodendrum acerbianum (Vis.) Benth. & Hook.f.	Labiatae (Lamiaceae)	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		3	S	MPUMPU
Leucas urticifolia (Vahl) R.Br. var angustifolia Sebald	Labiatae (Lamiaceae)	L	10767	Forest 64 - Hewani South2, Pt 673 - 674	RKC	2X	WH	
Premna velutina Guerke	Labiatae (Lamiaceae)	L	10711	Forest 65 - Bvumbwe North, Pt 652 - 653		3	SS	
Barringtonia racemosa (L.) Spreng.	Lecythidaceae	R&L	sr	Forest 60 - Hewani East2		5	ST	MTOLO
Lemna sp	Lemnaceae	R&L	sr	Forest 66 - Bvumbwe South		5	H	
Utricularia inflexa Forssk. var inflexa	Lentibulariaceae	R&L	5346	Forest 66 - Bvumbwe South	RKC	5	H	
Strychnos mitis S.Moore	Loganiaceae	L	10713	Forest 48 - Kulesa East, Pt 654 - 656		4	T	MUWARE

Agelanthus sansibarensis (Engl.) Polh. & Wiens ssp sansibarensis	Loranthaceae	R&L	sr	Forest 66 - Bvumbwe South		3	P	MNYUNI
Oncella curviramea (Engl.) Danser	Loranthaceae	L	sr111	Forest 63 - Hewani South1, Pt 670		2	P	on Indigofera
Nesaea stuhlmannii Koehne	Lythraceae	L&R	1250	Forest 65 - Bvumbwe North	RK	2	WH	
Abutilon pannosum (Forst.f.) Schlecht.	Malvaceae	R&O	6425	nr Wema		5	WH	
Abutilon zanzibaricum Mast.	Malvaceae	L	10749	Forest 63 - Hewani South1, Pt 670		3	WH	
Hibiscus calyphyllus Cav.	Malvaceae	L	sr057	Forest 48 - Kulesa East, Pt 654 - 656	RKC?	2X?	WH	
Hibiscus cannabinus L.	Malvaceae	L	sr	Nr Wema		4	WH	
Hibiscus hildebrandtii Sprague & Hutch.?	Malvaceae	L	sr072	Forest 67 - Lango la Simba, Pt 666 - 66		3?	WH	
Hibiscus micranthus L.f.	Malvaceae	L&R	sr	Forest 65 - Bvumbwe North		5	WH	MVUNJAHUKUMU
Hibiscus panduriformis Burm.f.	Malvaceae	L	10719	Nr Wema	RKC	5	WH	
Thespesia danis Oliv.	Malvaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		3	ST	MUORO, MUDANISA
Marsilea fadeniana Launert?	Marsileaceae	R&L	5318	Forest 66 - Bvumbwe South	R	2	F	
Azadirachta indica A.Juss.	Meliaceae	L	sr008	Forest 59 - Hewani East1, Pt 669		5	T	Exotic invasive
Ekebergia capensis Sparrm.	Meliaceae	L	10779	Forest 69 - Mitapani South1, Pt 680	RKC	4	T	
Trichilia emetica Vahl	Meliaceae	L&R	sr	Forest 65 - Bvumbwe North		5	T	MUWAHI*

Anisocycla blepharosepala Diels ssp tanzaniensis Vollesen	Menispermaceae	L	10707	Forest 65 - Bvumbwe North, Pt 652 - 653		2	L	
Cissampelos mucronata A.Rich.	Menispermaceae	L	10746	Forest 59 - Hewani East1, Pt 669	RKC	4	L	MUCHOVE
Cissampelos pareira L. var hirsuta (DC.) Forman	Menispermaceae	L&R	sr	Forest 65 - Bvumbwe North		5	L	
Tiliacora funifera (Miers) Oliv.	Menispermaceae	L	sr080	Forest 63 - Hewani South1, Pt 670		4	L	
Acacia mellifera (Vahl) Benth.	Mimosaceae (Leguminosae)	L	sr031	Forest 68 - Wema East4, Pt 657 - 659		4	T	MUSOVASA
Acacia pentagona (Schumach. & Thonn.) Hook.f.	Mimosaceae (Leguminosae)	L&R	1241	Forest 61 - Hewani East3		4	L	TSEHWAA. 1st Tana Distr?
Acacia robusta Burch. Ssp usambarensis (Taub.) Brenan	Mimosaceae (Leguminosae)	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		3	T	MUNGA. CHARCOAL
Acacia rovumae Oliv.	Mimosaceae (Leguminosae)	L	sr033	Forest 48 - Kulesa East, Pt 654 - 656		3	T	MUNGA NGOWE*
Acacia senegal (L.) Willd.	Mimosaceae (Leguminosae)	L	sr058	Forest 61 - Hewani East3, Pt 672		4	T	
Acacia stuhlmannii Taub.	Mimosaceae (Leguminosae)	L	sr001	Forest 64 - Hewani South2, Pt 673 - 674		4	ST	MUDSEDSEWE
Acacia zanzibarica (S.Moore) Taub. var zanzibarica	Mimosaceae (Leguminosae)	R&L	sr	Forest 66 - Bvumbwe South		3	ST	MURIELLA
Albizia glaberrima (Schumach. & Thonn.) Benth. var glabrescens (Oliv.) Brenan	Mimosaceae (Leguminosae)	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		4	T	MPHUMPE, MSADSASUMBII. CANOES
Albizia saman (Jacq.) F.Muell.	Mimosaceae (Leguminosae)	L	sr059	Forest 66 - Bvumbwe South, Pt 661 - 664		5	T	Exotic
Leucaena latisiliqua (L.) Gillis	Mimosaceae (Leguminosae)	L	sr069	Forest 61 - Hewani East3, Pt 672		5	ST	Exotic
Mimosa pigra L.	Mimosaceae (Leguminosae)	R&L	5347	Forest 66 - Bvumbwe South		5	S	
Neptunia oleracea Lour.	Mimosaceae (Leguminosae)	L	sr	nr Forest 67		5	WH	
Newtonia erlangeri (Harms) Brenan	Mimosaceae (Leguminosae)	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		2	T	MUKAMI. CHARCOAL
Pithecellobium dulce (Roxb.) Benth.	Mimosaceae (Leguminosae)	L	sr059	Forest 61 - Hewani East3, Pt 672		5	T	Exotic

Prosopis juliflora DC.	Mimosaceae (Leguminosae)	L	sr059	Forest 67 - Lango la Simba, Pt 666 - 66	5	T	Exotic
Ficus bubu Warb.	Moraceae	L	sr093	Forest 48 - Kulesa East, Pt 654 - 656	4	T	
Ficus bussei Mildbr. & Burret	Moraceae	L	sr065	Forest 48 - Kulesa East, Pt 654 - 656	3	T	HIDOLE
Ficus natalensis Hochst.	Moraceae	L	sr047	Forest 56 - Wema East1, Pt 660	4	T	HIDOLE, MVUMA*
Ficus scassellatii Pamp. ssp scassellatii	Moraceae	L	10729	Forest 68 - Wema East4, Pt 657 - 659	4	T	
Ficus sycomorus L.	Moraceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653	5	T	MKUYU, MKUJU*. CANOES
Eugenia capensis (Eckl. & Zeyh.) Sond. ssp multiflora Verdc.	Myrtaceae	R&L	5326	Forest 66 - Bvumbwe South	2	ST	
Eugenia nigerina A.Chev.	Myrtaceae	L&R	1259	Forest 68 - Wema East4	3	S	
Boerhavia erecta L.	Nyctaginaceae	L	sr012	Forest 61 - Hewani East3, Pt 672	4	WH	
Nymphaea lotus L.	Nymphaeaceae	L	sr056	Forest 61 - Hewani East3, Pt 672	5	H	
Ochna thomasiana Engl. & Gilg	Ochnaceae	R&L	5317	Forest 66 - Bvumbwe South	2	ST	
Ximenia americana L. var caffra (Sond.) Engl.	Olacaceae	R&L	sr	Forest 66 - Bvumbwe South	4	ST	
Jasminum fluminense Vell.	Oleaceae	L	sr039	Forest 63 - Hewani South1, Pt 670	4	L	

Opilia amentacea Roxb.	Opiliaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		4	L	
Microcoelia exilis Lindl.?	Orchidaceae	R&L	5322	Forest 66 - Bvumbwe South		4?	E	
Borassus aethiopum Mart.	Palmae (Arecaceae)	R&L	sr	Forest 66 - Bvumbwe South		4	T	MHABFA*
Elaeis guineensis Jacq.	Palmae (Arecaceae)	L	sr022	Forest 59 - Hewani East1, Pt 669		5	T	MUVUTSE
Hyphaene compressa H.Wendl.	Palmae (Arecaceae)	R&L	sr	Forest 66 - Bvumbwe South		3	T	MKOMA
Phoenix reclinata Jacq.	Palmae (Arecaceae)	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		4	T	MKINDU
Abrus precatorius L. ssp africanus Verdc.	Papilionaceae (Leguminosae)	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		5	L	
Aeschynomene uniflora E.Mey. var uniflora	Papilionaceae (Leguminosae)	R&L	5348	Forest 66 - Bvumbwe South		5	WH	1st Tana District?
Alysicarpus glumaceus (Vahl) DC. ssp glumaceus var glumaceus	Papilionaceae (Leguminosae)	R&L	5349	Forest 66 - Bvumbwe South	RKC	5	WH	MGOMBA NFOFI?
Angylocalyx braunii Harms	Papilionaceae (Leguminosae)	L	10758	Forest 63 - Hewani South1, Pt 670		2	ST	
Clitorea ternatea L.	Papilionaceae (Leguminosae)	L	sr015	Forest 56 - Wema East1, Pt 660		5	L	
Crotalaria laburnoides Klotzsch var laburnoides	Papilionaceae (Leguminosae)	L	10762	Forest 63 - Hewani South1, Pt 670		5	WH	
Dalbergia vacciniifolia Vatke	Papilionaceae (Leguminosae)	R&L	5329	Forest 66 - Bvumbwe South		2	SS	
Indigofera schimperi Jaub. & Spach var schimperi	Papilionaceae (Leguminosae)	L	10736	Forest 67 - Lango la Simba, Pt 666 - 66		4	S	
Rhynchosia micrantha Harms	Papilionaceae (Leguminosae)	L	10765 A	Forest 61 - Hewani East3, Pt 672		4	L	
Rhynchosia minima (L.) DC. var minima	Papilionaceae (Leguminosae)	L	10730 B	Forest 56 - Wema East1, Pt 660		5	L	

Rhynchosia sp	Papilionaceae (Leguminosae)	L	sr007	Forest 67 - Lango la Simba, Pt 666 - 66		?	L	
Rhynchosia sublobata (Schumach.) Meikle	Papilionaceae (Leguminosae)	L	10765 B	Forest 63 - Hewani South1, Pt 670		5	L	
Sesbania quadrata Gillett	Papilionaceae (Leguminosae)	L	sr	Nr Wema	RKC	3	WH	
Sesbania speciosa Taub.	Papilionaceae (Leguminosae)	R&L	5350	Forest 66 - Bvumbwe South	RK	2	WH	
Teramnus labialis (L.f.) Spreng. ssp arabicus Verdc.	Papilionaceae (Leguminosae)	L	10766	Forest 61 - Hewani East3, Pt 672		5	L	
Adenia gummifera (Harv.) Harms var gummifera	Passifloraceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		4	L	
Adenia rumicifolia Engl.?	Passifloraceae	L	sr040	Forest 59 - Hewani East1, Pt 669		4?	L	
Polygala sadebeckiana Guerke	Polygalaceae	L	10743	Forest 67 - Lango la Simba, Pt 666 - 66		4	WH	
Persicaria senegalense (Meisn.) Sojak	Polygonaceae	L	sr	Nr Wema	RKC?	5	WH	
Talinum portulacifolium (Forssk.) Schweinf.	Portulacaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		4	H	MUNONO
Scutia myrtina (Burm.f.) Kurz	Rhamnaceae	L	sr046	Forest 67 - Lango la Simba, Pt 666 - 66		5	L	
Ziziphus mauritiana Lam.	Rhamnaceae	L	sr044	Forest 61 - Hewani East3, Pt 672		5	ST	
Cassipourea gummiflua Tul. ? var ugandensis (Stapf) J.Lewis	Rhizophoraceae	L	10718	Forest 48 - Kulesa East, Pt 655	RK	?	T	1st Tana District
Afrocanthium peteri (Bridson) Lantz	Rubiaceae	L	10724	Forest 68 - Wema East4, Pt 657 - 659	RK	2	ST	

Canthium mombazense Baill.	Rubiaceae	R&L	5335	Forest 66 - Bvumbwe South		3	ST	
Catunaregam sp nov	Rubiaceae	L	10714	Forest 48 - Kulesa East, Pt 654 - 656		2	ST	Previously known as Catunaregam spinosa
Coffea sessiliflora Bridson ssp sessiliflora	Rubiaceae	R&L	5336	Forest 66 - Bvumbwe South		1	ST	
Gardenia volkensii K.Schum. ssp volkensii	Rubiaceae	L	10751	Forest 63 - Hewani South1, Pt 670		4	ST	
Geophila repens (L.) I.M.Johnston	Rubiaceae	L	sr094	Forest 48 - Kulesa East, Pt 654 - 656	RKC	5	H	
Ixora narcissodora K.Schum.	Rubiaceae	L&R	1246	Forest 65 - Bvumbwe North		3	ST	MPAMAWANO
Keetia zanzibarica (Klotzsch) Bridson ssp zanzibarica	Rubiaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		2	SS	
Kohautia obtusiloba (Hiern) Bremek.	Rubiaceae	R&L	5310	Hewani-Wema		2	H	
Kraussia kirkii (Hook.f.) Bullock	Rubiaceae	L&R	1257	Forest 68 - Wema East4		2	S	MUKUANO
Lamprothamnus zanguebaricus Hiern	Rubiaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		2	ST	MUTSOME
Pavetta linearifolia Bremek.	Rubiaceae	L&R	1254	Forest 68 - Wema East4	RK	2	S	
Polysphaeria multiflora Hiern	Rubiaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		5	ST	MRORA
Polysphaeria parvifolia Hiern	Rubiaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		4	S	MRORA
Psychotria amboniana K.Schum. var amboniana	Rubiaceae	R&L	5339	Forest 66 - Bvumbwe South		2	S	
Psychotria amboniana K.Schum. var velutina (Petit) Verdc.	Rubiaceae	R&L	5320	Forest 66 - Bvumbwe South		2	S	
Psychotria capensis (Eckl.) Vatke ssp riparia (K.Schum. & K.Krause) Verdc. var riparia	Rubiaceae	L&R	sr	Forest 65 - Bvumbwe North		4	ST	
Psychotria punctata Vatke	Rubiaceae	L	10708	Forest 65 - Bvumbwe North, Pt 652 - 653	RKC?	2X?	S	MPUGE
Psychotria schliebenii Petit	Rubiaceae	L	10705	Forest 65 - Bvumbwe North, Pt 652 - 653	RK?	3	S	
Psydrax kaessneri (S.Moore) Bridson	Rubiaceae	L	10716	Forest 48 - Kulesa East, Pt 654 - 656	R?	2	SS	
Rytigynia sp L of FTEA?	Rubiaceae	L&R	1247	Forest 65 - Bvumbwe North	R?	1?	S	

Spermacoce sp cf tenuior L.	Rubiaceae	L	10730 A	Forest 56 - Wema East1, Pt 660	RK	5?	WH	2nd for Kenya? (= TPR535)
Uncaria africana G.Don ssp africana	Rubiaceae	L&R	1245	Forest 65 - Bvumbwe North	RK?	5	L	
Citrus aurantifolia (Christm.) Swing.	Rutaceae	L	sr081	Forest 63 - Hewani South1, Pt 670		5	ST	Lime - Escape
Vepris eugeniifolia (Engl.) Verdoorn	Rutaceae	R&L	5334	Forest 66 - Bvumbwe South		3	ST	NDONGORE
Zanthoxylum chalybeum Engl. var chalybeum	Rutaceae	L	sr044	Forest 69 - Mitapani South1, Pt 680		4	T	
Flacourtia indica (Burm.f.) Merr.	Salicaceae	L	sr046	Forest 48 - Kulesa East, Pt 654 - 656		5	ST	MWAMBA NGOMA
Oncoba spinosa Forssk.	Salicaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		5	ST	MPUJU
Scolopia zeyheri (Nees) Harv.	Salicaceae	L	10769	Forest 64 - Hewani South2, Pt 673 - 674	RKC	4	ST	1st Tana District
Azima tetracantha Lam.	Salvadoraceae	R&L	sr	Forest 66 - Bvumbwe South		5	SS	
Dobera loranthifolia (Warb.) Harms	Salvadoraceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		3	T	MUKUPHA, MUKUBFA*. FRTS
Salvadora persica L.	Salvadoraceae	L	sr037	Forest 67 - Lango la Simba, Pt 666 - 66		2X/5	SS	MNFUBFA*
Allophylus rubifolius (A.Rich.) Engl. var alnifolius (Baker) Friis & Vollesen	Sapindaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		4	S	
Blighia unijugata Baker	Sapindaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		4	T	MUBO
Cardiospermum halicacabum L. var halicacabum	Sapindaceae	L	10747	Forest 59 - Hewani East1, Pt 669		5	L	
Chytranthus obliquinervis Engl.	Sapindaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		2	ST	MADANGHUI, MUDJANSUWE
Deinbollia borbonica Scheff. forma glabrata Radlk.	Sapindaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		4	ST	MNKONDONKONDO

Haplocoelum foliolosum (Hiern) Bullock ssp mombasense (Bullock) Verdc.	Sapindaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		2	ST	MHUMBI-MWEUSI
Lecaniodiscus fraxinifolius Baker ssp scassellatii (Chiov.) Friis	Sapindaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		2	T	MHUMBI-MWEUPE, KIWAMBWE-KINKUNDU
Majidea zanguebarica Oliv.	Sapindaceae	L	sr064	Forest 48 - Kulesa East, Pt 654 - 656		3	T	
Paullinia pinnata L.	Sapindaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		5	L	MKAWA
Manilkara mochisia (Baker) Dubard	Sapotaceae	L	sr055	Forest 67 - Lango la Simba, Pt 666 - 66		4	T	MURAIDHE
Mimusops obtusifolia Lam.	Sapotaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		5	T	MNGUVWE
Sideroxylon inerme L. ssp diospyroides (Baker) J.H.Hemsl.	Sapotaceae	R&L	sr	Forest 66 - Bvumbwe South		5	T	
Synsepalum msolo (Engl.) Pennington	Sapotaceae	L&R	sr	Forest 65 - Bvumbwe North	RK	4	T	MCHAMBYA
Harrisonia abyssinica Oliv.	Simaroubaceae	L&R	sr	Forest 65 - Bvumbwe North		4	SS	CHEEWA, MWIYENGWA
Solanum sp	Solanaceae	L	10771	Forest 64 - Hewani South2, Pt 673 - 674		?	S	DULUWAYA
Solanum zanzibarense Vatke	Solanaceae	L	10759	Forest 63 - Hewani South1, Pt 670		3	SS	1st Tana District?
Cola clavata Mast.	Sterculiaceae	L	10723	Forest 48 - Kulesa East, Pt 654 - 656		2	T	MNOFU-WA-NKUKU
Melochia corchorifolia L.	Sterculiaceae	L&R	1252	Forest 65 - Bvumbwe North		4	WH	
Sterculia appendiculata K.Schum.	Sterculiaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		3	T	MFUNE
Sterculia rhynchocarpa K.Schum.	Sterculiaceae	R&L	sr	Forest 66 - Bvumbwe South		3	T	MUKARIKARI, MUKARARI

Synaptolepis kirkii Oliv.	Thymelaeaceae	L	sr039	Forest 69 - Mitapani South1, Pt 680		2	SS	
Grewia capitellata Bojer	Tiliaceae	L	10737	Forest 67 - Lango la Simba, Pt 666 - 66		2	SS	
Grewia densa K.Schum.	Tiliaceae	L	10740	Forest 67 - Lango la Simba, Pt 666 - 66		2	ST	MKOLWE, MKOI, MKOLI*
Grewia kakothamnus K.Schum.?	Tiliaceae	R&L	sr	Forest 66 - Bvumbwe South		4?	S	
Grewia truncata Mast.	Tiliaceae	R&L	5331	Forest 66 - Bvumbwe South		3	S	
Trema orientalis (L.) Blume	Ulmaceae	L	sr041	Forest 61 - Hewani East3, Pt 672		5	ST	
Rinorea elliptica (Oliv.) Kuntze	Violaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		3	ST	MNOFU-WA-NKUKU, MRHIGATI (GWANO)
Ampelocissus africana (Lour.) Merr. var africana	Vitaceae	L	sr004	Forest 57 - Wema East2, Pt 675		4	L	
Cissus phymatocarpa Masinde & L.E.Newton	Vitaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		3	L	MUNEKE
Cissus rotundifolia (Forssk.) Vahl var rotundifolia	Vitaceae	L	sr	Forest 65 - Bvumbwe North, Pt 652 - 653		4	L	MURHABARHABA
Cissus sciaphila Gilg	Vitaceae	L&R	1243	Forest 65 - Bvumbwe North		2	L	
Cyphostemma adenocaule (A.Rich.) Wild & Drummond ssp adenocaule	Vitaceae	L	sr057	Forest 61 - Hewani East3, Pt 672		4	L	
Cyphostemma duparquetii (Planch.) Descoings?	Vitaceae	L&R	sr	Forest 65 - Bvumbwe North		2?	L	
Cyphostemma kirkianum (Planch.) Wild & Drummond ssp kirkianum	Vitaceae	L&R	1244	Forest 65 – Bvumbwe North		3	L	
Cyphostemma sp2	Vitaceae	L	sr032	Forest 56 - Wema East1, Pt 660		?	L	
Rhoicissus revoilii Planch.	Vitaceae	R&L	sr	Forest 66 – Bvumbwe South		5	L	

	Abbreviations:			COLLECTORS		PHYTO-GEOGRAPHIC CODES		
				L = Luke WRQ		1 = Kenyan Coast Endemic		
				L&R = Luke WRQ & Robertson SA		2 = Zanzibar-Inhambane (ZI) Endemic		
				R&L = Robertson SA & Luke WRQ		3 = ZI + 1		
				R&O = Robertson SA & Ochiago		4 = Pan African		
				R&G = Robertson SA & Gabio		5 = Pan Tropical		
				sr = sight record				
						HABIT CODES		
				RARITY		E = Epiphyte		
				R = Rare in World Sense		P = Hemi-parasite		
				RK = Rare in Kenya		F = Fern		
				RKC = Rare on Kenya Coast		H = Herb		
						WH = Woody Herb		
	NB * against local name from Glenday, (2005)					L = Liane or Climber		
						SS = Scandent Shrub		
						S = Shrub		
						ST = Small Tree		
						T = Tree		

Appendix 4. Species Distribution throughout TDIP Forests, IUCN Threat Status & Primate Food Trees
(Families arranged according to modified Bentham/Hooker order as per EAH)
NB : Numbers represent dominance level (Glenday, 2005), highlights represent species not recorded by QL

SPECIES	48	56	57	59	60	61	63	64	65	66	67	68	69	Threat Status	PFT
Azolla nilotica Mett.						X				X					
Marsilea fadeniana Launert?										X				P	
Annona muricata L.				X											
Asteranthe asterias (S.Moore) Engl. & Diels ssp *asterias*	X													P	
Monanthotaxis trichocarpa (Engl. & Diels) Verdc.									X				X	P	
Uvaria leptocladon Oliv. ssp *septentrionalis* Verdc.										X					
Uvaria lucida Benth. ssp *lucida*	X						X	X	X		X	X	X	P	
Nymphaea lotus L.						X									
Anisocycla blepharosepala Diels ssp *tanzaniensis* Vollesen	X					X	X	X	X	X	X	X	X	P	
Cissampelos mucronata A.Rich.		X	X	X		X									
Cissampelos pareira L. var *hirsuta* (DC.) Forman									X						
Cadaba farinosa Forssk. ssp *farinosa*							X				X		X		
Capparis sepiaria L. var *subglabra* (Oliv.) DeWolf													X		
Capparis viminea Oliv.	X					X	X	X		X	X	X	X		
Maerua grantii Oliv.										X					
Maerua holstii Pax	X													P	
Maerua kirkii (Oliv.) F.White	X														
Maerua macrantha Gilg?								X	X	X		X			
Ritchiea capparoides (Andr.) Britten	X	X				X		X	X						
Thilachium thomasii Gilg										X				P	

Rinorea elliptica (Oliv.) Kuntze	3	X	X	X		X	X	X	X	X	X	X	2		
Polygala sadebeckiana Guerke											X				
Glinus oppositifolius (L.) A.DC.							X								
Talinum portulacifolium (Forssk.) Schweinf.	X						X		X	X			X		
Persicaria senegalense (Meisn.)Sojak															
Achyranthes aspera L.	X					X	X		X	X					
Cyathula coriacea Schinz	X						X	X	X	X		X	X	P	
Digera muricata (L.) Mart. ssp *trinervis* C.C.Towns. var *trinervis*															
Gomphrena celosioides Mart.															
Psilotrichum scleranthum Thwaites	X								X						
Pupalia lappacea (L.) A.Juss.									X				X	P? (if var argyrophylla or glabrescens)	
Rosifax sabuletorum C.C.Towns.							X								
Nesaea stuhlmannii Koehne						X			X					P	
Synaptolepis kirkii Oliv.	X							X				X	X	P	
Boerhavia erecta L.						X									
Adenia gummifera (Harv.) Harms var *gummifera*	X								X						
Adenia rumicifolia Engl.?				X											
Coccinia grandis (L.) Voigt	X	X		X		X	X					X	X		
Kedrostis abdallai A.Zimm.															
Kedrostis foetidissima (Jacq.) Cogn.							X								
Momordica trifoliolata Hook.f.	X	X		X		X	X	X	X		X	X	X		
Ochna thomasiana Engl. & Gilg	X						X	X	X	X	X	X		P	
Eugenia capensis (Eckl. & Zeyh.) Sond. ssp *multiflora* Verdc.						X	X	X		X	X			P	
Eugenia nigerina A.Chev.	X						X		X	X	X	X			

Barringtonia racemosa (L.) Spreng.		X	2	X	1	1									
Combretum butyrosum (G.Bertol.) Tul.	X					X	X	X	X	X	X	X	X	P	
Combretum constrictum (Benth.) Laws.	X									X	X			P	
Combretum hereroense Schinz ssp *volkensii* (Engl.) Wickens var *parvifolium* (Engl.) Wickens				X											
Combretum paniculatum Vent. ssp *paniculatum*	X	X	X			X		X	X				X		
Pteleopsis tetraptera Wickens	X	1							X		1	X		P	
Terminalia brevipes Pampan.	X						X	X	X	X	3	X	X		
Cassipourea gummiflua Tul. ? var *ugandensis* (Stapf) J.Lewis	X														
Garcinia livingstonei T.Anderson	5	X	3	X	X	X	1	2	X	X	X	2	4		
Grewia capitellata Bojer	X					X	X	X	X	X	X	X	X	P	
Grewia densa K.Schum.	X			X	5		X	X	X		X		X	P	
Grewia kakothamnus K.Schum.?										X					
Grewia truncata Mast.										X					
Cola clavata Mast.	X							X	X				X	P	
Melochia corchorifolia L.									X						
Sterculia appendiculata K.Schum.	X								X						
Sterculia rhynchocarpa K.Schum.										X	X				
Adansonia digitata		3													
Abutilon pannosum (Forst.f.) Schlecht.	X		X			X	X	X		X	X	X	X		
Abutilon zanzibaricum Mast.							X	X	X				X	P	
Hibiscus calyphyllus Cav.	X														
Hibiscus cannabinus L.															
Hibiscus hildebrandtii Sprague & Hutch.?											X				
Hibiscus micranthus L.f.							X		X		X				

Hibiscus panduriformis Burm.f.															
Thespesia danis Oliv.	4	X				X	X	3	4	X	4	X	X		
Erythroxylum fischeri Engl.	X	2	5					X	X						
Acalypha echinus Pax & K.Hoffm.	X						X	X	X	X		X	X	P	
Acalypha fruticosa Forssk.	X								X						
Acalypha indica L.								X							
Antidesma venosum Tul.							X								
Bridelia cathartica G.Bertol.	X	X	X			X	X	X	X	X	X	X			
Bridelia micrantha (Hochst.) Baill.				X											
Caperonia fistulosa Beille			X			X			X						
Croton menyharthii Pax										X					
Dalechampia scandens L. var *cordofana* (Webb) Muell.Arg.	X	X	X	X		X	X		X	X		X	X		
Drypetes natalensis (Harv.) Hutch. var *leiogyna* Brenan	X							X					X	P	
Erythrococca kirkii (Muell.Arg.) Prain									X						
Euphorbia indica Lam.															
Euphorbia tirucalli L.										X					
Flueggea virosa (Willd.) Voigt ssp *virosa*	X	X	X			X	X	X	X	X	X	X	X		
Phyllanthus reticulatus Poir.			X	X			X	X		X	X				
Phyllanthus somalensis Hutch.										X				P	
Ricinus communis L.						X									
Spirostachys venenifera (Pax) Pax							X	X	1	4	5	5	X		
Suregada zanzibariensis Baill.	X							X	X						
Tragia furialis Bojer	X	X							X						
Tragia hildebrandtii Muell.Arg.							X								

Dichapetalum sp 1 of CFS	X						X	X				X		P (should be listed)	
Afzelia quanzensis Welw.						X									
Caesalpinia volkensii Harms													X		
Cassia abbreviata Oliv. ssp *beareana* (Holmes) Brenan							X	X							
Cynometra lukei Beentje							4		2	1	2	1		EN	
Oxystigma msoo Harms		X	X	2		5								VU	
Parkinsonia aculeata L.								X							
Senna occidentalis (L.) Link									X						
Senna singueana (Delile) Lock		X	X		X	X									
Tamarindus indica L.	X						X								Y
Acacia mellifera (Vahl) Benth.												X			
Acacia pentagona (Schumach. & Thonn.) Hook.f.		X	X			X		X	X				X		
Acacia robusta Burch. ssp *usambarensis* (Taub.) Brenan	1	X					X	X	X	X	X	X	X		Y
Acacia rovumae Oliv.	X														
Acacia senegal (L.) Willd.						X									
Acacia stuhlmannii Taub.						X	X	X							
Acacia zanzibarica (S.Moore) Taub. var *zanzibarica*	X					X	X	X		X				P	
Albizia glaberrima (Schumach. & Thonn.) Benth. var *glabrescens* (Oliv.) Brenan						X		X	X						Y
Albizia saman (Jacq.) F.Muell.										X					
Leucaena latisiliqua (L.) Gillis						X									
Mimosa pigra L.										X	X				
Neptunia oleracea Lour.															
Newtonia erlangeri (Harms) Brenan	X						X	X	X	X				P	
Pithecellobium dulce (Roxb.) Benth.						X									

Prosopis juliflora DC.											X				
Abrus precatorius L. ssp *africanus* Verdc.									X						
Aeschynomene uniflora E.Mey. var *uniflora*										X					
Alysicarpus glumaceus (Vahl) DC. ssp *glumaceus* var *glumaceus*								X		X					
Angylocalyx braunii Harms							X	X						VU	
Clitorea ternatea L.		X		X		X									
Crotalaria laburnoides Klotzsch var l*aburnoides*							X								
Dalbergia vacciniifolia Vatke										X				VU	
Indigofera schimperi Jaub. & Spach var *schimperi*						X	X	X			X		X		
Rhynchosia micrantha Harms						X									
Rhynchosia minima (L.)DC. var *minima*		X													
Rhynchosia sp										X	X		X		
Rhynchosia sublobata (Schumach.) Meikle							X								
Sesbania quadrata Gillett															
Sesbania speciosa Taub.										X				P	
Teramnus labialis (L.f.) Spreng. ssp *arabicus* Verdc.						X									
Flacourtia indica (Burm.f.) Merr.	X														
Oncoba spinosa Forssk.									X				X		
Scolopia zeyheri (Nees) Harv.								X							
Ficus bussei Mildbr. & Burret	X														Y
Ficus natalensis Hochst.	X	X													Y
Ficus scassellatii Pamp. ssp *scassellatii*												X	X		
Ficus sycomorus L.	X	X	4	4	X	2	X	X	X				X		Y
Gymnosporia heterophylla (Eckl. & Zeyh.) Loes.	X						X	X	X	X	X	X	X		

Loeseneriella africana (Willd.) N.Halle var *richardiana* (Cambess.) N.Halle	X							X				X	X		
Maytenus undata (Thunb.) Blakelock	X								X	X					
Salacia erecta (G.Don) Walp.	X	X		X		X	X	X	X			X	X		
Salacia stuhlmanniana Loes.	X						X	X	X	X	X	X	X		
Iodes *usambarensis* Sleumer								X					X	P	
Azima tetracantha Lam.	X						X			X			X		
Dobera loranthifolia (Warb.) Harms	X						X	X	X	X	X	X	X		
Salvadora persica L.		4					X				X				
Ximenia americana L. var *caffra* (Sond.) Engl.										X					
Opilia amentacea Roxb.	X	X					X	X	X	X	X				
Agelanthus sansibarensis (Engl.) Polh. & Wiens ssp *sansibarensis*										X					
Oncella curviramea (Engl.) Danser							X							P	
Scutia myrtina (Burm.f.) Kurz										X	X				
Ziziphus mauritiana Lam.						X									
Ampelocissus africana (Lour.) Merr. var *africana*		X	X												
Cissus phymatocarpa Masinde & L.E.Newton	X						X		X	X	X			P	
Cissus rotundifolia (Forssk.) Vahl var *rotundifolia*	X		X				X	X	X	X	X	X	X		
Cissus sciaphila Gilg	X			X	X	X			X					P	
Cyphostemma sp2	X	X													
Cyphostemma adenocaule (A.Rich.) Wild & Drummond ssp *adenocaule*						X									
Cyphostemma duparquetii (Planch.) Descoings?									X					P	
Cyphostemma kirkianum (Planch.) Wild & Drummond ssp *kirkianum*	X					X			X						
Rhoicissus revoilii Planch.										X					
Citrus aurantifolia (Christm.) Swing.							X								

Vepris eugeniifolia (Engl.) Verdoorn	X								X	X					
Zanthoxylum chalybeum Engl. var *chalybeum*											X		X		
Harrisonia abyssinica Oliv.	X			X		X		X	X				X		
Commiphora africana (A.Rich.) Engl. ?										X					
Commiphora campestris Engl. ssp *glabrata* (Engl.) Gillett	X						X	X			X		X		
Azadirachta indica A.Juss.	X			X		X	X	X		X		X	X		
Ekebergia capensis Sparrm.													X		
Trichilia emetica Vahl	X	X	X	X		X	X		X	X			X		
Allophylus rubifolius (A.Rich.) Engl. var *alnifolius* (Baker) Friis & Vollesen	X						X	X	X	X	X	X	X		
Blighia unijugata Baker	X					X		X	X				X		Y
Cardiospermum halicacabum L. var *halicacabum*				X											
Chytranthus obliquinervis Engl.	X			X	X	3	X	X	X			X	X	VU	
Deinbollia borbonica Scheff. *forma glabrata* Radlk.							X	X	X	X					
Haplocoelum foliolosum (Hiern) Bullock ssp *mombasense* (Bullock) Verdc.	X	X			X		X	X	X	X	X	X		P	
Lecaniodiscus fraxinifolius Baker ssp *scassellatii* (Chiov.) Friis	2						5	X	3	X	X		X	P	
Majidea zanguebarica Oliv.	X							X				X			Y
Paullinia pinnata L.	X		X	X	X	X	X	X	X	X	X	X			
Lannea schweinfurthii (Engl.) Engl. var *stuhlmannii* (Engl.) Kokwaro										X			X		
Mangifera indica L.			X	3											Y
Rhus natalensis Krauss							X	X		X					
Sorindeia madagascariensis DC.	X	X	1	X	3		X	X	X	X	X	3	X		Y
Agelaea pentagyna (Lam.) Baill.	X	X			X				X			X	X		
Alangium salviifolium (L.f.) Wangerin ssp *salviifolium*	X								X						Y
Diospyros abyssinica (Hiern) F.White ssp *abyssinica*	X								X				X		

Diospyros bussei Guerke							X			X				P	
Diospyros consolatae Chiov.										X	X				
Diospyros ferrea (Willd.) Bakh.	X	X					X	X	X	X	X	X	X		
Diospyros greenwayi F.White							X					X		VU	
Diospyros kabuyeana F.White								X					X	P	
Diospyros mespiliformis A.DC.	X	X	X	X		X	X	X	X	X	X	X	X		Y
Diospyros natalensis (Harv.) Brenan	X								X	X		X			
Euclea divinorum Hiern								X		X					
Euclea racemosa Murr. ssp *schimperi* (A.DC.) F.White ?										X	X				
Manilkara mochisia (Baker) Dubard							X				X				
Mimusops obtusifolia Lam.	X	X	X	X	2	4	2	5	X	2	X	X	X		
Sideroxylon inerme L. ssp *diospyroides* (Baker) J.H.Hemsl.										X					
Synsepalum msolo (Engl.) Pennington	X		X	X	X	X			X						Y
Strychnos mitis S.Moore	X	5							X	X		X			
Jasminum fluminense Vell.							X			X					
Adenium obesum (Forssk.) Roem. & Schult.															
Alafia caudata Stapf													X		
Alafia microstylis K.Schum.									X						
Carissa spinarum L.							X		X	X	X	X			
Hunteria zeylanica (Retz.) Thwaites	X	X						X	X						
Landolphia watsoniana Romburgh	X							X	X				X	P	
Oncinotis tenuiloba Stapf	X														
Saba comorensis (Bojer) Pichon	X	X					X		X	X		X			
Schizozygia coffaeoides Baill.				X					X				X		

Strophanthus courmontii Franch.	X	X	X						X						
Marsdenia sp cf *macrantha* (Klotzsch)Schltr.													X		
Pentatropis nivalis (J.F.Gmel.) D.V.Field & J.R.L.Wood							X	X		X	X				
Pergularia daemia (Forssk.) Chiov.			X	X	X				X						
Tacazzea apiculata Oliv.		X					X			X	X				
Tylophora apiculata K.Schum.					X					X				P	
Afrocanthium peteri (Bridson) Lantz												X		P	
Canthium mombazense Baill.										X					
Catunaregam sp nov	X						X							P (should be listed)	
Coffea sessiliflora Bridson ssp *sessiliflora*	X							X	X	X		X		P	
Gardenia volkensii K.Schum. ssp *volkensii*							X	X				X	X		
Geophila repens (L.) I.M.Johnston	X														
Ixora narcissodora K.Schum.	X	X			X	X			X	X		X			
Keetia zanzibarica (Klotzsch) Bridson ssp *zanzibarica*	X	X			X	X		X	X	X		X	X	P	
Kohautia obtusiloba (Hiern) Bremek.							X							P	
Kraussia kirkii (Hook.f.) Bullock	X						X	X	X	X		X		P	
Lamprothamnus zanguebaricus Hiern	X						X	X	X	X	X	X	X	P	
Pavetta linearifolia Bremek.										X		X		VU	
Polysphaeria multiflora Hiern ssp *multiflora*	X	X	X	X	4		3	4	X	X	X	X	3		
Polysphaeria parvifolia Hiern	X						X	X	X	X	X	X			
Psychotria amboniana K.Schum. var *amboniana*										X		X		P	
Psychotria amboniana K.Schum. var *velutina* (Petit) Verdc.										X				P	
Psychotria capensis (Eckl.) Vatke ssp *riparia* (K.Schum. & K.Krause) Verdc. var *riparia*			X		X		X	X			X				
Psychotria punctata Vatke	X								X						

Psychotria schliebenii Petit				X					X				X	P	
Psydrax kaessneri (S.Moore) Bridson	X									X	X	X		P	
Rytigynia sp L of FTEA?			X	X					X					P	
Spermacoce sp cf *tenuior* L.		X													
Uncaria africana G.Don ssp *africana*	X					X			X						
Aspilia mossambicensis (Oliv.) Wild				X											
Blepharispermum ellenbeckii Cufod.?												X			
Eclipta prostrata (L.) L.							X								
Launaea cornuta (Oliv. & Hiern) C.Jeffrey															
Microglossa hildebrandtii O.Hoffm.	X							X	X	X	X	X		P	
Pluchea dioscoridis (L.) DC.		X	X	X		X	X	X		X	X		X		
Pluchea ovalis (Pers.) DC.							X								
Tridax procumbens L.						X									
Vernonia aemulans Vatke?							X								
Vernonia cinerea (L.) Less. var *cinerea*				X			X						X		
Vernonia hildebrandtii Vatke	X					X	X	X					X	P	
Enicostema axillare (Lam.) A.Raynal ssp *axillare*						X			X						
Cordia faulknerae Verdc.	X						X	X	X	X	X	X	X	P	
Cordia goetzei Guerke	X					X	X	X	X		X		4		
Cordia sinensis Lam.			X							X					
Solanum sp								X							
Solanum zanzibarense Vatke							X							P	
Hewittia malabarica (L.) Suresh		X				X			X				X		
Ipomoea aquatica Forssk.						X									

Ipomoea garckeana Vatke		X	X	X		X								P	
Ipomoea shupangensis Baker									X						
Jacquemontia ovalifolia (Vahl) Hallier f.															
Utricularia inflexa Forssk. var *inflexa*										X					
Kigelia africana (Lam.) Benth.	X						X		X			X	X		
Spathodea campanulata P.Beauv. ssp *nilotica* (Seem.)Bidgood ined.						X									
Anisotes sp										X				P? (if A.parvifolius)	
Asystasia ansellioides C.B.Clarke								X							
Asystasia gangetica (L.) T.Anders. s.l.				X					X						
Barleria ramulosa C.B.Clarke forma										X					
Ecbolium amplexicaule S.Moore										X				P	
Elytraria acaulis (L.f.) Lindau											X				
Justicia schimperiana (Nees) Lindau										X					
Justicia stachytarphetoides (Lindau) C.B.Clarke									X	X				P	
Megalochlamys tanaensis Vollesen									X			X		P	
Megalochlamys trinervia (C.B.Clarke) Vollesen							X				X	X		P	
Rhinacanthus gracilis Klotzsch										X					
Ruellia amabilis S.Moore		X						X	X			X	X		
Ruellia patula Jacq.	X						X				X		X		
Basilicum polystachyon (L.) Moench											X				
Clerodendrum acerbianum (Vis.) Benth. & Hook.f.	X						X	X	X	X	X				
Leucas urticifolia (Vahl) R.Br. var *angustifolia* Sebald								X							
Premna velutina Guerke									X			X		P	
Ottelia exerta (Ridley) Dandy										X					

Limnophyton obtusifolium (L.) Miq.										X					
Aneilema calceolus Brenan													X		
Commelina sp cf petersii Hassk.													X		
Commelina benghalensis L.											X		X		
Commelina bracteosa Hassk.							X						X		
Commelina erecta L.									X		X				
Flagellaria guineensis Schumach.	X	X	X			X	X	X	X	X	X	X	X		
Crinum sp															
Scadoxus multiflorus (Martyn) Raf. ssp *multiflorus*									X						
Chlorophytum comosum (Thunb.) Jacq.										X					
Chlorophytum sp								X							
Culcasia orientalis Mayo	X	X		X	X	X	X		X			X	X	P	
Gonatopus boivinii (Decne.) Engl.								X	X						
Pistia stratiotes L.						X				X					
Lemna sp										X					
Sansevieria conspicua N.E.Br.										X					
Sansevieria powellii N.E.Br.									X	X	X				
Borassus aethiopum Mart.	X			X		X	X	X		X	X	X	1		
Elaeis guineensis Jacq.				X											
Hyphaene compressa H.Wendl.										X			X		
Phoenix reclinata Jacq.	X	X	X	1	X	X	X	X	X	X		X	X		Y
Microcoelia exilis Lindl.?										X		X			
Bolboschoenus maritimus (L.) Palla															
Brachiaria 3							X								

Brachiaria xantholeuca?								X							
Cyrtococcum trigonum (Retz.) A.Camus								X							
Oryza eichingeri Peter							X								
Oryza longistaminata A.Chev. & Rochr.															
Panicum maximum Jacq.				X			X			X					
Panicum sp										X				P? (if P.pleianthum)	
Sorghum arundinaceum (Desv.) Stapf				X											
Stenotaphrum dimidiatum (L.) Brongn.							X			X	X	X	X		
TOTAL TAXA RECORDED	**117**	**47**	**33**	**43**	**20**	**71**	**111**	**98**	**121**	**128**	**77**	**77**	**93**		
TOTAL PRIMATE FOOD TREES RECORDED (Y)	**12**	**6**	**6**	**6**	**4**	**6**	**6**	**8**	**9**	**4**	**3**	**5**	**6**		
SIZE Ha. (Wakuluzu, 2005)	**30.4**	**4.0**	**1.6**	**1.6**	**1.9**	**2.5**	**12.2**	**48.5**	**46.2**	**4.9**	**9.9**	**43.1**	**1.2**		

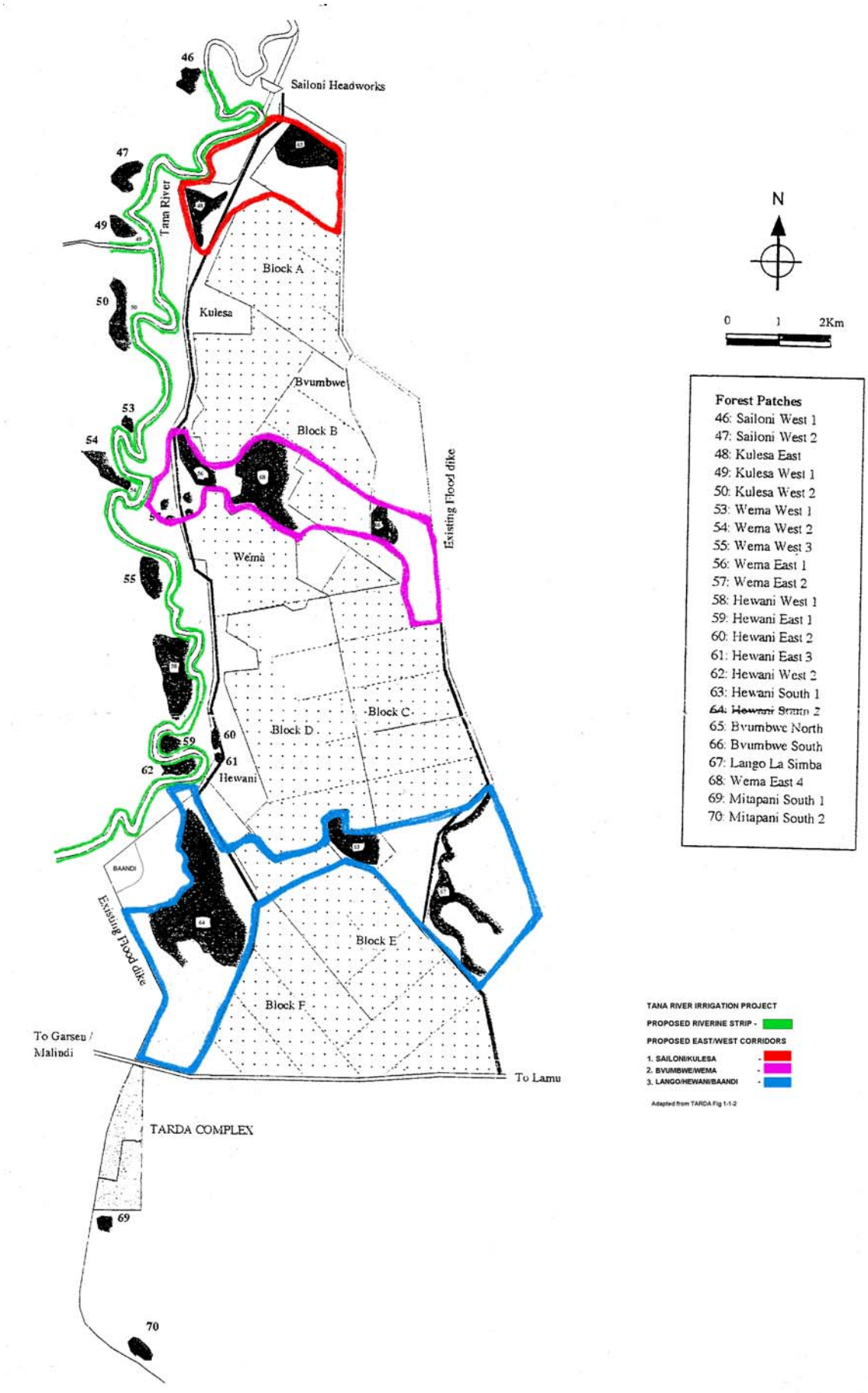
Appendix 5. Tree species - Dominants, Frequencies and Coverage (Glenday, 2005)

Forest #	mean basal area (m3/ha)	mean stem density (trees/ha)	dominant species 1	dom value	Dominant species 2	dom value	dominant species 3	dom value	dominant species 4	dom value	dominant species 5	dom value
48	17.6	1039.9	*Acacia robusta*	42.2%	*Lecaniodiscus fraxinifolius ssp scassellatii*	25.1%	*Rinorea elliptica*	24.9%	*Thespesia danis*	21.6%	*Garcinia livingstonei*	17.6%
56	27.7	1508.9	*Terminalia prunioides*	38.7%	*Erythroxylum fischeri*	35.8%	*Salvadora persica*	29.9%	*Adansonia digitata*	21.7%	*Strychnos mitis*	18.1%
57	41.8	1867.3	*Sorindeia madagascariensis*	48.6%	*Barringtonia racemosa*	33.5%	*Garcinia livingstonei*	20.6%	*Ficus sycomorus*	19.5%	*Erythroxylum fischeri*	15.7%
59	38.4	562.1	*Phoenix reclinata*	65.9%	*Oxystigma msoo*	54.6%	*Mangifera indica*	42.6%	*Ficus sycomorus*	36.9%	*Sorindeia madagascariensis*	26.7%
60	34.2	1138.4	*Barringtonia racemosa*	52.4%	*Mimusops obtusifolia*	51.4%	*Sorindeia madagascariensis*	45.7%	*Ficus sycomorus*	35.8%	*Polysphaeria multiflora*	23.3%
61	16.6	813.2	*Barringtonia racemosa*	70.9%	*Ficus sycomorus*	45.0%	*Chytranthus obliquinervis*	29.5%	*Mimusops obtusifolia*	19.9%	*Oxystigma msoo*	17.5%
63	26.2	562.9	*Garcinia livingstonei*	52.4%	*Cynometra lukei*	39.2%	*Mimusops obtusifolia*	33.9%	*Polysphaeria multiflora*	25.8%	*Terminalia prunioides*	22.2%
64	38.7	526.4	*Garcinia livingstonei*	34.3%	*Terminalia prunioides*	28.7%	*Mimusops obtusifolia*	22.9%	*Cordia goetzei*	21.4%	*Thespesia danis*	17.6%
65	36.6	1217.6	*Spirostachys venenifera*	39.5%	*Cynometra lukei*	24.4%	*Lecaniodiscus fraxinifolius ssp scassellatii*	23.9%	*Mimusops obtusifolia*	19.6%	*Thespesia danis*	15.9%
66	30.1	483.8	*Cynometra lukei*	80.9%	*Mimusops obtusifolia*	48.8%	*Cordia goetzei*	18.8%	*Spirostachys venenifera*	18.1%	*Thespesia danis*	15.9%
67	9.2	808.3	*Cynometra lukei*	37.4%	*Thespesia danis*	34.3%	*Terminalia brevipes*	31.9%	*Terminalia prunioides*	28.5%	*Spirostachys venenifera*	23.3%
68	27.8	1075.4	*Cynometra lukei*	55.8%	*Sorindeia madagascariensis*	32.3%	*Garcinia livingstonei*	29.2%	*Acacia rovumae*	19.2%	*Spirostachys venenifera*	17.6%
69	34.5	882.8	*Borassus aethiopum*	35.0%	*Polysphaeria multiflora*	26.9%	*Rinorea elliptica*	26.8%	*Garcinia livingstonei*	18.1%	*Cordia goetzei*	13.9%

Forest #	frequent species 1	stem density (trees/ha)	% of forest total	frequent species 2	stem density (trees/ha)	% of forest total	frequent species 3	stem density (trees/ha)	% of forest total	frequent species 4	stem density (trees/ha)	% of forest total	frequent species 5	stem density (trees/ha)	% of forest total
48	*Thespesia danis*	597.1	24.5%	*Rinorea elliptica*	597.1	24.5%	*Lecaniodiscus fraxinifolius ssp scassellatii*	597.1	24.5%	*Garcinia livingstonei*	398.1	16.3%	*Acacia robusta*	104.8	4.3%
56	*Erythroxylum fischeri*	796.2	32.8%	*Terminalia prunioides*	597.1	24.6%	*Adansonia digitata*	398.1	16.4%	*Strychnos mitis*	247.8	10.2%	*Polysphaeria multiflora*	207.0	8.5%
57	*Barringtonia racemosa*	1409.5	43.7%	*Garcinia livingstonei*	597.1	18.5%	*Sorindeia madagascariensis*	564.5	17.5%	*Erythroxylum fischeri*	398.1	12.3%	*Ficus sycomorus*	112.1	3.5%
59	*Phoenix reclinata*	398.1	82.0%	*Oxystigma msoo*	63.7	13.1%	*Ficus sycomorus*	15.9	3.3%	*Mangifera indica*	8.0	1.6%	*Deinbollia borbonica*	199.0	7.5%
60	*Barringtonia racemosa*	495.6	37.4%	*Sorindeia madagascariensis*	288.3	21.7%	*Grewia densa*	199.0	15.0%	*Polysphaeria multiflora*	199.0	15.0%	*Mimusops obtusifolia*	103.5	7.8%
61	*Barringtonia racemosa*	1035.5	60.2%	*Chytranthus obliquinervis*	597.1	34.7%	*Ficus sycomorus*	55.7	3.2%	*Sorindeia madagascariensis*	16.3	0.9%	*Oxystigma msoo*	8.0	0.5%
63	*Polysphaeria multiflora*	796.2	23.3%	*Garcinia livingstonei*	696.2	20.3%	*Terminalia prunioides*	414.3	12.1%	*Hunteria zeylanica*	398.1	11.6%	*Phoenix reclinata*	398.1	11.6%
64	*Terminalia prunioides*	4793.2	30.5%	*Thespesia danis*	2693.0	17.1%	*Polysphaeria multiflora*	2006.7	12.8%	*Garcinia livingstonei*	1994.3	12.7%	*Acacia robusta*	852.9	5.4%
65	*Spirostachys venenifera*	3383.7	34.1%	*Thespesia danis*	1592.3	16.1%	*Lecaniodiscus fraxinifolius ssp scassellatii*	1592.3	16.1%	*Hunteria zeylanica*	995.2	10.0%	*Cynometra lukei*	511.2	5.2%
66	*Cynometra lukei*	354.2	57.3%	*Mimusops obtusifolia*	231.5	37.5%	*Spirostachys venenifera*	16.3	2.6%	*Cordia goetzei*	16.3	2.6%	*Cynometra lukei*	511.2	5.2%
67	*Acacia rovumae*	2189.4	24.9%	*Terminalia brevipes*	2047.3	23.3%	*Thespesia danis*	1990.4	22.7%	*Spirostachys venenifera*	812.4	9.3%	*Cynometra lukei*	656.4	7.5%
68	*Garcinia livingstonei*	1281.8	28.4%	*Sorindeia madagascariensis*	973.9	21.6%	*Cynometra lukei*	944.1	20.5%	*Spirostachys venenifera*	446.8	9.9%	*Acacia rovumae*	446.8	9.9%
69	*Rinorea elliptica*	2985.6	40.6%	*Polysphaeria multiflora*	1656.0	22.5%	*Cordia goetzei*	670.1	9.1%	*Sorindeia madagascariensis*	398.1	5.4%	*Rauvolfia mombasiana*	398.1	5.4%

Forest #	coverage spp 1	basal area coverage	% of forest total	Coverage spp 2	basal area coverage	% of forest total	coverage spp 3	basal area coverage	% of forest total	coverage spp 4	basal area coverage	% of forest total	coverage spp 5	basal area coverage	% of forest total
48	*Acacia robusta*	11.2	22.5 %	*Lecaniodiscus fraxinifolius ssp scassellatii*	8.8	17.6 %	*Rinorea elliptica*	8.4	16.8 %	*Sorindeia madagascariensis*	7.8	15.6 %	*Mimusops obtusifolia*	5.8	11.6 %
56	*Terminalia prunioides*	6.9	24.9 %	*Salvadora persica*	5.3	19.0 %	*Adansonia digitata*	4.2	15.3 %	*Strychnos mitis*	3.0	10.7 %	*Acacia robusta*	2.3	8.4%
57	*Sorindeia madagascariensis*	23.6	28.3 %	*Barringtonia racemosa*	19.6	23.6 %	*Ficus sycomorus*	18.0	21.7 %	*Garcinia livingstonei*	8.4	10.0 %	*Mimusops obtusifolia*	7.0	8.5%
59	*Oxystigma msoo*	12.5	50.8 %	*Mangifera indica*	6.4	26.1 %	*Phoenix reclinata*	3.9	15.8 %	*Ficus sycomorus*	1.8	7.4%	*Phoenix reclinata*	8.1	7.8%
60	*Mimusops obtusifolia*	24.2	46.4 %	*Barringtonia racemosa*	10.4	19.9 %	*Sorindeia madagascariensis*	8.0	15.2 %	*Oxystigma msoo*	2.9	5.6%	*Ficus sycomorus*	2.9	5.6%
61	*Barringtonia racemosa*	32.3	52.4 %	*Ficus sycomorus*	19.5	31.7 %	*Mimusops obtusifolia*	5.7	9.3%	*Chytranthus obliquinervis*	2.3	3.8%	*Oxystigma msoo*	1.2	1.9%
63	*Garcinia livingstonei*	41.1	36.7 %	*Mimusops obtusifolia*	25.7	23.0 %	*Cynometra lukei*	15.9	14.2 %	*Phoenix reclinata*	6.3	5.6%	*Spirostachys venenifera*	5.4	4.8%
64	*Garcinia livingstonei*	34.0	18.8 %	*Terminalia prunioides*	23.4	12.9 %	*Sorindeia madagascariensis*	19.8	11.0 %	*Mimusops obtusifolia*	19.6	10.8 %	*Polysphaeria multiflora*	13.3	7.4%
65	*Spirostachys venenifera*	36.9	34.2 %	*Cynometra lukei*	19.3	17.9 %	*Kigelia africana*	7.6	7.1%	*Thespesia danis*	7.2	6.7%	*Mimusops obtusifolia*	6.9	6.4%
66	*Cynometra lukei*	40.5	85.4 %	*Mimusops obtusifolia*	4.3	9.0%	*Cordia goetzei*	1.8	3.8%	*Spirostachys venenifera*	0.8	1.8%	*Mimusops obtusifolia*	6.9	6.4%
67	*Cynometra lukei*	28.2	29.6 %	*Terminalia brevipes*	21.4	22.5 %	*Acacia rovumae*	15.8	16.6 %	*Spirostachys venenifera*	10.0	10.5 %	*Terminalia prunioides*	5.5	5.8%
68	*Cynometra lukei*	55.2	46.8 %	*Garcinia livingstonei*	21.7	19.1 %	*Sorindeia madagascariensis*	17.5	15.4 %	*Acacia rovumae*	8.7	7.7%	*Rinorea elliptica*	4.3	3.7%
69	*Borassus aethiopum*	74.8	52.3 %	*Rinorea elliptica*	21.3	14.9 %	*Polysphaeria multiflora*	11.7	8.2%	*Cordia goetzei*	10.7	7.5%	*Ficus natalensis*	7.0	4.9%

Appendix 6. Proposed River Strip and East/West Corri dors



CENSUS OF THE TANA RIVER RED COLOBUS *(Procolobus rufomitratus*) AND TANA RIVER CRESTED MANGABEY (*Cercocebus galeritus*):

POPULATION AND DISTRIBUTION CHANGES 1972 – 2005

By

Pamela Cunneyworth

SUMMARY

A census was carried out to clarify the conservation status of the Tana River red colobus and Tana River crested mangabey to assess the current situation within a spatial and temporal framework. Intermittent data is available for the 23 forests in the lower Tana River delta area beginning in 1972 with the last census carried out in 2001. The 2001 data shows that approximately 20 groups of red colobus in eleven forests (45.8% of the forests surveyed) and 14 groups of mangabey in nine forests (37.5% of forests surveyed) remained.

This study observed/heard 14 groups of colobus in six forests and in one previously unlabelled forest patch. In addition, a single colobus individual remains in an eighth forest. Total forest patches having colobus is 34.8%. Twelve groups of mangabeys were seen in seven (31.8%) forest patches. The results show a decrease from the 2001 group numbers of six and two groups, for red colobus and mangabeys respectively. The numbers of colobus individuals have reduced significantly from the 1994 census, decreasing from 260 to 127 whereas mangabey individuals have stayed stable (144 in 1994, >149 in 2005).

Colobus distribution has continued with a fairly regular pattern over the census years of two populations, a very small one in the northern part of the TARDA managed area and a larger population centred on forest #58. Colobus were observed in varying forest sizes while mangabeys appear to have favoured the larger forests, as they were found only in the six largest forest blocks censused and two small isolated patches.

GIS maps in this report illustrate forest area surveyed, troop locations for colobus, mangabeys, sykes and baboons. In addition, changes in distribution over time are presented for colobus and mangabeys.

INTRODUCTION

A census of the Tana River red colobus and Tana River crested mangabey in the Tana and Athi River Development Authority (TARDA) area of the lower Tana River delta was carried out between 3rd January and 11th January 2005. The census was carried out to assess the conservation status and distribution of these endemic and endangered species. The assessment is part of an overall project to develop habitat corridors included in the TDIP project.

METHODOLOGY

A primate census was carried out in forests in the TARDA area of the lower Tana River, Kenya. Using the Marsh/Decker forest designation system, 22 patches plus one unnumbered patch were censused: #46 to #69 inclusive, excluding #51 and #52. See Forests Surveyed map.

The field map used for this census was a 19xx TARDA irrigation scheme technical drawing which included delineations of forest boundaries. Forest boundaries in the field were estimated based on change of vegetation generally from forest and isolated trees and bush to bushland or grassland.

Census data was gathered between January 3rd and 11th 2005. Quadratic transect data collection methods (based on Struhsaker, 1981) were used with transect spacing set at 50 metre intervals with field errors ranging ±20 metres. Initially five teams were employed which increased to eight teams on 7th January once the local field technician team from Wenje and the Colobus Trust team had spent time censusing together. During this time, the Colobus Trust team familiarized themselves with vocalisations and behaviours of the colobus and mangabeys. The Colobus Trust team was already competent in the survey techniques. Field teams normally consisted of one field technician responsible for setting the bearing and data collection and one field worker to assist in cutting the transect and observing for monkeys. Two of the eight teams were accompanied by a guard for security purposes.

Morning transects were generally walked between 06:00 and 10:30 while afternoon transects began at 15:00. Only in the largest forest #64 did the teams continue censusing through midday in order to finish the survey before stopping. All forests were censused once.

Teams moved through the forest at a rate of approximately 1km/hr stopping to look for and observe monkeys when sightings were made. At the end of each forest, discussions by the team were undertaken to ascertain any double troop counts. 201 transects were carried out with a total distance of 52.3 km. See Transects Map.

Two data sets were recorded. The first was the transect data set filled in by each field technician at the start and end of transects. The forest name, transect number, GPS start and end locations, bearing and time start and end were recorded.

The second data set was for the recording of primate sightings or vocalisations. The following information was recorded: GPS reading of group location, species, number of individuals counted, estimated number, behaviour of individual/troop, direction of movement and when possible, sex and age,. In addition, quality of group count was indicated (good/incomplete), and whether or not, it was a vocalisation. Counts were generally considered "good" if the troop was seen moving as a whole, often between trees.

Age/sex was found to be difficult to judge accurately in colobus and mangabeys due to a large flight distances. Age/sex was not recorded for sykes and baboons and group size for both species was deemed inconsistent and was not recorded.

Equipment used included three Garmin Etrex Legend GPS's and eight hand bearing compasses of mixed brand but similar good quality.

GIS MAPPING

The use of Geographic Information System (GIS) was key to the analysis of the data collected. ESRI ArcGIS Desktop 8.1 was used to process the data contained in a Microsoft Access database.

Standards are considered important in the presentation of the maps and the following standards apply in order that future field work may relate easily to these maps:

- Map Projection: The projection of the maps is Transverse Mercator, with the Clarke 1880 Spheroid, and ARC 1960 Datum.
- Unit of measure is Metres
- Grid system is Universal Transverse Mercator, Zone 37 South
-

These standards are identical to those used on all topographic maps published by the Survey of Kenya, and therefore all GPS co-ordinates and grid references can be used with those publications.

The analysis of the data resulted in five maps being produced that display the results clearly. Each map is explained in detail in the following sections.

Forests Surveyed Map

The areas that are shown as forest are actual areas that were censused by transects. These "forests" were mosaics of open and closed canopy forest and bush and grassland and cannot be considered actual forest size though it does give an indication of the reduction of forest habitat from that indicated on the 19xx map.

The boundary of the forest displayed on this map is determined by tracing the transect start and end points which indicate the beginning and end of the forest. For this reason the boundaries and therefore the stated forest area sizes can only be considered estimates.

These maps also display the extent of the overall census area, and defines the current path of the Tana River and the main infrastructure.

Please note that these maps are very high resolution, and printouts on a standard office printer may not allow the clearest view. In that case refer to the supplied PDF versions of the maps that will allow a high degree of zoom.

Transects Map
This map displays transects that were performed during the census period. The start point of a transect is marked with a triangle and the end of a transect is marked with a disc.
This data is the source of the forest boundaries.

Troop Locations Map
Spatial distribution of the four primate species (colobus, mangabey, baboon, sykes) is displayed with this map. Each species has a unique identifier and for each observation in the census data a mark is displayed on the map. Each mark represents one troop or a solitary individual.

This map enables simple observation of spatial trends such as clustering of species in certain areas.

Tana River Red Colobus Map
Temporal trends of number of troops per forest over time for each forest for colobus are displayed on this map.

Each column chart displayed on each forest shows the number of troops observed in that forest in a given year (e.g. Forest #61, in 1994 one troop of colobus was observed). With all the years displayed side by side the trend of the population in that forest can be observed.

Please note that due to a limitation of the GIS software, the bar graphs consider that an observation of zero troops to be the same as an observation of forest not censused. These two categorisations are very different, and display on the map as a zero reading. Please refer to Table 6 for data on troop counts from census records 1972-2005.

Tana River Crested Mangabey Map
As above. Please refer to Table 7 for data on troop counts from census records 1972-2005.

RESULTS

Forest Size and Location
The current study covered 67.8% of the 1994 census area but only 29.4% of the study in 2001 (see Table 14). It is clear that differences in the area censused between studies is likely to be a result of differences in the definition of "forest" as well as differences in methodologies and accuracy of estimates and measurements. Interestingly, though the forest area covered in the 2005 study is markedly less than that of the other censuses, the troop numbers have remained fairly consistent indicating that the core areas of troop locations are being captured in the main forest patches of the area.

In some respects, forest areas generated by the transect end points of this census more closely resembles the forest boundaries provided by Karere *et al.* (2004). Main differences are in the forests #56, 63 and 67, all three of which have 'a' and 'b' sections of which the b sections were not censused in this study. The shape of #67, Lango La Simba appears to be more representative of the TARDA technical drawing forest shape rather than that in the 2001 map.

Unusual discrepancies between patch size in the 1994 and 2005 survey are marked in forest #48a. This forest was acacia woodland and considerable effort was made prior to the survey to define the start boundaries of transects in the surrounding bushland.

Forest #64 shows a significant reduction in forest size from the TARDA technical drawing and what is listed in the 1994 and 2001 census. However, the overall shape of the forest is consistent with that of the 2001 map.

The remnant patch of #62 has been entirely cleared for cultivation as has been noted by Muoria *et al.* (2003).

Table 14. Area surveyed in ha by forest number with corresponding human activity levels.

Forest Name	Forest #	1994[1] (ha)	2001[2] (ha)	2005[3] (ha)	Human Activity[1] 1994	Human Activity 2003[4]
Sailoni 1	46	5	12.50	2.83	light	
Sailoni 2	47	3	28.20	3.11	light	
Kulesa East 1	48a	30*	19.30	30.40	heavy	
Kulesa West 1	49	1	11.10	3.76	light	
Kulesa West 2	50	2	28.10	2.18	light	
Wema West 1	53	2	7.60	2.89	light	
Wema West 2	54	14	18.50	11.34	moderate	
Wema West 3	55	13	45.10	16.86	moderate	light
Wema East 1	56	22	28.10	4.00	heavy	clearing
Wema East 2 (d)	57	5	15.90	1.59		heavy
Hewani West 1	58	34	65.70	20.83	light	clearing
Hewani East 1	59	3	11.40	1.57	moderate	clearing
Hewani East 2	60	2	4.20	1.90	light	moderate
Hewani East 3	61	1	9.60	2.35	light	clearing
Hewani West 2	62	16	10.10	0.00	light	clearing
Hewani South 1	63a	17	17.00	12.16		moderate
Hewani South 2	64	124	116.40	48.51	moderate	
Bvumbwe North	65	53	136.50	46.16	heavy	
Bvumbwe South	66a	4	178.10	4.94		
Lango La Simba	67	15	79.20	9.88		
Wema East 4	68	63	63.20	43.14		clearing
Mitapani 1	69	3	27.00	1.15	heavy	light
Unknown forest				2.92		
Total Forest Area Surveyed		405.00	932.80	274.48		

** forest 48a area corrected from the original figure of 3ha to the correct 30ha (Luke pers com)*

1 Butynski and Mwangi, 1994
2 Karere et al. 2004
3 This study
4 Muoria et al., 2003

Spatial Distribution

The distribution of the four primate species observed during the census are indicated in Table 2 and Troop Locations Map. In total, 57 groups and two solitary (S) individuals were noted of which 14 +1S were colobus, 12 were mangabeys, 19 +1S were sykes and 12 were baboons. Colobus occur in six forests and in one previously unlabelled forest patch. In one forest, a single individual remains. A total of 34.8% forest patches contain at least one colobus monkey. Mangabeys were seen in seven (31.8%) forest patches.

From estimates of group size in the field, the number of individuals in the troops observed was 127 colobus and 149 mangabeys in the TARDA managed area. Vocalisations were not accounted for in these estimates.

Table 15. Number of troops and estimated number of individuals of primates in the TARDA managed areas.

Forest	Forest #	# of troops of Colobus (est. troop size)	# of troops of Mangabey (est. troop size)	Sykes	Baboon
Sailoni 1	46	0	1 (20)	1	0
Sailoni 2	47	0	0	0	1
Kulesa East 1	48a	0	1 (15)	3	1
Kulesa East 2	48b	NC	NC	NC	NC
Kulesa West 1	49	1 (8)	0	1	0
Kulesa West 2	50	0	0	1	0
Wema West 1	53	0	0	1	1
Wema West 2	54	0	0	0	0
Wema West 3	55	1 (8)	0	1	1
Wema East 1	56	0	0	0	1
Wema East 2	57	0	0	1	0
Hewani West 1	58	7 (7,8,8,9,10,12,17)	3 (3,20,V)	2	1
Hewani East 1	59	1 (7)	0	0	1
Hewani East 2	60	2 (4,7)	0	1	0
Hewani East 3	61	0	0	0	0
Hewani West 2	62	-	-	-	-
Hewani South 1	63	0	0	0	1
Hewani South 2	64	1 (9)	4 (10,20,35,V)	2	1
Bvumbwe North	65	0	1 (15)	1	1
Bvumbwe South	66	0	0	0	0
Lango La Simba	67	1S	0	1	0
Wema East 4	68	0	1 (6)	21S	1
Mitapani 1	69	0	1 (5)	1	0
Mitapani 2	70	NC	NC	NC	NC
Unknown		1 (16)	0	0	1

NC – not censused
V – vocalisation

For the most part (except forest 46 and #69), mangabeys were sighted in the six largest forest patches (#48a, 55, 58, 64, 65, 68). This makes the population highly fragmented and prone to genetic isolation due to the distances between these forest patches. However, there may be some movement between forests as perhaps the troop of mangabeys seen in forest #49 in 2001 is the same troop as observed in forest #46 in 2005.

Colobus on the other hand, were found in forests of varying size. There is a clear concentration of colobus between forest #55 to the north and #64 to the south and on the west side of Tana River and on the east side between the river and the road. Clearly the centre of the population is in forest #58. A much smaller population lies in the northern part of the TARDA managed area where two troops were found but as obligatory arborealists, group isolation likely exists between the two populations and between populations on the east and west side of the river.

Temporal Trends

Overall, for both colobus and mangabeys, their ranges have changed over time. For colobus, the distribution has remained in a similar pattern with two populations, a very small one to the north in the forest block of #46, 47 and 49 and one to the south centred on forest #58. There appears to be an increasing trend of red colobus troops in forest #58 perhaps due to the complete loss of forest #62. The range restriction generally comes from the loss of groups in outlier and isolated forests, specifically forests #48, 53, 54, 56, 63, 67, 68.

Even for colobus, an obligatory arboreal species, riverine forest, isolated trees and small forest patches may provide adequate tree cover to allow for dispersal between larger forest patches explaining the changes of pattern of troop locations through time, with due consideration to census error. Possible seasonal changes of movement must also be taken into account.

On the other hand, mangabeys previously appeared throughout the census area in all but seven (31.8%) of the forests. As recorded in this census, their range has expanded into forests that previously did not report mangabeys (forest #46 and #69). Nine forests (40.9%) with previous records of mangabey did not have mangabeys noted in 2005. Interestingly, three troops are missing from the forests on the west side of the river (#54, 59, 62) in the vicinity of forest #58 while forest #58 has three troops more than previously reported in the 2001 census. Inter-forest movement of groups may account for this.

Comparing the forest area of the current census to the map of forest areas generated by Karere *et al.* (2004), this survey did not census the northern portion of forest #56 or 63b, 67b. Interestingly, two troops of colobus accounted for in the 2001 study (one each in forest #63 and #67) that were not counted in this census, come from these forests. It is possible, that these uncounted troops were previously observed in these uncensused forest patches. Complete loss of both species of primate has occurred in five of the 22 areas censused (22.7%) however only Wema West 2 (#54), had both species missing. This forest was noted in 1994 for having "moderate human activity".

The other forests which had complete loss of groups, either colobus or mangabey had varying levels of human activity as noted in Table 3. Please note that the activity level noted in Table 5 may well have changed from 1994 description as it has been stated that forest clearing has escalated since then (Wieczkowski *et al.*, 2002). There may not be a direct relationship between forest disturbance and primate group density but that disturbance may lead to reduced group sizes rather than a reduction in troops (Muoria *et al.,* 2003).

Table 16. Levels of disturbance in forests that have lost colobus and mangabeys in this census.

Colobus			Mangabey		
Forest #	**Human Activity**	**Reference**	**Forest #**	**Human Activity**	**Reference**
47	Light	Butynski and Mwangi 1994	49	light	Butynski and Mwangi 1994
48	Heavy	Butynski and Mwangi 1994	54	moderate	Butynski and Mwangi 1994
54	Moderate	Butynski and Mwangi 1994	56	cleared areas	Muoria *et al.,* 2003
63	Moderate	Muoria *et al.,* 2003	57	heavy	Muoria *et al.,* 2003
68	cleared areas	Muoria *et al.,* 2003	59	cleared areas	Muoria *et al.,* 2003

Table 17. Red colobus census data 1972 – 2005. Adapted from Appendix A Butynski & Mwangi 1994.

Forest #	Forest	1972/74	1975	1985	1986	1987	1989	1990	1992	1994	2000	2001	2005	Est. ind.
46	Sailoni 1	0								1	NC	0	0	0
47	Sailoni 2	0								0	NC	1	0	0
48a	Kulesa East 1		0					1	0	0	NC	2	0	0
48b	Kulesa East 2		0							0	NC	0	NC	NC
49	Kulesa West 1		0							0	NC	1	1	8
50	Kulesa West 2									0	NC	0	0	0
53	Wema West 1		0	0						1	NC	0	0	0
54	Wema West 2		0							1	NC	2	0	0
55	Wema West 3	some								1S	0	0	1	8
56	Wema East 1	0	1	0	1	0	2	1	0	0	0	0	0	0
57	Wema East 2	0	0						0		0	0	0	0
58	Hewani West 1	some	1	0	0	1		1	1	3	6	5	7	67
59	Hewani East 1	some	0	0	1	1S			1	1	1	1	1	7
60	Hewani East 2	some	1	1	1	2			1	1	1	1	2	11
61	Hewani East 3		1	1	0	1	1		1	1	0	0	0	0
62	Hewani West 2	some	1	0					1	1	1	0	0	0
63	Hewani South 1	0	0		0	0			0		3	1	0	0
64	Hewani South 2	8	5	0	1-2	2			3	10-13 1S	NC	4	1	9
65	Bvumbwe North	0							0	0	NC	0	0	0
66	Bvumbwe South	0									NC	0	0	0
67	Lango La Simba	2	0						2	(2)	NC	1	1S	1
68	Wema East 4	0	0								0	1	0	0
69	Mitapani 1								0	1S	0	0	0	0
70	Mitapani 2								2	3	0	0	NC	NC
	Unknown forest												1	16
	Total:											**20**	**14+1S**	**127**

S - solitary individual

NC - not censused

Data taken from:

1972 Groves et al., 1974; Andres et al., 1975
1974 Homewood, 1976
1975 Marsh 1976, 1986
1985 Marsh, 1985
1986 and 1987 Decker & Kinnaird, 1991; Decker, 1994
1989 and 1990 Ochiago 1990, 1991
1992 Decker, 1994
1993 Kahumbu & Davies, 1993
1994 Butynski and Mwangi, 1994
2000 Muroia et al. 2003
2001 Karere et al., 2004
2005 This report

Table 18. Crested mangabey census data 1972 – 2005. Adapted from Appendix B Butynski & Mwangi 1994.

Forest #	Forest	1972/74	1975	1985	1986	1987	1989	1992	1994	2000	2001	2005	Est. ind.
46	Sailoni 1	0							0	NC	0	1	20
47	Sailoni 2	0							1	NC	0	0	0
48a	Kulesa East 1		0					0	1	NC	1	1	15
48b	Kulesa East 2		0						0	NC	0	NC	NC
49	Kulesa West 1		0						0	NC	1	0	0
50	Kulesa West 2								0	NC	0	0	0
53	Wema West 1		0	0					0	NC	0	0	0
54	Wema West 2		0						1-2	NC	2	0	0
55	Wema West 3	some							0	0	1	0	0
56	Wema East 1	0	1	1	1-2	1	1	0	0	0	0	0	0
57	Wema East 2	some	0					0		0	1	0	0
58	Hewani West 1	some	1	1	0	0	1	1	1	2	0	3	>23
59	Hewani East 1	some	0	0	0	0	0	0	0	1	1	0	0
60	Hewani East 2	some	0	0	0	0	0	0	0	0	0	0	0
61	Hewani East 3		0	0	0	0	0	0	0	0	0	0	0
62	Hewani West 2	1	1	1			0	1	1	1	0	0	0
63	Hewani South 1	0	0		0	0		0		0	0	0	0
64	Hewani South 2	2	2	2	1-2	1	1	3	4	NC	4	4	>65
65	Bvumbwe North	0						0	0	NC	1	1	15
66	Bvumbwe South	0								NC	0	0	0
67	Lango La Simba	some	0					0	0	NC	0	0	0
68	Wema East 4	0	0							3	2	1	6
69	Mitapani 1							0	0	0	0	1	5
70	Mitapani 2							0	0	0	0	NC	NC
	Total:										14	12	>149

NC - not censused

Data taken from:														
1972 Groves et al., 1974; Andres et al., 1975			1985 Marsh, 1985					1992 Decker, 1994			2000 Muroia et al. 2003		
1974 Homewood, 1976			1986 and 1987 Decker & Kinnaird, 1991; Decker, 1994					1993 Kahumbu & Davies, 1993			2001 Karere et al., 2004		
1975 Marsh 1976, 1986			1989 and 1990 Ochiago 1990, 1991					1994 Butynski and Mwangi, 1994			2005 This report		

Table 19. Spatial distribution and temporal trend notes by forest.

Forest #	Forest Name	Comment
46	Sailoni West 1	The one troop of red colobus reported in 1994 has not been reported since. A troop of mangabeys was observed that hadn't been seen here before and should be considered to be a genetically isolated group. The only other mangabey troop in this area that could possibly be the troop sighted, is the troop in forest patch #49, recorded in 2001. This is only one of two small forest patches where mangabeys were found; the other forest patch is #69.
47	Sailoni West 2	
48a	Kulesa East	All species recorded have been recorded for forest #48a. #48b was not located and no troop sightings were recorded in #48b from the 1994 and 2001 census for either colobus or mangabey.
48b	Kulesa East	As above.
49	Kulesa West 1	The mangabey troop recorded in this forest in 2001 may have moved to forest patch #46.
50	Kulesa West 2	No troops were found here previously or during the current census.
53	Wema West 1	After mapping, we recognise that this is not the location of forest #53. The forest should be located further south. One troop of red colobus had been seen in forest #53 in 1994 but not in 2001.
54	Wema West 2	Though this patch has not decreased considerably between the 1994 and 2005, no troops at all were observed.
55	Wema West 3	One troop of colobus was observed which hadn't been seen in 2000 or 2001.
56	Wema East 1	Patch #56 has reduced in size markedly from 22 ha in 1994 to 4 ha in 2005. Likely due to the massive human activity, mangabeys appear to have moved from patch #56 to #69 as in earlier censuses, troops were found in #56 but not #68 however in later census work, the reverse is true.
57	Wema East 2	Two of these small patches have been reduced to isolated trees.
58	Hewani West 1	This was by far the most interesting forest patch. Monkeys abound here. Colobus were more than double the numbers observed in 1994 from three to seven while mangabey numbers increased from two in 2000 to three groups. Of all the forests, forest #58 shows a clear trend of increasing troop numbers over time.
59	Hewani East 1	This patch has a core area of forest and is surrounded by mango trees with much human activity. Only the forest area was censused.
60	Hewani East 2	In 1994, there was one troop of colobus in each forest – #60 and #61. This census showed that perhaps the troop from #61 has now moved to #60 though the second troop was not recorded during the 2000 or 2001 work. #60 and #61 are separated by a gap of grass and bushland.
61	Hewani East 3	As above
62	Hewani West 2	This forest is completely gone along with one troop each of colobus and mangabey both seen in 2000 but not in 2001 or during this study.
63	Hewani South 1	This patch shows a progressive decrease in colobus troops from three in 2000 to 1 in 2001 and zero in 2005.
64	Hewani South 2	Strangely, the 10-13 groups of colobus sighted in 1994 were not found. Instead only four groups were seen in 2001 and one troop in 2005. Mangabeys have maintained a constant level of four troops since 1994.
65	Bvumbwe North	One mangabey troop seems to have moved into this patch prior to 2001 and still remains. Little decrease in forest area was seen since 1994.
66	Bvumbwe South	From our mapping, this forest appears to be further south that the field map we were using. Could the field map be misreported as we did not see any other forest in the vicinity? Regardless, there were no colobus or mangabey previously reported in this forest.

67	Lango La Simba	One of the "old channel forests". Previously this forest had one troop of colobus, but during this survey, only one solitary adult was seen. The other "old channel forest", Hewani South 2 (#64) also had a reduction in colobus numbers. Further census will show if indeed there is a trend between loss of colobus in this type of forest as has been seen in senescent and dying forests #30, 33, 41, 45, 51, 52 along Channel 1 (Butynski and Mwangi, 1994). This forest had a high buffalo population. There is a possibility that troops were missed by teams looking more closely for buffalo than for monkeys though all teams had been increased from two to four members to increase the number of people looking for both buffaloes and monkeys.
68	Wema East 4	Curiously, mangabeys have not been previously sighted in this large forest until this survey. The move of a troop to this forest from nearby #56 which had steady sightings of mangabeys until 1989.
69	Mitapani South 1	Four elephants in this forest. Though four transects were started, only one was completed. One mangabey troop was sighted. This group is probably genetically isolated from the main concentration of mangabeys to the north.
70	Mitapani South 2	This forest was very difficult to find due to the change of the river course and the lack of canoes to transfer the team to the other side. Therefore, this forest was not censused however in the 2000 and 2001 censuses, neither red colobus nor mangabey were observed.
	Unknown forest	Although this forest is not on the original list of forests to census, we observed a group of colobus while we were in the area.

Status and Distribution of Sykes Monkeys and Yellow Baboons

Tana River sykes monkey (*Cercopithecus mitis albotorquatus)* and yellow baboons *(Papio cynocephalus cynocephalus)* were observed throughout the census area. Nineteen troops and one solitary adult of sykes and twelve troops of baboon were recorded. Other groups were seen outside forest patches. Due to the inconsistency of counts of individuals, this information was not collected for either sykes or baboon.

RECOMMENDATIONS

In the light of the survey carried out and the subsequent observations, the following brief recommendations are made:

1. Assessments should be made on the two groups of colobus in the northern section of the census area to determine their long term survival risk and to review potential management strategies to incorporate them into the main population area depending on appropriate available forest habitat.
2. Forest #58 and #64 are important for mangabeys as they are the only forests with more than one troop (three and four respectively), only #58 had significant troop numbers of both mangabeys and colobus making it the most crucial forest in terms of requirements for conservation.
3. An assessment should be made to establish the suitability of erecting *colobridges* between isolated trees, between forest patches and over the Tana River to provide habitat corridors. Since 1997, *colobridges* have been successfully providing habitat connectivity in the Diani area (150,000 crossings per year for 22 *colobridges*). This could be an additional tool in developing corridors at the early stage, and for enabling connectivity between forest patches across barriers such as the Main Canal, Tana River and Main Access Roads.

FOREST REFERENCE CHART

The following chart serves as a reference for use with the supplied maps. Forest numbers are translated to forest names, and also the UTM Grid coordinates are given for each forest to enable future surveys to understand the forests censused.

Table 20. Forest reference.

Forest #	Forest Name	Easting[1]	Northing[2]
46	Sailoni 1	630269	9762082
47	Sailoni 2	629320	9760870
48a	Kulesa East 1	630270	9760824
49	Kulesa West 1	629306	9760230
50	Kulesa West 2	629430	9758876
53	Wema West 1	629978	9758220
54	Wema West 2	629202	9757212
55	Wema West 3	629734	9755858
56	Wema East 1	630388	9757212
57	Wema East 2 (d)	630392	9756766
58	Hewani West 1	630361	9754890
59	Hewani East 1	630101	9753874
60	Hewani East 2	630774	9753962
61	Hewani East 3	630897	9753716
62	Hewani West 2	630108	9753566
63	Hewani South 1	632347	9752502
64	Hewani South 2	630829	9752250
65	Bvumbwe North	631670	9761054
66	Bvumbwe South	633425	9755526
67	Lango La Simba	633787	9751614
68	Wema East 4	631569	9756966
69	Mitapani 1	629536	9747674
0	Unknown forest	630526	9761374

1 Easting using Grid: UTM Zone 37 South, Datum ARC 1960

2 Northing using Grid: UTM Zone 37 South, Datum ARC 1960

FIELD TEAM MEMBERS

An excellent team was developed for this survey. Team members included supervisory and technician staff from the Colobus Trust, as well as technician staff from Wenje who have participated in many of the previous surveys in this area, both at TARDA and also from the Mchelelo Research Station at TRPNR.

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REFERENCES

Andres, P., Groves, C.P. & Horne, J.F.M., 1975. Ecology of the lower Tana River flood plain (Kenya). *J. East Afr. Nat. Hist. Soc & Nat. Mus.* 151:1-31.

Butynski, T. M., and Mwangi, G., 1994. *Conservation Status and Distribution of the Tana River Red Colobus and Crested Mangabey*, Report for Zoo Atlanta, KWS, NMK, IPR and EAWLS.

Butynski, T. M., Mbora, D. M., Kirathe, J. N., and Wiesczowski, J., 2000. *Group Sizes and Composition of the Tana River Red Colobus and Tana River Crested Mangabey*, Report for KWS, NMK and GEF.

Decker, B.S. & Kinnaird, M.F. 1992. Tana River red colobus and crested mangabey: Results of recent censuses. *Am. J. Primatol.* 26:47-52.

Decker, B.S. 1994. Effects of habitat disturbance on the behavioural ecology and demographics of the Tana River red colobus (*Colobus badius rufomitratus*). *Int. J. Primatol.* 26:47-52.

Groves, P.G., Andrews, P. & Horne, J.F.M. 1974. The Tana colobus and mangabey. *Oryx* 12: 565-575.

Homewood, K.M. 1975. Can the Tana mangabey survive? *Oryx* 13:53-59.

Homewood, K.M. 1976. The ecology and behaviour of the Tana mangabey. PhD Dissertation, University College, London.

Kahumbu, P., and Davies,G. 1993. Tana River National Reserve: Primate census. March 1993. *East Afr. Nat. Hist. Soc. Bull.* 23: 35–44.

Karere, G. M., Oguge, N. O., Kirathe, J. Muoria, P. K., Moinde, N. N., and Suleman, M. A., 2004. Population Sizes and Distribution of Primates in the Lower Tana River Forests, Kenya. *International Journal of Primatology, Vol. 25, No. 2.*

Kinnaird, M. F., and O'Brien, T., 1991. Viable populations for an endangered forest primate, the Tana River crested mangabey (*Cercocebus galeritus galeritus*). *Cons. Biol.* 5: 203–213.

Marsh, C. W. 1976. *A Management Plan for the Tana River Game Reserve*. Report to the Kenya Department of Wildlife Conservation and Management, Nairobi.

Marsh, C.W. 1985. *A resurvey of Tana River primates.* Unpublished report to the Institute of Primate Research, Kenya.

Marsh, C.W. 1986. A resurvey of Tana River primates and their habitat. *Primate conserv.* 7:72-82.

Muoria, P. K., Karere, G. M., Moinde, N. N., and Suleman, M. A. 2003. Primate census and habitat evaluation in the Tana delta region, Kenya. *Afr. J. Ecol*. 41: 157–163.

Ochiago, W.O., 1990. The Tana River red colobus (*Colobus badius rufomitratus*). *Utafiti* 3:1-5.

Ochiago, W. O. 1991. *The demography of the Tana River red colobus, Colobus badius ruformitratus.* MSc, Thesis, University of Nairobi, Nairobi, Kenya.

Struhsaker, T. T., 1981. Census methods for estimating densities. In *Techniques for the Study of Primate Population Ecology*, National Academy Press, Washington, DC.

Wieczkowski, J., Mbora, D.N.M., Kariuki, A., and Strum, S., 2002. *Tana River primate and habitat monitoring project*. Progress report for Conservation International – Margot Marsh Biodiversity Foundation.

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CRITICAL ECOSYSTEM PARTNERSHIP FUND

The Critical Ecosystem Partnership Fund (CEPF) is a joint initiative of Conservation International, the Global Environment Facility, the Government of Japan, the John D. and Catherine T. MacArthur Foundation and the World Bank. A fundamental goal is to ensure civil society is engaged in biodiversity conservation.

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